Product Liability Influences Incentives for Horizontal Mergers

Andreea Cosnita-Langlais
Tim Friehe
Eric Langlais

2024-10 Document de Travail/ Working Paper

EconomiX - UMR 7235 Bâtiment Maurice Allais
Université Paris Nanterre 200, Avenue de la République
92001 Nanterre Cedex

Site Web : economix.fr
Contact : secreteriat@economix.fr
Twitter : @EconomixU

Product Liability Influences Incentives for Horizontal Mergers

Andreea Cosnita-Langlais* Tim Friehe† Eric Langlais‡

March 20, 2024

Abstract

This paper shows how product liability rules influence merger incentives. Consumers' product risk misperception critically influences which liability rule induces the strongest merger incentives. When consumers overestimate product risk, merger incentives under negligence and strict liability are similar and weaker than under no liability. When consumers underestimate product risk, merger incentives under negligence are weaker than those under strict liability but stronger than those under no liability.

Keywords: Liability; Merger; Cournot; Market Structure.
JEL classification: K13, L13.

*EconomiX UMR 7235 CNRS & Paris Nanterre, 200 Avenue de la Republique, 92001 Nanterre cedex, France. E-mail: acosnita@parisnanterre.fr.

†University of Marburg, Public Economics Group, Am Plan 2, 35037 Marburg, Germany. CESifo, Munich, Germany. E-mail: tim.friehe@uni-marburg.de.

‡EconomiX UMR 7235 CNRS & Paris Nanterre, 200 Avenue de la Republique, 92001 Nanterre cedex, France. E-mail: eric.langlais@parisnanterre.fr..

1 Introduction

Product liability - the liability of producers for the harm they cause to their consumers - is a significant legal institution in Europe and the United States. It is meant to improve product safety, cause the prices of products to reflect their risks, and compensate consumers (e.g., Polinsky and Shavell 2010). Empirical studies document that the design of product liability rules is relevant for economic activity, such as levels of employment and R&D expenditures (e.g., Geistfeld 2009, Shepherd 2013, Viscusi and Moore 1993), and that the onset of product liability litigation can significantly alter firm value (Prince and Rubin 2002). This profound impact of product liability on important market outcomes makes studying the interrelationship of product liability and market structure relevant.

Traditional law & economics analyses find that liability policy need not be market-specific as firms' safety levels are independent of the market structure (e.g., Daughety and Reinganum 2013, 2018). However, subsequent contributions emphasize that the specifics of the market may be critical for the performance of product liability. For example, in Daughety and Reinganum (2006), the degree of product substitution determines the safety incentives of strictly liable Cournot firms. In Chen and Hua (2017), optimal liability may vary non-monotonically with the number of competitors. Such articles thus suggest that the liability rule may have to be modified when the market specifics change. In contrast, this paper asks whether the market structure changes when the applicable product liability rule varies. For this, we examine how product liability rules influence the profitability of horizontal mergers.

This paper analyzes the profitability of a horizontal merger when Cournot firms are subject to either strict liability, negligence, or no liability.[1] Merging is an essential competitive strategy with a substantial impact on the welfare a specific market generates (e.g., Asker and Nocke 2021, Fauli-Oller and Sandonis 2018). Horizontal mergers reduce the number of competitors and can thus have welfare-decreasing price effects.[2] Without efficiency effects, a merger's profitability

[1]Mergers are more frequent in specific industries. Using the M&A Statistics of the *Institute for Mergers, Acquisitions, & Alliances*, for example, much activity can be found in motor vehicles, pharmaceuticals, chemicals, and retail. At the same time, product liability is more relevant in some industries than others, where the former surely also includes the pharmaceutical, motor vehicles, and chemical industries (e.g., Philipson and Sun 2008). In other words, merger activity seems relevant in industries where product liability provides significant incentives.

[2]Farrell and Shapiro (1990) show that a horizontal merger without synergies is necessarily price-increasing and profitable only when the insiders' joint market share is large enough. Regarding welfare, Nocke and Schutz (forthcoming) show for the Cournot model with homogeneous goods and no cost savings from a merger (i.e.,

depends on the relative magnitude of two forces: (i) the reduction of output by the firms involved in the merger, and (ii) the increase of output by the firms outside the merger (e.g., Belleflamme and Peitz 2015). We show that product liability molds these effects and, as a result, influences merger incentives.

In our stylized framework, firms incur a fixed safety cost (Daughety and Reinganum 2006) and consumers misperceive product risk (Polinsky and Rogerson 1983, Spence 1977).[3] Before firms choose their output and safety levels, the profitability of a horizontal merger is assessed. To measure the strength of merger incentives, we follow the standard approach by focusing on how many firms must be included in the merger to make the merged entity's profits as high as the combined profits of the merging firms in the status quo (e.g., Salant et al. 1983).

Our primary result is that product liability influences merger incentives and that consumers' product risk misperception shapes this impact. When consumers *overestimate* product risk, strict liability and negligence produce identical merger incentives, which are weaker than those induced by no liability. Strict liability and negligence create identical merger incentives because firms subject to negligence choose to be negligent when consumers overestimate product risk. In contrast, when consumers *underestimate* product risk, no liability generates the weakest merger incentives, and strict liability the strongest. Negligence induces greater merger incentives than no liability – although consumers anticipate bearing full harm in both regimes – because the equilibrium safety level is higher under negligence.

Our central finding - product liability influences merger profitability - is important for public policy. Decision-makers in charge of liability policy will often take the market structure as given and as something falling exclusively under antitrust authorities' competence. Our findings suggest that liability policy influences the relative attractiveness of different market structures from the standpoint of firms. To that extent, decision-makers may influence the

the model we also study) that the lost consumer surplus due to a merger is approximately proportional to the change in the concentration as measured by the HHI. Such arguments feed into the discussion concerning structural presumption in merger analysis (e.g., Nocke and Whinston 2022).

[3]In reality, consumers often misperceive product risk (e.g., Jolls 1998, Marino 1988, Viscusi 2012), and this behavioral bias affects the performance of liability rules (Baniak and Grajzl 2016, 2017; Miceli and Segerson 2016, Miceli et al. 2015). Risk misperceptions may stem from limited knowledge about the objective harm probability (e.g., Teitelbaum 2007). However, for example, Kahneman and Tversky (1979) suggest that, even if the objective harm probabilities are known, choices will be based on probability weights differing from objective probabilities.

market structure when choosing a liability rule. In terms of implications, our results imply that the historical move towards a more significant role of strict liability is consistent with a greater tendency to observe mergers when consumers underestimate product risk. An underestimation of product risk seems to be the empirically more relevant case in many industries (e.g., Fischer 2017, Landes and Posner 1987), making our results for this case particularly noteworthy. However, there are also important examples in which consumers tend to overestimate produce risk, for example, in the case of vaccines (e.g., Viscusi and Moore 1993).

The rest of the paper is structured as follows. Section 2 discusses the related literature. Section 3 presents the model. Section 4 presents the analysis for the cases of strict and no liability and turns to negligence next before concluding with a numerical illustration. Section 5 concludes.

2 Related Literature

We contribute to the product-liability strand of the literature. Most papers from this literature take the market structure as given. The famous *irrelevance result* was derived using the traditional framework (e.g., Daughety and Reinganum 2013, 2018). It states that the liability rule (strict liability, no liability, or negligence) is irrelevant to the market outcome regarding equilibrium safety. The intuition runs as follows: the expected harm, which is proportional to output, enters the firms' optimization either via the consumer's willingness to pay (under no liability and negligence) or the firms' liability exposure (under strict liability) and determines safety incentives jointly with proportional safety costs.[4]

More recent contributions identify circumstances in which incentives created by the liability policy and those created by the market interact, meaning that the implications of a given liability rule will vary across different market structures (e.g., Chen and Hua 2017, Daughety and Reinganum 2006). Daughety and Reinganum (2011, 2014) consider the possibility of cumulative harm, that is, the case in which the expected harm is increasing and convex in usage. This produces results fundamentally different from the insights obtained in the traditional

[4]Polinsky (1980) considers a setup with competitive firms that influence the expected harm their activity implies for third parties and emphasizes that strict liability and negligence will lead to different numbers of firms in the industry in the long run. It is important to note that this asymmetry would not result if the harm is incurred by consumers instead of third parties.

framework. Liability rules co-determine market outcomes (i.e., irrelevance no longer applies), and outcomes depend upon the market structure.

We consider how liability rules influence merger incentives. Mergers are a classic concern of antitrust authorities, just like tacit collusion among firms. Friehe (2014) and Baumann et al. (2020) examine how liability rules shape incentives to collude, assuming that the market structure in terms of the number of firms is constant. In other words, these contributions examine whether various liability rules influence market performance for a given market structure via collusion incentives in different ways. This paper explores whether liability rules change market performance via incentives to alter the market structure.

Our paper also contributes to the literature on merger incentives in industrial organization (e.g., Fauli-Oller and Sandonis 2018, Whinston 2007). This strand of the literature has considered many aspects as potential determinants of merger incentives. However, our paper is the first to show that product liability is a relevant factor. This addition is important given that product safety concerns provide strong incentives in many markets. In addition, our analysis emphasizes demand-side effects stemming from the consumers' potential uncompensated expected losses. In contrast, the literature on horizontal merger profitability largely ignored how market demand affects merger incentives. In an early exception, Cheung (1992) shows, using general demand functions, that the merger is unprofitable unless at least half of the industry firms participate.

3 Model

Our framework includes risk-neutral, profit-maximizing Cournot firms and risk-neutral, utility-maximizing consumers. We will provide information about these agents after we explain how their interaction unfolds.

Timing: In Stage 1, a merger's profitability is evaluated by assessing how many firms must be included to make the merged entity's profits as high as the combined pre-merger profits. In Stage 2, firms simultaneously choose output and safety. This is analytically similar to firms deciding about safety first and output second if firms' production cannot condition on other firms' safety choices. In Stage 3, the consumer makes her purchase decision. In Stage 4, accidents

occur according to equilibrium product safety and output levels, and compensating transfers are made according to the liability rule. We will consider strict liability (SL), under which firms are mandated to compensate consumers' harm; no liability (NL), under which consumers' harm remains uncompensated; and negligence (N), under which firms must compensate injured consumers for their harm only when they do not obey a standard of care.

Firms: At the outset, the industry has $n > 2$ firms. When m firms merge into one, the number of firms remaining after the merger will be $\tilde{n} = n - m + 1$. We denote total industry output by Q. Firm i sells output q_i at a price p_i. Products potentially differ concerning their observable safety level but are homogeneous otherwise. Firm i's safety, denoted $x_i \in [0, 1)$, implies a safety cost $c(x_i) = Kx_i^2/2$ and expected harm amounting to $H(x_i) = h(1 - x_i)$.[5] The safety cost is independent of the output level (see, for example, Daughety and Reinganum 2006, Polinsky 1980).[6] Regarding merger incentives, we focus on price effects and abstract from potential efficiency effects.[7] The previous literature has shown that – without efficiency benefits – the number of Cournot firms to be included in the merger to make it profitable relative to the pre-merger state is high.[8] This level effect is inconsequential to our research objective, which concerns whether product liability rules influence merger incentives and, if so, which liability rules provide relatively stronger incentives.

[5]We assume specific functional forms for tractability. For similar setups with strictly convex safety costs and a linear accident probability, see Baumann et al. (2018) and Schmitz (2000), for example. The specific cost function is widely used in the context of competition in quality (see, e.g., Motta, 1993).

[6]For example, firms may choose safety as an investment in R&D before assessing output. As explained above, the sequential choice is similar to the case with simultaneous choices when a firm's safety investment remains its private information until firms choose their output level. There are many circumstances in which safety attributes are designed before the output level is determined. Nussim and Tabbach (2009) analyze the case in which care costs are not proportional to the activity level and denote the associated care as *durable*. Such a fixed expenditure may result from the firm's acquisition of assets specifically adapted to its business, which cannot easily be relocated to other businesses or production lines.

[7]Cost savings can counter the price increase and even induce welfare increases. We abstract from such efficiency gains in our analysis for greater transparency. Note that there is not much evidence supporting the existence of cost savings as an outcome of market concentration. Asker and Nocke (2021) reviewed around 30 retrospective studies on mergers, out of which only one found evidence of long-run efficiencies.

[8]A merger in an industry with symmetric Cournot firms, linear costs, and a linear demand function will be profitable only when the post-merger concentration is at least 80% of the market (Salant et al. 1983). In contrast, mergers of any size will be profitable in an industry where firms offer differentiated products and compete in prices (Deneckere and Davidson 1985).

Consumer: A representative consumer perceives expected harm as $\lambda H(x_i)$. The parameter $\lambda \in \left[\underline{\lambda}, \bar{\lambda}\right]$ – with $\frac{1}{2} < \underline{\lambda} < 1 < \bar{\lambda}$ – indicates the consumer's perception of product risk. She overestimates the expected harm when $\lambda > 1$ and underestimates it when $\lambda < 1$. The consumer is unaware of her misperception while it is transparent to firms.[9] These assumptions match those in Polinsky and Rogerson (1983) and the subsequent literature (e.g., Miceli et al. 2015, Miceli and Segerson 2016). Using $Q = \sum_{i=1}^{\tilde{n}} q_i$ to denote total output, the consumer's demand function originates from:

$$\max_{q_i} U = aQ - \frac{b}{2}Q^2 - \sum_i \left(p_i + g\lambda H(x_i)\right) q_i,$$

where p_i represents firm i's price, and $g\lambda H(x_i)$ is the consumer's share in the expected harm as perceived by her, $g \in [0, 1]$. When the share g equals one (zero), no (strict) liability applies. The inverse demand function for firm i's product reads

$$p_i = a - bQ - g\lambda H(x_i). \tag{1}$$

Regarding the parameters used, we make the following assumption.

Assumption 1 *It holds that (i)* $a > \bar{\lambda}h$*, and (ii)* $b > \frac{a\bar{\lambda}h}{K}$.

This assumption ensures positive reservation prices and profit levels and that the equilibrium safety level is less than one, consistent with firm i's accident probability $1 - x_i$.

We now turn to firms' objective functions. Firm i seeks to

$$\max_{q_i, x_i} \Pi_i = p_i q_i - (1 - g)H(x_i)q_i - c(x_i),$$

which can, using p_i from (1) and Q_{-i} to denote total supply minus firm i's output, be rewritten as

$$\max_{q_i, x_i} \Pi_i = \left(a - b(q_i + Q_{-i}) - K\phi(1 - x_i)\right) q_i - \frac{K}{2}x_i^2, \tag{2}$$

with

$$\phi(g, \lambda) \equiv \frac{(1 - g + g\lambda)h}{K}. \tag{3}$$

The allocation of liability represented by g influences firm i's profits via the weight ϕ only if the consumers' risk perception is inaccurate (i.e., if $\lambda \neq 1$). Shifting more losses to the consumer (i.e., increasing g) implies that ϕ changes by $(\lambda - 1)h/K$. In other words, shifting more losses to the consumer increases (decreases) the weight ϕ in the firms' profit equation when consumers overestimate (underestimate) product risk.

[9] This assumption of consumers' naivety is standard in the behavioral industrial organization literature. See, for example, Köszegi and Heidhues (2018).

4 Analysis

First, we analyze strict liability with full compensation of harm and no liability. These rules emerge as two specific cases ($g = 0$ and $g = 1$, respectively) of the general scenario in which firms maximize Π_i as stated in equation (2). The case in which $g \in (0, 1)$ can be interpreted as strict liability with different extents of partial compensation. In Section 4.2, we consider the scenario in which firms are subject to negligence.

We solve the respective games by backward induction. The consumer's demand (Stage 3) as a function of safety and the consumer's share of harm was described above. Below, our analysis starts with the firms' output and safety choices in Stage 2.

4.1 Strict and No Liability

Stage 2: Output and Safety Levels

Firms maximize (2) using their output and safety levels for a given number of symmetric firms $\tilde{n}$ remaining in the industry (i.e. after m firms have merged). Firms obey the following first-order conditions

$$a - 2bq_i - bQ_{-i} - K\phi(1 - x_i) = 0 \tag{4}$$

$$\phi q_i - x_i = 0. \tag{5}$$

Condition (4) leads to the best-reply output as a function of safety and the other firms' output:

$$\hat{q}_i(Q_{-i}; x_i, \phi) = \frac{a - bQ_{-i} - K\phi(1 - x_i)}{2b}.$$

A higher safety level lowers the expected harm per output unit, inducing a higher output level conditional on other firms' production.[10] A greater weight ϕ raises the expected cost per output unit, thereby decreasing the profit-maximizing output level conditional on other firms' quantity.

Condition (5) leads to the profit-maximizing safety level that is linear in output

$$\hat{x}_i(q_i, \phi) = \phi q_i. \tag{6}$$

[10] In the traditional model, expected harm and safety costs are proportional to output, implying that output increases (decreases) with safety at low (high) levels of safety.

When expected harm's weight in firm i's profits increases, the profit-maximizing safety level increases conditional on the firm's output level q_i. Safety depends on the number of firms in the industry as each firm's output depends on it.

Subgame Equilibrium

Using conditions (4) and (5) and the symmetry of firms, we write subgame equilibrium safety and output levels for the case in which m firms merge into one, implying that the number of active firms amounts to $\tilde{n} = n - m + 1$, as follows:

$$q^*(m, \phi) = \frac{a - K\phi}{\Omega} \tag{7}$$

$$x^*(m, \phi) = \phi q^*, \tag{8}$$

where $\Omega = b(\tilde{n} + 1) - K\phi^2$ to simplify the expressions.

It is interesting to study how the equilibrium level of output changes with its arguments. We find:

$$\frac{\partial q^*}{\partial \phi} = K\frac{(\phi(2a - K\phi) - b(\tilde{n} + 1))}{\Omega^2} < 0 \tag{9}$$

$$\frac{\partial q^*}{\partial m} = b\frac{(a - K\phi)}{\Omega^2} > 0 \tag{10}$$

$$\frac{\partial^2 q^*}{\partial m \partial \phi} = -bK\frac{(\phi(4a - 3K\phi) - b(\tilde{n} + 1))}{\Omega^3} < 0. \tag{11}$$

The sign in (9) follows from Assumption 1 and implies that the profit-maximizing output level of a firm subject to no liability is higher (smaller) than that of a strictly liable firm if the consumer underestimates (overestimates) product risk. The output level per firm increases when the number of active firms decreases (see condition (10)), and this change is less pronounced when the level of ϕ is higher. This interdependence is also intuitive as the per-firm output that vanishes when m increases by one is smaller at a higher ϕ (by the result in condition (9)).

The arguments above refer to output per active firm. When some firms merge, output from the merging firm reduces but that of non-merging firms increases. Starting from $Q^*(1, \phi)$, the change from merging firms is $q^*(m, \phi) - mq^*(1, \phi)$ and the change from outsider firms is $(\tilde{n} - 1)(q^*(m, \phi) - q^*(1, \phi))$. The total output effect of one more merging firm results as

$$\frac{\partial Q^*}{\partial m} = -q^*(m, \phi) + \tilde{n}\frac{\partial q^*(m, \phi)}{\partial m} = -\frac{(a - K\phi)(b - K\phi^2)}{\Omega^2} < 0,$$

the sign of which signifies that firm i's price increases. This effect is smaller when ϕ is higher:

$$\frac{\partial^2 Q}{\partial m \partial \phi} = \frac{K\left(b - K\phi^2\right)}{\Omega^2} + \frac{2K\phi\left(a - K\phi\right)\left[\Omega + 2\left(b - K\phi^2\right)\right]}{\Omega^3} > 0,$$

implying a smaller price level effect from one more firm merging when the weight ϕ is high.

We can use equilibrium output and safety levels to obtain firm profits

$$\Pi^*(m,\phi) = (a - bq_i^* - b(n-m)q_j^*)q_i^* - K\phi(1-x^*) - \frac{K}{2}(x^*)^2. \tag{12}$$

After the use of $q_i^* = q_j^*$ and $x^* = \phi q^*$, we receive

$$\Pi^*(m,\phi) = \left(b - \frac{K\phi^2}{2}\right)\left(q^*\right)^2. \tag{13}$$

Regarding the statement of profits in (13), it is clear that a higher number of merging firms m will be relevant to the extent that it increases equilibrium output:

$$\frac{\partial \Pi^*}{\partial m} = \left(2b - K\phi^2\right) q^* \frac{\partial q^*}{\partial m} > 0. \tag{14}$$

Intuitively, a change in the liability rule that raises ϕ decreases profits as:

$$\frac{\partial \Pi^*}{\partial \phi} = -q^*\left[K\phi q^* + \left(b - \frac{K\phi^2}{2}\right)\frac{\partial q^*}{\partial \phi}\right] < 0. \tag{15}$$

The profit level of a firm subject to no liability is higher (smaller) than that of a strictly liable firm if the consumer underestimates (overestimates) product risk.

Starting from (14), we get

$$\frac{\partial^2 \Pi^*}{\partial m \partial \phi} = \frac{\partial q^*}{\partial m}\left[\left(2b - K\phi^2\right)\frac{\partial q^*}{\partial \phi} - 2Kq^*\right] + \left(2b - K\phi^2\right) q^* \frac{\partial^2 q^*}{\partial m \partial \phi} < 0, \tag{16}$$

which means that the profit gains from fewer firms in the industry are less pronounced at higher expected-harm weights ϕ. Interpreted differently, an increase in the weight ϕ is more consequential when the number of active firms is smaller.

Stage 1: Merger Incentives

Firms assess a merger's profitability, anticipating how the Stage 2 subgame equilibrium unfolds as a function of the number of merging firms.[11] A merger is profitable if the profits of the

[11] Note that profitability of a merger is a necessary but not a sufficient condition for a merger. This results from the fact that non-merging firms may benefit more from a merger than the merging firms (e.g., Heywood and McGinty, 2007).

merged firm are weakly higher than the combined profits of the firms in the pre-merger state (e.g., Fauli-Oller and Sandonis 2018). As is standard, we measure the strength of merger incentives by the number of firms that must merge to have the merged firm's profits as high as the combined profits of the merging firms in the status quo (e.g., Salant et et al. 1983).

The critical number of merging firms solves

$$\Delta \equiv \Pi^*(m, \phi) - m\Pi^*(1, \phi) = 0, \tag{17}$$

which can be, using (13), restated as

$$\Delta = \left(b - \frac{K}{2}\phi^2\right)(a - K\phi)^2 \left[\left(\frac{1}{\Delta}\right)^2 - m\left(\frac{1}{\Delta + (m-1)b}\right)^2\right]. \tag{18}$$

Lemma 1 *The difference of profits Δ is equal to zero for $m = 1$, $m = m_1(\phi)$, and $m = m_2(\phi)$, where $1 < m_1(\phi) < n < m_2(\phi)$. A merger is profitable only if $m \in (m_1(\phi), n]$, where*

$$m_1(\phi) = n + \frac{3}{2} - \frac{K\phi^2}{b} - \sqrt{n + \frac{5}{4} - \frac{K\phi^2}{b}}.$$

Proof. See the appendix. ■

The critical level of m depends on how losses are allocated to the consumer and firms. We are interested in how ϕ influences $m_1(\phi)$. Stated in general terms, we want to understand

$$\frac{dm_1}{d\phi} = -\frac{\frac{\partial \Pi(m_1,\phi)}{\partial \phi} - m_1 \frac{\partial \Pi(1,\phi)}{\partial \phi}}{\frac{\partial \Pi(m_1,\phi)}{\partial m} - \Pi(1,\phi)}, \tag{19}$$

where the denominator is positive by the fact that Δ increases with m at m_1. The critical level of m will decrease when the marginal decrease of profits of the merged entity is less than the combined marginal decrease of combined pre-merger profits.

Using the explicit m_1, we find that

$$\frac{dm_1(\phi)}{d\phi} = -\frac{K\phi}{b}\left(2 - \left(n + \frac{5}{4} - \frac{K\phi^2}{b}\right)^{-\frac{1}{2}}\right) < 0, \tag{20}$$

which is positive under Assumption 1. We find that shifting losses to the consumer raises the profitability of the merger when consumers overestimate product risk. This stems from the fact that the combined profits with n firms in the industry react more strongly to the change in product liability than the profits of the merged entity. This directly leads to:

Proposition 1 *When consumers overestimate product risk, merger incentives under no liability exceed those under strict liability. When consumers underestimate product risk, merger incentives under no liability are weaker than those under strict liability.*

Proof. With $\phi = \lambda h/K$ under no liability and $\phi = h/K$ under strict liability, it results that no liability is associated with the higher (lower) level of ϕ when consumers overestimate (underestimate) product risk. The result is straightforward from (20). ■

In summary, we find that the profitability of a merger depends on how losses are allocated to the consumer and firms. Moreover, which liability rule induces stronger incentives depends on the consumer's misperception of product risk.

4.2 Negligence

Stage 2: Output and Safety Choice Given Market Structure

Under negligence, a firm compensates victims only if its safety violates the due-care standard. We assume that

$$x_s = \frac{h}{K} q^* \left(m, \frac{h}{K} \right) = \frac{x^* \left(m, \frac{h}{K} \right)}{1 - g + g\lambda}$$

defines the standard. This standard offsets the bias in the profit-maximizing safety level stemming from the consumer's risk misperception (see the denominator of the right-hand side expression) and thereby minimizes the sum of safety costs and expected harm conditional on a firm's output $q^* \left(m, \frac{h}{K} \right)$ that the court has to take into account when it assesses a firm's potential negligence after a product-related accident. Similarly, Daughety and Reinganum (2006) assume that courts choose safety conditional on output levels as a function of safety.[12]

For given output by the other firms and the standard of care, firm i's profit results as

$$\Pi_i^N = \begin{cases} (a - bq_i - bQ_{-i} - \lambda H(x_i))q_i - c(x_i) \text{ if } x_i \geq x_s \\ (a - bq_i - bQ_{-i} - H(x_i))q_i - c(x_i) \text{ if } x_i < x_s. \end{cases} \tag{21}$$

If firm i complies with due care, the consumer anticipates that the harm will fall on her. Accordingly, she adjusts her willingness to pay by the perceived expected harm $\lambda H(x_i)$. Suppose

[12] To be precise, Daughety and Reinganum (2006) consider the case in which the regulator chooses safety to maximize welfare, knowing how strictly liable firms respond in terms of output. We assume that the courts set a due-care standard corresponding to the minimization of $H(x_i)q^*(m, 1) + c(x_i)$.

instead that firm i does not comply with due care. In that case, the consumer expects full compensation and is indifferent regarding the expected harm, which enters the second line of (21) as a liability cost of the firm.

Consumer Underestimates Product Risk: When $\lambda < 1$, the first line in (21) exceeds the second one for any combination of safety and output levels. The first line is relevant only for $x_i \geq x_s$. The firm prefers x_s out of these levels. Considering the second line and for which safety levels it applies, the firm would like to choose $x_i = \frac{h}{K} q_i$, that is, due care when $q_i = q^*$.[13] When the consumer underestimates product risk, firms comply with due care and implement output level

$$q_N^* = \frac{a - \lambda h}{b(\tilde{n}+1) - \frac{\lambda h^2}{K}}, \tag{22}$$

which is similar but higher than the output level under no liability,

$$q^*\left(m, \frac{\lambda h}{K}\right) = \frac{a - \lambda h}{b(\tilde{n}+1) - \frac{\lambda^2 h^2}{K}}.$$

The difference to no liability results from firms subject to negligence investing more in product safety than when subject to no liability.

Consumer Overestimates Product Risk: When $\lambda > 1$, the second line in (21) exceeds the first one for any combination of safety and output levels. Moreover, the profit in the first line is maximized by $x_i = \lambda \frac{h}{K} q_i$ and will thus *exceed* due care when $q_i = q^*$. Firms respond to the consumer's misperception of product risk by supplying *excessive* safety. In contrast, the unconstrained second line is maximized by $x_i = x_s$ when $q_i = q^*$. The firm can choose a safety level marginally below the due-care standard to ensure that the consumer does not discount the willingness to pay by the overestimated expected harm.

Firm i must compare the profit from choosing either both $\tilde{x} > x_s$ and $\hat{q}\left(Q_{-i}; \tilde{x}; \frac{\lambda h}{K}\right)$ or both x_s and $\hat{q}\left(Q_{-i}; x_s; \frac{h}{K}\right)$.[14] To answer which of the two combinations will be preferred by the firm, we consider the following objective function

$$\Pi(\gamma) = (a - bq_i(\gamma) - bQ_{-i} - \gamma H(x(q_i(\gamma)))q_i(\gamma) - c(x(q_i(\gamma))), \tag{23}$$

[13] More specifically, firm profits are increasing with x for $x_i < q_i h/K$ and experience a discontinuous increase at $x_i = x_s$.

[14] In the following discussion we neglect that the firm must marginally undercut x_s to end up in the second line of (21).

where the other firms' output is fixed and the firms' safety is a function of output. The profit levels at $\gamma = 1$ and $\gamma = \lambda > 1$ represent non-compliance and compliance with due care, respectively. This results because $\left(\tilde{x}, \hat{q}\left(Q_{-i}; \tilde{x}; \frac{\lambda h}{K}\right)\right)$ are profit-maximizing if $\gamma = \lambda$ and $\left(x_s, \hat{q}\left(Q_{-i}; x_s; \frac{h}{K}\right)\right)$ is profit-maximizing if $\gamma = 1$. The intermediate values of γ are only hypothetical. By application of the envelope theorem, the negative direct effect of γ is decisive. Thus, we conclude that firm i chooses to be negligent to avoid facing a willingness to pay adjusted downward by *overestimated* expected harm. If consumers overestimate harm, firms choose to be negligent by undercutting due care only marginally and thus behave in terms of safety and output as under strict liability.[15]

Stage 1: Merger Incentives

In this section, we start our profitability analysis with the case discussed last, that is, the case in which the consumer overestimates risk.

Consumer Overestimates Product Risk: In Stage 2, firms choose to be negligent and behave as under strict liability. This implies that negligence-related merger incentives are the same as under strict liability if the consumer overestimates risk. Explicitly, for $\lambda > 1$, we have that

$$m_1^N = m_1^{SL} = n + \frac{3}{2} - \frac{h^2}{Kb} - \sqrt{n + \frac{5}{4} - \frac{h^2}{bK}}.$$

From (20), we infer that $m_1^{SL} > m_1^{NL}$, because $\phi = h/K$ under strict liability and $\phi = \lambda h/K$ under no liability.

Consumer Underestimates Product Risk: Following the approach laid out above, we can derive a critical level for the number of merging firms (see the appendix for details)

$$m_1^N(\lambda) = n + \frac{3}{2} - \frac{\lambda h^2}{Kb} - \sqrt{n + \frac{5}{4} - \frac{\lambda h^2}{bK}}. \tag{24}$$

[15] Similarly, when studying the implications from cumulative harm, Daughety and Reinganum (2011) also find that firms may choose to be negligent to avoid a large weight on expected harm.

This level can be compared with the level under no and strict liability, restated here for convenience:

$$m_1^{NL}(\lambda) = n + \frac{3}{2} - \frac{\lambda^2 h^2}{Kb} - \sqrt{n + \frac{5}{4} - \frac{\lambda^2 h^2}{bK}}, \tag{25}$$

$$m_1^{SL} = n + \frac{3}{2} - \frac{h^2}{Kb} - \sqrt{n + \frac{5}{4} - \frac{h^2}{bK}}. \tag{26}$$

Clearly, when $\lambda < 1$, we have that $m_1^{SL} \neq m_1^N \neq m_1^{NL}$. The next proposition summarizes our discussion and presents the central result of the paper.

Proposition 2 *When consumers overestimate product risk, merger incentives under negligence are similar to those under strict liability and smaller than under no liability. In contrast, when consumers underestimate product risk, merger incentives under negligence are weaker than those under strict liability but larger than those under no liability.*

Proof. See the appendix. ■

4.3 Numerical application

For illustration, we turn to an example in which we assume $n = 10$ and $a = h = b = 1$ to represent the different critical numbers of firms participating in the merger. For strict liability, we have $\phi = 1/K$. In contrast, under no liability, we have $\phi = \lambda/K$.

In Figure 1, we assume $K = 5$ and plot the critical number of firms under strict liability, no liability, and negligence. The figure considers the following range for the misperception parameter: $\lambda \in [0.6, 1.3]$. When the consumer underestimates product risk, the critical number of firms under negligence is in the middle of the values under no liability and strict liability, where the latter is represented by the horizontal line as there is no relationship with λ. When the consumer overestimates product risk, the critical number of firms under negligence equals the one under strict liability. Under negligence and no liability, merger incentives are more substantial when the consumer overestimates product risk.

To get a context for the exact levels of m in Figures 1 and 2, note that in the classic setup studied in Salant et al. (1983), having less than 80 percent of the firms collude is sufficient to make the merger unprofitable.

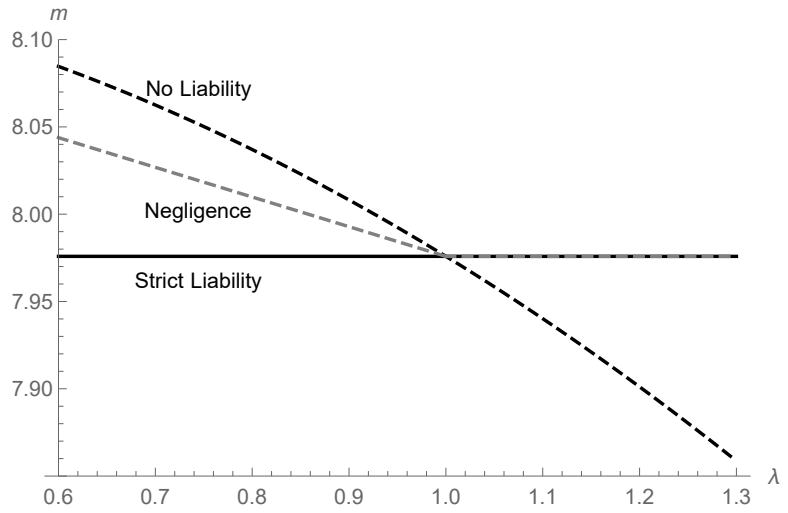

Figure 1: Critical Number of Firms in the Merger As A Function of the Risk Perception

Figure 2 plots the critical number of firms depending on the safety cost parameter K, assuming either $\lambda = 0.7$ or $\lambda = 1.3$. A higher safety cost lowers the safety investment. The different liability regimes induce more similar merger incentives at very high K but significantly different merger incentives when K is small.

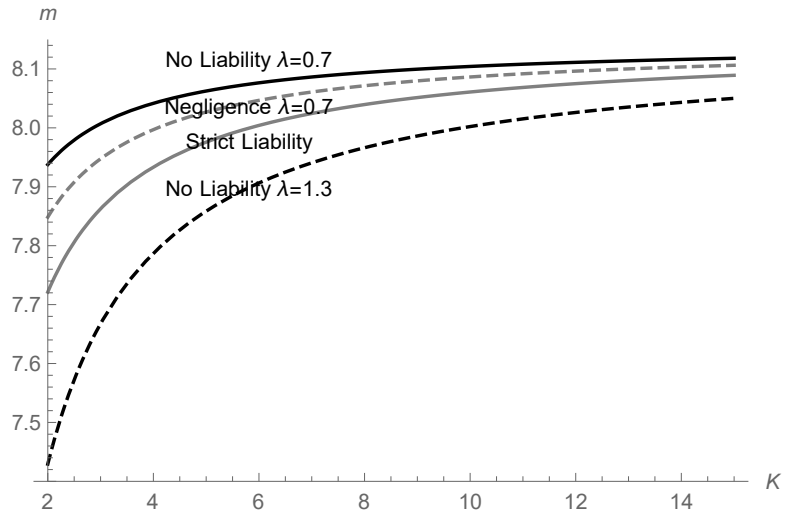

Figure 2: Critical Number of Firms in the Merger As A Function of the Safety Cost Parameter

5 Conclusion

Merger incentives determine market structures, which are key to market performance. In the traditional framework, product liability rules create incentives independent of the market

structure and do not influence it. We present an analysis showing that liability rules influence the profitability of a merger.

The relative strength of merger incentives under no liability, strict liability, and negligence depends on whether consumers underestimate or overestimate product risk. Interestingly, the implications from overestimation and underestimation are not simply reversed images. When consumers *overestimate* product risk, the profitability of a horizontal merger is the same under strict liability and negligence. This results from firms choosing to be negligent. However, many scholars believe that the scenario in which consumers *underestimate* product risk is empirically more relevant. In this case, merger incentives under negligence are weaker than those under strict liability and larger than those under no liability. Our results highlight that product liability rules may have implications that have been neglected so far.

Our analysis is intentionally kept simple to focus on the primary mechanisms, from product liability to merger incentives. We consider merger profitability in a Cournot industry with linear demand from a representative consumer who can sue firms at zero cost and symmetric firms that invest in observable product safety. Different variations of our assumptions, such as asymmetric information about product safety, seem to be exciting avenues for future research. Regarding negligence, we make the reasonable assumption that courts set due care to minimize the sum of expected harm and safety costs for the output level the court observes in a case.

Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

A Appendix

A.1 Proof of Lemma 1

The following three levels of m solve $\Delta = 0$:

$$\left\{1, n + \frac{3}{2} - \frac{K\phi^2}{b} - \sqrt{n + \frac{5}{4} - \frac{K\phi^2}{b}}, n + \frac{3}{2} - \frac{K\phi^2}{b} + \sqrt{n + \frac{5}{4} - \frac{K\phi^2}{b}}\right\}$$

The first root represents the status quo.

Next, we verify that the two other roots exceed 1. Assuming, for example, that $m_1(\phi) = n + \frac{3}{2} - \frac{K\phi^2}{b} - \sqrt{n + \frac{5}{4} - \frac{K\phi^2}{b}} < 1$ holds, yields:

$$\begin{aligned}
n + \frac{1}{2} - \frac{K\phi^2}{b} &< \sqrt{n + \frac{5}{4} - \frac{K\phi^2}{b}} \\
\left(n + \frac{1}{2} - \frac{K\phi^2}{b}\right)^2 - \frac{1}{4} &< n + 1 - \frac{K\phi^2}{b} \\
\left(n - \frac{K\phi^2}{b}\right)\left(n + 1 - \frac{K\phi^2}{b}\right) &< n + 1 - \frac{K\phi^2}{b} \\
n - \frac{K\phi^2}{b} &< 1
\end{aligned}$$

which contradicts Assumption 1. In turn, it is straightforward that $m_1(\phi) < n$, since this is equivalent to $\frac{3}{2} - \frac{K\phi^2}{b} < \sqrt{n + \frac{5}{4} - \frac{K\phi^2}{b}} \Leftrightarrow n > \frac{1}{4} + \left(\frac{3}{2} - \frac{K\phi^2}{b}\right)\left(\frac{1}{2} - \frac{K\phi^2}{b}\right)$ where the RHS is lower than $1 + \left(\frac{K\phi^2}{b}\right)^2 (< 2 < n)$ by Assumption 1.

Finally, the third root does not qualify as it can be shown to exceed n: $m_2(\phi) = n + \frac{3}{2} - \frac{K\phi^2}{b} + \sqrt{n + \frac{5}{4} - \frac{K\phi^2}{b}} > n$ holds, where the LHS is equivalent to $\frac{1}{2} + \left(1 - \frac{K\phi^2}{b}\right) + \sqrt{n + \frac{5}{4} - \frac{K\phi^2}{b}}$, which is positive under Assumption 1. Hence the result.

It holds that $\Delta < 0$ for any $m \in \left[1, n + \frac{3}{2} - \frac{K\phi^2}{b} - \sqrt{n + \frac{5}{4} - \frac{K\phi^2}{b}}\right]$, and $\Delta > 0$ for any $m \in \left[n + \frac{3}{2} - \frac{K\phi^2}{b} - \sqrt{n + \frac{5}{4} - \frac{K\phi^2}{b}}, n\right]$. When we consider how the decisive term in Δ changes with m at $m = 1$, we obtain:

$$\begin{aligned}
&\frac{d}{dm}\left(\left(\frac{1}{b(n - m + 2) - K\phi^2}\right)^2 - m\left(\frac{1}{b(n+1) - K\phi^2}\right)^2\right)|_{m=1} \\
&= \left(\frac{2b}{\left(b\left(n - m + 2\right) - K\phi^2\right)^3} - \frac{1}{\left(b\left(n+1\right) - K\phi^2\right)^2}\right) \\
&= \frac{2b - b\left(n+1\right) + K\phi^2}{\left(b\left(n+1\right) - K\phi^2\right)^3} = \frac{-b\left(n-1\right) + K\phi^2}{\left(b\left(n+1\right) - K\phi^2\right)^3} < 0.
\end{aligned}$$

Hence the result.

A.2 Selection of Relevant Critical Number of Firms Under Negligence

We have derived that the critical number of firms matches the number resulting in the case in which strict liability applies when consumers overestimate product risk. The critical number of firms when consumers underestimate product risk results from

$$\bar{\Delta} = \left(b - \frac{1}{2}\frac{h^2}{K}\right)(a-\lambda h)^2 \left[\left(\frac{1}{b(\tilde{n}+1) - \frac{\lambda h^2}{K}}\right)^2 - m\left(\frac{1}{b(n+1) - \frac{\lambda h^2}{K}}\right)^2\right] = 0$$

We find that the set of solutions is:

$$\left\{1, n + \frac{3}{2} - \frac{\lambda h^2}{bK} - \sqrt{n + \frac{5}{4} - \frac{\lambda h^2}{bK}}, n + \frac{3}{2} - \lambda\frac{h^2}{Kb} + \sqrt{n + \frac{5}{4} - \frac{\lambda h^2}{bK}}\right\}.$$

By Assumption 1, we obtain :

$$1 < m_1^N(\lambda) = n + \frac{3}{2} - \frac{\lambda h^2}{bK} - \sqrt{n + \frac{5}{4} - \frac{\lambda h^2}{bK}} < n < m_2^N(\lambda) = n + \frac{3}{2} - \frac{\lambda h^2}{bK} + \sqrt{n + \frac{5}{4} - \frac{\lambda h^2}{bK}}.$$

A.3 Proof of Proposition 2

Consider first the difference in merger incentives between strict liability and negligence:

$$m_1^{SL} - m_1^N = \frac{h^2}{bK}(\lambda - 1) + \sqrt{n + \frac{5}{4} - \frac{\lambda h^2}{bK}} - \sqrt{n + \frac{5}{4} - \frac{h^2}{bK}}.$$

Then,

$$\frac{d}{d\lambda}\left(m_1^{SL} - m_1^N\right) = \frac{1}{2}\frac{h^2}{bK}\left(2 - \left(n + \frac{5}{4} - \frac{\lambda h^2}{bK}\right)^{-\frac{1}{2}}\right),$$

where the term in parentheses is positive under Assumption 1 (since it implies that $b(n+1) - \frac{\lambda h^2}{4K} > 0$). Thus,

$$\frac{d}{d\lambda}\left(m_1^{SL} - m_1^N\right) > 0,$$

and since $\left(m_1^{SL} - m_1^N\right)_{\lambda=1} = 0$, we have that $m_1^{SL} < m_1^N$ when $\lambda < 1$.

Consider now the difference in merger incentives between negligence and no liability:

$$m_1^N - m_1^{NL} = \frac{h^2}{bK}\lambda(\lambda - 1) + \sqrt{n + \frac{5}{4} - \frac{\lambda h^2}{bK}} - \sqrt{n + \frac{5}{4} - \frac{(\lambda h)^2}{bK}}.$$

Then

$$\frac{d}{d\lambda}\left(m_1^N - m_1^{NL}\right) = \frac{h^2}{bK}\left((2\lambda - 1) + \frac{1}{2}\left(n + \frac{5}{4} - \frac{\lambda h^2}{bK}\right)^{-\frac{1}{2}} - \lambda\left(n + \frac{5}{4} - \frac{(\lambda h)^2}{bK}\right)^{-\frac{1}{2}}\right),$$

where the term in parentheses can be written as

$$2\lambda\underbrace{\left(1 - \frac{1}{2}\left(n + \frac{5}{4} - \frac{(\lambda h)^2}{bK}\right)^{-\frac{1}{2}}\right)}_{A} - \underbrace{\left(1 - \frac{1}{2}\left(n + \frac{5}{4} - \frac{\lambda h^2}{bK}\right)^{-\frac{1}{2}}\right)}_{B};$$

Assumption 1 implies that $A > 0$ and $B > 0$, while $\lambda < 1$ implies $A > B$. Finally, we have that $2\lambda A > B$, meaning that $\frac{d}{d\lambda}\left(m_1^{SL} - m_1^N\right) > 0$. Since $\left(m_1^N - m_1^{NL}\right)_{\lambda=1} = 0$, this means that $m_1^N < m_1^{NL}$.

To sum up, when consumers underestimate risk (i.e., when $\lambda < 1$), then $m_1^{SL} < m_1^N < m_1^{NL}$.

References

Asker, J., & Nocke, V. (2021). Collusion, mergers, and related antitrust issues. In: Ho, K., Hortacsu, A., & Lizzeri, A. (Eds.). Handbook of Industrial Organization 5, 177-279.

Baniak A. & Grajzl P. (2016). Product liability when consumers vary in their susceptibility to harm and may misperceive risk. Contemporary Economic Policy 33, 468–476.

Baniak A. & Grajzl P. (2017). Optimal liability when consumers mispredict product usage, American Law and Economics Review 19, 202–243.

Baumann, F., Charreire, M., & Cosnita-Langlais, A. (2020). Market collusion with joint harm and liability sharing. International Review of Law and Economics 62, 105885.

Baumann, F., Friehe, T., & Rasch, A. (2018). Product liability in markets for vertically differentiated products. American Law and Economics Review 20, 46-81.

Belleflamme, P., & Peitz, M. (2015). Industrial Organization: Markets and Strategies. Cambridge, UK: Cambridge University Press.

Chen, Y., & Hua, X. (2017). Competition, product safety, and product liability. Journal of Law, Economics, & Organization 33, 237-267.

Cheung, F.K. (1992). Two remarks on the equilibrium analysis of horizontal mergers. Economics Letters 40, 119–123.

Daughety, A.F., & Reinganum, J.F. (2006). Markets, torts, and social inefficiency. Rand Journal of Economics 37, 300-323.

Daughety, A.F., & Reinganum, J.F. (2011). Cumulative harm and resilient liability rules for product markets. Vanderbilt University Department of Economics and Law School Working Paper No. 11-W25.

Daughety, A.F., & Reinganum, J.F. (2013). Economic analysis of products liability: Theory, in: Arlen, J. (Ed.). Research Handbook on the Economics of Torts, Edward Elgar.

Daughety, A.F., & Reinganum, J.F. (2014). Cumulative harm and resilient liability rules for product markets. Journal of Law, Economics, & Organization 30, 371-400.

Daughety, A.F., & Reinganum, J.F. (2018). Market structure, liability, and product safety.

In: Luis C. Corchon and Marco A. Marini (Eds.). Handbook of Game Theory and Industrial Organization II. Edward Elgar.

Deneckere, R., & Davidson, C. (1985). Incentives to form coalitions with Bertrand competition. Rand Journal of Economics 16, 473–486.

Farrell, J., & Shapiro, C. (1990). Horizontal Mergers: An Equilibrium Analysis. American Economic Review 80, 107-126.

Fauli-Oller, R., & Sandonis, J. (2018). Horizontal mergers in oligopoly. In: Luis C. Corchon and Marco A. Marini (Eds.). Handbook of Game Theory and Industrial Organization II. Edward Elgar.

Fischer, A.R.H. (2017). Perception of product risks, in: Emilien, G., Weitkunat, R. & Lüdicke, F. (Eds.). Consumer Perceptions of Product Risks and Benefits. Berlin: Springer.

Friehe, T. (2014). Tacit collusion and liability rules. European Journal of Law and Economics 38, 453-469.

Geistfeld, M. (2009). Products liability. In: Faure, M. (Ed.). Tort Law and Economics. Edward Elgar.

Heywood, J.S., & McGinty, M. (2007). Convex cost and the merger paradox revisited. Economic Inquiry 45, 342-349.

Jolls, C., 1998. Behavioral economics analysis of redistributive legal rules. Vanderbilt Law Review 51, 1653–1677.

Kahneman, D. & Tversky, A. (1979). Prospect theory: an analysis of decision under risk. Econometrica 47, 263-292.

Köszegi, B., & Heidhues, P. (2018). Behavioral industrial organization. In: Douglas B. Bernheim, DellaVigna, S., & Laibson, D. (Eds.). Handbook of Behavioral Economics I. Amsterdam: North-Holland.

Landes, W.M., & Posner, R.A. (1987). The Economic Structure of Tort Law. Harvard University Press.

Miceli T. & Segerson K. (2013). Liability versus regulation for dangerous products when

consumers vary in their susceptibility to harm and may misperceive risk, Review of Law and Economics 9, 341–355.

Miceli, T.J., Segerson, K., & Wang, S. (2015). Products liability when consumers vary in their susceptibility to harm and may misperceive risk. Contemporary Economic Policy 33, 468-476.

Motta, M. (1993). Endogenous quality choice: Price and quantity competition. Journal of Industrial Economics 41, 113-31.

Nocke, V., & Whinston, M. (2022). Concentration thresholds for horizontal mergers. American Economic Review 112, 1915-1948.

Nocke, N., & Schutz, N. (forthcoming). An Aggregative Games Approach to Merger Analysis in Multiproduct-Firm Oligopoly. Rand Journal of Economics.

Nussim, J., & Tabbach, A.D. (2009). A revised model of unilateral accidents. International Review of Law and Economics, 29, 169-177.

Philipson, T.J., & Sun, E. (2008). Is the Food and Drug Administration safe and effective? Journal of Economic Perspectives 22, 85-105.

Polinsky, A.M. (1980). Strict liability vs. negligence in a market setting. American Economic Review Papers & Proceedings 70, 363-367.

Polinsky, A.M., & Rogerson, W.P. (1983). Products liability, consumer misperceptions, and market power. Bell Journal of Economics 14, 581-589.

Polinsky, A.M., & Shavell, S. (2010). The uneasy case for product liability. Harvard Law Review 123, 1437-1492.

Prince, D.W., & Rubin, P.H. (2002). The effects of product liability litigation on the value of firms. American Law and Economics Review 4, 44-87.

Salant, S.W., Switzer, S., & Reynolds, R.J. (1983). Losses from horizontal merger: The effects of an exogenous change in the industry structure on Cournot-Nash equilibrium. Quarterly Journal of Economics 98, 185-199.

Schmitz, P.W. (2000). On the joint use of liability and safety regulation. International Review of Law and Economics 20, 371-382.

Shepherd, J. (2013). Products liability and economic activity: An empirical analysis of Tort Reform's impact on businesses, employment, and production. Vanderbilt Law Review 66, 257-321.

Spence, M. (1977). Consumer misperceptions, product failure and producer liability. Review of Economic Studies 44, 561-572.

Teitelbaum, J.C. (2007). A unilateral accident model under ambiguity. Journal of Legal Studies 36, 431-477.

Viscusi, W.K. (2012). Does product liability make us safer? Regulation, Spring, 24-31.

Viscusi, W.K., & Moore, M.J. (1993). Product liability, research and development, and innovation. Journal of Political Economy 101, 161-184.

Whinston, M.D. (2007). Antitrust policy toward horizontal mergers. In: M. Armstrong, R.H. Porter (Eds.). Handbook of Industrial Organization Vol. 3. Amsterdam: North-Holland.