Why product liability may lower product safety∗

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Abstract

This paper shows that shifting accident losses from consumers to a monopolist may lower product safety when fully informed consumers differ in their level of harm. In determining product safety, the monopolist considers a convex combination of the average harm of consumers served and the harm level of the marginal consumer. Shifting more losses to the monopolist allocates more of the firm’s attention to the average harm level, which is smaller than the harm level of the marginal consumer. From a welfare perspective, while the monopolist profits from this shifting of losses to the firm, individual consumers or consumers as a group may oppose it.

Keywords: product liability, imperfect competition, product safety


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1 Introduction

Product liability makes the manufacturers of defective products liable for harm caused to their consumers. This policy has gained significant importance in the US and increasingly in Europe as well (e.g., Lovells 2003). Product liability is commonly associated with the attempt to induce firms to improve the safety of their products (e.g., Polinsky and Shavell 2010).

This paper shows that product liability may in fact lower product safety. We use a parametric liability specification whereby we vary the extent to which the legal system leaves injured consumers uncompensated, where no compensation represents the case of no liability. Our key finding is established in a unilateral-care setup in which consumers with heterogeneous harm levels and perfect information about product safety are served by a monopolist who cannot price discriminate. Our results contrast with findings from a standard setup in which fully informed consumers incur the same level of harm; in such cases, shifting losses to firms is inconsequential for the level of product safety (see, e.g., the recent survey by Daughety and Reinganum 2013). Moreover, for the setting with heterogeneous consumers, our paper highlights that the firm chooses product safety by considering a convex combination of the average harm of consumers served and the harm level of the marginal consumer (where the extent of loss-shifting determines the respective weights). From a welfare perspective, while the monopolist profits from the shifting of losses to the firm, individual consumers or consumers as a group may oppose it. This results from the fact that the group of consumers is less heterogeneous when the monopolist bears a greater share of losses, allowing the monopolist more rent extraction.

The main contribution of this paper relative to previous analyses of product liability (e.g., Boyd 1994, Daughety and Reinganum 1995, Marino 1988, Polinsky and Rogerson 1983) lies in determining the repercussions of consumer heterogeneity for the level of harm in a monopoly. Consumers who differ in the level of harm have been considered by Choi and Spier (2014), who focus on the risk selection effects of contractual liability in a perfectly competitive industry, and by Miceli et al. (2015), who assume that the industry is perfectly competitive and that consumers misperceive risk. Endres and Lüdecke (1998) study a monopolist who segments the market with different product varieties when consumers may misperceive risk, whereas Baumann et al. (2015) examine the strategic effects
emerging between duopolistic firms that offer one product variety each.

2 The model and analysis

Consumers We consider a mass of risk-neutral individuals normalized to one. Each individual may buy one unit of the product. Consumers who buy the product obtain the benefit \( v, v > 0 \), and suffer type-specific harm \( h \) with probability \( q(x) \), where \( x \) denotes product safety and \( q' < 0 \leq q'' \) holds. Harm levels are distributed according to the cumulative distribution function \( F(h) \) on \([h, \bar{h}]\), where \( F'(h)/F(h) \) is decreasing in \( h \).\(^1\) The type-specific level of harm is private information at the time of purchase, but verifiable in court in the event of an accident. The payoff of an individual who does not purchase the product is normalized to zero. Hence, an individual potentially suffering harm \( h \) purchases the product if the expected net benefit is weakly greater than zero,

\[
v - p - q(x)(1 - \gamma)h \geq 0,
\]

where \( p \) denotes the price charged by the firm and \( \gamma \in [0, 1) \) represents the share of the consumer’s harm that is compensated by the firm under strict liability. Thus, in line with Daughety and Reinganum (2006), among others, we focus on the case in which some harm always remains with the victim. The harm level of the individual who is indifferent between buying the product and not buying is given by

\[
h_k = \frac{v - p}{q(x)(1 - \gamma)}.
\]

Producer The product is sold by a monopolist with unit production costs \( c(x) \), where \( c'(x) > 0 \) and \( c''(x) \geq 0 \). Given the harm level of the marginal consumer, \( h_k \), the price charged by the monopolist can be expressed as \( p = v - q(x)(1 - \gamma)h_k \). The monopolist seeks to

\[
\max_{h_k, x} \pi = [v - q(x)[(1 - \gamma)h_k + \gamma E(h|h \leq h_k)] - c(x)] F(h_k),
\]

where the second term, \( F(h_k) \), is the share of consumers buying the product and the first term is the price-cost margin \( (p - c(x) - q(x)\gamma E(h|h \leq h_k)) \), with \( E(h|h \leq h_k) = F(h_k)^{-1} \int_{h_k}^{h} h dF(h) \) representing the average harm level of product-buying consumers.

\(^1\)This monotone hazard rate assumption is satisfied by many parametric single-peak density functions (see Bagnoli and Bergstrom 2005).
The first-order conditions for an interior solution can be stated as

\[ v - q(x^*)h_k^* - c(x^*) = q(x^*)(1 - \gamma) \frac{F(h_k^*)}{F'(h_k^*)} \]

(1)

\[ -q'(x^*) [(1 - \gamma)h_k^* + \gamma E(h|h \leq h_k^*)] = c'(x^*). \]

(2)

From (1) and (2), we obtain equilibrium values \( x^*(\gamma) \) and \( h_k^*(\gamma) \) as a function of the firm’s share of losses. In the monopolist’s profit maximum, the benefit \( v \) exceeds social costs for the marginal consumer, \( q(x^*)h_k^* + c(x^*) \) (see equation (1)). Condition (2) highlights that the monopolist chooses product safety by taking into account the harm level of both the average and the marginal consumer, where the weights follow from the firm’s share of losses. This results from the fact that a marginal increase in product safety (i) raises the price as a function of the harm level of the marginal consumer (as \( p = v - q(x^*)(1 - \gamma)h_k^* \)) and (ii) changes the expected liability payments as a function of the harm level of the average product-buying consumer.

**Lemma 1** The monopolist’s safety choice is determined by a convex combination of the average harm to product-buying consumers and the harm level of the marginal consumer, where the weight on the harm level of the average (marginal) consumer is \( \gamma \ (1 - \gamma) \).

Using equilibrium levels \( x^*(\gamma) \) and \( h_k^*(\gamma) \), condition (2) implies that product safety falls with the level of losses allocated to the firm when

\[ \frac{dx^*}{d\gamma} = \frac{q'(x^*) [h_k^* - E(h|h \leq h_k^*)] - \frac{dh_k^*}{d\gamma} \left( (1 - \gamma) + \gamma \frac{\partial E(h|h \leq h_k^*)}{\partial h_k^*} \right)}{q''(x^*) [(1 - \gamma)h_k^* + \gamma E(h|h \leq h_k^*)] + c''(x^*)} < 0. \]

(3)

In other words, the direct effect of shifting more losses to the firm is a reduction in product safety (since \( h_k^* \geq E(h|h \leq h_k^*) \)); the fact that the firm may serve consumers with higher harm levels represents an opposing influence.

**Proposition 1** The monopolist’s safety level decreases in the firm’s share of accident losses when the direct effect resulting from a higher weight on average harm dominates the influence stemming from a possible increase in the marginal consumer’s level of harm.

Note that when \( h_k^* = \bar{h} \) (i.e., when the market is fully covered) before and after the increase in \( \gamma \), it unambiguously follows that shifting more losses to the firm lowers the level of product safety, as the firm selects \( \hat{x}(\gamma) = \arg \min \{ q(x) [(1 - \gamma)\bar{h} + \gamma E(h)] + c(x) \} \).

\(^2\)The second-order conditions for a profit maximum are assumed to be fulfilled.
Welfare  Apart from the direct influence on the behavior of the monopolist and consumers, an increase in the level of $\gamma$ brings about changes in profits and consumer surplus. We find that the monopolist benefits from an increase in the level of losses shifted to the firm. Using the envelope theorem, we obtain

$$
\frac{d\pi}{d\gamma} = q(x^*)(h^*_k - E(h|h \leq h^*_k))F(h^*_k) > 0
$$

for $\gamma \in [0, 1)$. This result is attributable to the fact that the monopolist can better extract consumer surplus when consumers become more similar, as expected harm becomes less relevant to the purchase decision for higher $\gamma$. This implies that the group of consumers and the firm will have opposing interests on the matter of whether to set $\gamma = 0$ or $\gamma \to 1$, since consumers will enjoy rents only in the former case.

With regard to the influence on the expected rent $S$ of a single consumer with harm level $h$, we obtain

$$
S(h, \gamma) = v - p - q(x^*)(1 - \gamma)h = q(x^*)(1 - \gamma)(h^*_k - h)
$$

and

$$
\frac{dS}{d\gamma} = -q(x^*)(h^*_k - h) + q'(x^*)\frac{dx^*}{d\gamma}(1 - \gamma)(h^*_k - h) + q(x^*)(1 - \gamma)\frac{dh^*_k}{d\gamma}.
$$

The first effect is negative and indicates that the price increase more than offsets the higher compensation in the event of an accident (since $h \leq h^*_k$ for all product-buying consumers). According to the second term, the consumer’s rent increases with a decrease in safety. The inframarginal consumer benefits from a decrease in safety, since the accompanying price decrease (proportional to $(1 - \gamma)h^*_k$) dominates the additional expected losses (proportional to $(1 - \gamma)h$). Finally, for higher output (an increase in $h^*_k$), the accompanying lower price increases the inframarginal consumer’s rent.

**Proposition 2**  The monopolist’s profit level increases in the firm’s share of accident losses, whereas the implication for consumer surplus is ambiguous. Consumers with $h \to h^*_k$ will benefit from greater loss shifting when the traded quantity increases, i.e., when $dh^*_k/d\gamma > 0$.

To illustrate the marginal effects of shifting losses to the firm in terms of the levels of product safety and consumer surplus, we now turn to a numerical example.

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3Note that all but the marginal consumer enjoy some rent.
Example  We assume a Pareto distribution with $F(h) = 1 - h^{-2}$ as a cumulative distribution function in the interval $h \in [1, \infty)$, $q(x) = 1 - x$, $c(x) = 3x^2$, and $v = 5$ as the numerical value for the consumers’ gross benefit. For this specification, the level of product safety $x^*$ (harm to the marginal consumer $h_k^*$) is decreasing (increasing) in the level of $\gamma$ (see panels (a) and (b) in Figure 1). Referring back to equation (3), it is evident that the direct effect of an increase in the monopolist’s share of losses on the profit-maximizing level of product safety outweighs the indirect effect stemming from a marginal consumer with a higher level of harm. Turning to the implications for consumer surplus, it results that both total expected consumer surplus $CS(\gamma) = \int_{h_k}^{h} S(h, \gamma) dF(h)$ and the surplus of individual consumers with low levels of harm are decreasing throughout with the firm’s share of losses. In contrast, a consumer with $h = 2.3$ (who is close to the consumer with $h = h_k^*$ for $\gamma = 0$) benefits from an increase in the firm’s share of losses at low levels of $\gamma$ (see Figure 2). Comparable to the consumer with $h = 2.3$, the expected surplus of consumers who buy the product only for some positive value of $\gamma$ (represented by $h = 3$ in the figure) first increases in $\gamma$ (after having reached a level sufficient to rationalize buying the product despite the relatively high level of harm) and reaches a maximum for some $\gamma < 1$. 

Figure 1: The impact of the firm’s share of losses on equilibrium levels of product safety and the marginal consumer’s harm level for the Pareto distribution $F(h) = 1 - h^{-2}$ (with $h \in [1, \infty)$, $q(x) = 1 - x$, $c(x) = 3x^2$, and $v = 5$).
Figure 2: Equilibrium level of total expected consumer surplus and the surpluses of individuals with harm levels $h = 1$, $h = 2.3$, and $h = 3$ (denoted $S(1, \gamma)$, $S(2.3, \gamma)$, $S(3, \gamma)$).

References


