

ISSN 1936-5349 (print)  
ISSN 1936-5357 (online)

# HARVARD

JOHN M. OLIN CENTER FOR LAW, ECONOMICS, AND BUSINESS

## PRODUCT SAFETY, BUYBACKS AND THE POST-SALE DUTY TO WARN

Kathryn E. Spier

Discussion Paper No. 597

10/2007

Harvard Law School  
Cambridge, MA 02138

This paper can be downloaded without charge from:

The Harvard John M. Olin Discussion Paper Series:  
[http://www.law.harvard.edu/programs/olin\\_center/](http://www.law.harvard.edu/programs/olin_center/)

The Social Science Research Network Electronic Paper Collection:  
[http://papers.ssrn.com/abstract\\_id=1023125](http://papers.ssrn.com/abstract_id=1023125)

# PRODUCT SAFETY, BUYBACKS AND THE POST-SALE DUTY TO WARN

OCTOBER 12, 2007

Kathryn E. Spier<sup>1</sup>

This paper considers the problem faced by a manufacturer who learns the product's risks after the product has already been sold and distributed to consumers. A product recall, where the manufacturer contacts old customers to warn them about the risks and (possibly) to offer to buy the product back, is costly to conduct. When held strictly liable for product-related injuries, the manufacturer solicits the return of the product when the product risk exceeds a threshold. Consumers comply with the recall and return the product when their private valuations of consumption are smaller than the buyback price. With strict liability alone, the manufacturer's private incentives to stage a recall are insufficient, the buyback price offered is too low, and the continued product usage by consumers is excessive. Strict liability with a warning defense, where the manufacturer can avoid liability by simply disclosing product risk, leads to too many product recalls but correct consumer usage following a recall. A carefully designed negligence based rule, the "post-sale duty to warn," implements the social welfare benchmark.

## 1. Introduction

In the summer of 2000, Williams-Sonoma learned that the small propane gas grills that they had been selling through their stores, their catalog, and the internet were defective.<sup>2</sup> Although no injuries had occurred, two customers reported that they had been unable to turn off the flow of the propane gas, suggesting a serious risk of a fire or an explosion. Using its own

---

<sup>1</sup> Harvard Law School and NBER, kspier@law.harvard.edu. The author thanks Ronen Avraham, Yeon-Koo Che, Jim Dana, Louis Kaplow, Mitchell Polinsky, Marshall Shapo, Steve Shavell, Abe Wickelgren and seminar participants at the University of Virginia and the American Law and Economics Association Meetings for comments and helpful discussions. The author acknowledges financial support from the John M. Olin Center for Law, Economics, and Business at the Harvard Law School.

<sup>2</sup> Williams-Sonoma, Inc. is a specialty retailer in the United States. Williams-Sonoma began in 1956 by importing high-quality pots and pans from France. More recently, they have expanded to selling small electric appliances, tableware, cookbooks, and specialty foods.

electronic credit card records and enlisting the help of credit card companies, Williams-Sonoma contacted the nearly 1000 customers who had purchased the grill, offering a full refund of the \$200 purchase price plus a \$50 gift certificate.<sup>3</sup> All but two of the grills were returned and Williams-Sonoma was publicly lauded for their fast and effective response.<sup>4</sup>

Product recalls have become increasingly common in recent years. In the United States in 2002, one in eleven cars on the road were recalled, a total of almost 19 million automobiles. In 2003, there were more than 5,000 consumer products recalled involving approximately 60 million consumer purchases.<sup>5</sup> The recall process is overseen by six government agencies: the Food and Drug Administration (FDA), the National Highway and Traffic Safety Administration (NHTSA), the Consumer Product Safety Commission (CPSC), the Department of Agriculture, the Coast Guard, and the Environmental Protection Agency (EPA). While many of the recalls instruct consumers to discontinue their use of the product and return it to the retailer or the manufacturer for a refund or a repair, the policies vary. Some recalls are simply warnings to

---

<sup>3</sup> See Finley (2002), Consumer Reports (2004), and the Federal Document Clearing House (2001). They also offered to reimburse shipping charges and to pick up the grills from the customers' homes. M2 Presswire (2000).

<sup>4</sup> Similarly, in 2005 Starbucks' coffee offered a full refund and a \$5 gift certificate for the return of certain tea kettles that could cause harm to consumers. See Parkin (2006). The example of the BernzOMatic Company stands in contrast to these success stories. The BernzOMatic Company initiated a recall of their low-budget gas heaters in 1987. Tragically, almost forty people had already died from its carbon monoxide emissions. Despite offering \$250 for the return of the heaters that originally were sold for just \$35, it is estimated that over 7,000 of the 40,000 heaters sold still remain in household use. See Finley (2002).

<sup>5</sup> See Consumer Reports (2004). Most of these products remain in use and unfixed. It is estimated that one third of all vehicles subject to recalls are never fixed, and the number of the unrepaired toys, appliances, electronics and car seats is far higher.

consumers to limit their use of products.<sup>6</sup> Others supplement their warnings with recommended consumer actions, such as removing or disabling a hazardous part of the product.<sup>7</sup>

This paper considers the problem faced by a manufacturer who learns the propensity of a product to harm consumers only after the product has been sold and distributed to customers. In the post-sale stage, the privately-informed manufacturer must decide whether to contact previous customers to warn them of the impending risks and (possibly) to offer to buy the product back. Recalls are costly, however – contacting consumers only makes financial sense when this cost is small relative to the benefits.<sup>8</sup> This paper considers the effects of several different liability regimes on the manufacturer’s decision to contact consumers, the manufacturer’s decision to repurchase the product from the market, and the subsequent reactions of consumers to the recall.

New information about product risks is socially valuable in our setting because of its potential to change consumer behavior. Suppose the previously-sold product is discovered to be more dangerous than originally expected. In this case, some consumers who might otherwise have continued to use the product (based upon the prior beliefs) should in fact discontinue their use.<sup>9</sup> On the flip side, if the product is discovered to be unusually safe – much safer than expected – then some consumers who might otherwise have stopped using the product should be encouraged to resume using it again. In general, it is shown that the socially optimal disclosure policy features disclosure of product risks at the two extremes: when the product is especially

---

<sup>6</sup> See, for example, “CPSC Warns of Choking Hazard from Halloween Pumpkin Erasers,” CPSC Release # 95-018.

<sup>7</sup> See, for example, “Baby Cookie Monster Toys Sold with DVD at Wal-Mart Recalled for Choking Hazard,” CPSC Release #07-009.

<sup>8</sup> In the words of Hal Stratton, the chairman of the CPSC in 2002, “We strive to get zero deaths but there are 280 million people out there ... We can’t send a letter to 280 million people. That’s cost-prohibitive.” As quoted in Finley (2002).

<sup>9</sup> If the product is extremely dangerous – causing death with certainty for example – then the product should be totally withdrawn from the market. More generally, however, consumers with sufficiently high valuations for the product are in a position to bear increased levels of risk.

dangerous and when the product is unusually safe. Assuming that the expected product risk is fairly small to begin with, and that the bulk of consumers derive sufficient value from using the product, allows us to restrict attention to the former case. This generates a realistic welfare benchmark where consumers are warned when (and only when) the product is discovered to be particularly hazardous.

This paper then compares several different liability regimes with this social welfare benchmark. First, we imagine that the manufacturer is held *strictly liable* for all consumer injuries regardless of any warnings or attempts to retrieve the product from the market.<sup>10</sup> If product buybacks were impossible, then consumers have no incentive to stop using a risky product since they expect to be fully compensated for their injuries. The manufacturer, realizing that their warnings will have no effect on consumer behavior, does not find it worthwhile to issue a warning. When the manufacturer has the opportunity to buy the product back from the market, however, then social welfare rises. The manufacturer privately benefits from a buyback when the buyback price that it offers to recall the product is smaller than the expected future liability.

The product buyback does not achieve the social optimum for two reasons, however. First, the manufacturer is a monopsonist in the post-sale stage and will therefore exercise market power, offering a price that is below his unit opportunity cost (the expected harm to a consumer).

---

<sup>10</sup> This rule is a variant of the familiar rule of strict liability with no defense of contributory negligence. The decision of a consumer to continue to use the product in our setting is analogous to consumer care to avoid accidents in the more traditional setting. A defense of contributory negligence in our model would shift liability to the consumer if the consumer continued to use the product despite having a low private valuation for consumption. In practice, a consumer's utility for consumption is private information so such a rule would be very hard for a court to enforce. For this reason, the rule of strict liability with a defense of contributory negligence is not formally considered here.

It follows that the price that the manufacturer offers is too low.<sup>11</sup> Second, the manufacturer will not recall the product often enough. Intuitively, consumers with the very lowest valuations receive consumer surplus from a product buyback (since their valuations for continued product use are below the buyback price). The manufacturer only considers his own profit when contemplating a buyback, not the consumer surplus associated with a buyback.

Next, we imagine a world where strict manufacturer liability is coupled with a “warning defense” – the manufacturer can evade liability altogether by contacting consumers and disclosing the products risks. In other words, the risk of product injuries is shifted to the consumers when the manufacturer issues a warning.<sup>12</sup> The manufacturer has an excessive incentive to warn customers in this regime. The manufacturer’s private benefit from warning customers reflects the total expected damages to consumers (since the manufacturer can avoid paying damages under this rule). However, the social benefit from a warning is much smaller, including only the change in consumer behavior associated with revelation of harm.<sup>13</sup>

Finally, we consider a negligence-based “duty to warn” that holds the manufacturer negligent if and only if he fails to issue a “cost-justified” warning. This rule achieves the socially efficient benchmark described above, but may be difficult to implement in practice. Implementing a rule along these lines would require the policy maker to understand the distribution of product harms, the *ex post* realization of product harms, the nature of consumer demand, and the cost to the manager of disclosing information.

---

<sup>11</sup> We maintain the assumption throughout the paper that the manufacturer cannot commit to a buyback price ahead of time. This is a reasonable assumption when the complexity of the product precludes an accurate *ex ante* forecast of all of the risks that might arise and the propensity for harm.

<sup>12</sup> The manufacturer has no incentive to buy the product back in this regime.

<sup>13</sup> In a more general framework, this excessive incentive could be mitigated by reputational concerns. If the quality of products is correlated through time then the decision to recall a product could reduce the perceived quality and future demand for the product.

There is a sizable empirical literature on product recalls. Jarrell and Peltzman (1985) conduct an events study of the pharmaceutical and automobile industries, looking at the reaction of the stock market to recall announcements. They show that the stock price reaction is much greater, in magnitude, than the direct costs of the recall.<sup>14</sup> Rupp and Taylor (2002) explore empirically why some automobile recalls are initiated by the automobile manufacturer while others are initiated by the NHTSA. In practice, about 80% of automobile recalls are manufacturer-initiated, while only 20% are government-initiated. They show that the manufacturer is more likely to initiate the less expensive recalls, while the government is more likely to initiate larger recalls.<sup>15</sup>

There is also a small theoretical literature on product recalls. Marino (1997) considers the design of *involuntary* recall procedures. In his model, the liability system is imperfect and, in the absence of regulatory involvement, the incentives of manufacturers to design safer products would be suboptimal. The threat of an audit, and the impending punishment of an involuntary recall, gives the manufacturer the incentive to design safer products *ex ante*.<sup>16</sup> Marino does not consider information disclosure, buybacks, or the post-sale incentives of manufacturers or consumers. Welling (1991) does consider the incentives of manufacturers to *voluntarily* recall products and warn consumers about product risks. In her model, firms are long-lived and have an incentive to develop reputations for being honest with consumers. Disclosing product defects

---

<sup>14</sup> Interestingly, rivals' stock prices were also negatively affected by the recalls, suggesting an industry-wide reduction in demand. But see the critique of Hoffer et. al. (1988).

<sup>15</sup> Hoffer et. al. (1994) show that owners of newer domestic models are more likely to respond to an automobile recall, bringing their cars in for repairs, than owners of older foreign models. Hartman (1987) shows that automobile recalls lead the resale prices of the affected models to fall, while the resale prices of other models manufactured by the same firm were unaffected. While not about recalls, Mathios (2000) explores the impact of disclosure laws on salad dressing sales.

<sup>16</sup> Marino shows that the second-best regulatory mechanism hinges on the degree of competition in the industry and on the efficacy of the liability system.

can boost consumer confidence and stimulate higher future sales. She does not, however, consider product buybacks or the post-sale duties to warn that are considered here.<sup>17</sup>

Ben-Shahar (2005) investigates the incentives of a manufacturer to continue selling a dangerous product when consumers are unsuspecting of the harms that they face. The manufacturer's decision to stop selling the product serves as an admission of guilt making victims more likely to sue. When faced with strict liability, manufacturers will keep dangerous products on the market too long to avoid stimulating a flood of lawsuits that wouldn't otherwise occur.<sup>18</sup> Ben-Shahar doesn't consider the behavior of existing consumers under different liability rules, however, nor does he consider the efficacy of other post-sale actions such as product buybacks.<sup>19</sup>

Shavell (1994) and Polinsky and Shavell (2006) consider the costly acquisition and subsequent disclosure of information about product quality (safety) by monopolists *prior to a sale*.<sup>20</sup> Manufacturers have a private incentive to disclose favorable information, since higher

---

<sup>17</sup> Welling shows that imposing strict liability on manufacturers when they fail to warn consumers (but not otherwise) implements the social optimum when consumers all face the same level of risk. In our model, strict liability with a warning defense leads to excessive disclosure.

<sup>18</sup> The manufacturer also has socially inadequate incentives to acquire information about product risks. Rule 407 of the Federal Rules of Evidence render the manufacturer's recall decision inadmissible as evidence at trial and restore proper incentives to recall products and acquire information. See Ben-Shahar (2006) for a discussion of the Vioxx case.

<sup>19</sup> Ben Shahar (1998) explores whether liability should be based on information that wasn't known at the time of sale, focusing on *ex ante* incentives rather than the post-sale incentives considered here.

<sup>20</sup> This paper is also related to the broader theoretical literature on information disclosure. Milgrom (1981) and Grossman (1981) showed that privately-informed parties would tend to disclose favorable information to avoid adverse inferences from non-disclosure, leading to unraveling. In contrast, Verrecchia (1983) found that partial pooling results when disclosure is costly. Parties with sufficiently unfavorable information pool together, suffering the average adverse inference for the group but saving on disclosure costs.

quality products command higher prices in the market.<sup>21</sup> Manufacturers who learn that they have low quality products (unsafe products) refrain from disclosing and, in equilibrium, pool with manufacturers who chose not to acquire the information at all. In contrast, the current paper considers information that is discovered after a sale has taken place and the impact that liability rules have on the decision to recall products. Our assumption that consumers are homogeneous *ex ante* allows us to focus exclusively on the *ex post* efficiency considerations.<sup>22</sup>

The next section presents a simple numerical example to illustrate the main ideas of this paper. Section 3 presents the model and Section 4 derives the social welfare benchmark. Section 5 analyzes several liability regimes, including no manufacturer liability, strict manufacturer liability with and without the possibility of product buybacks, strict liability with a warning defense, and a negligence-based duty to warn. Section 6 discusses several extensions including manufacturer incentives to design safer products and the incentives to issue product warnings prior to a sale. Section 7 concludes.

## 2. An Example

Suppose that a manufacturer has sold and distributed a potentially hazardous product to 100 consumers. There is a small chance that the product will cause an accident during normal product use, causing damages to a consumer of \$10,000. In this post-sale phase, the manufacturer receives a more precise private signal about the likelihood of an accident. Ninety-

---

<sup>21</sup> See also Dye (1985) for a model of partial pooling in the securities context. In Matthews and Postlewaite (1985) both acquisition and disclosure are costless. Daughety and Reinganum (1995) show that privately informed firms signal their product risks through the prices that they charge, but do not explore direct disclosure.

<sup>22</sup> In the model, all liability rules considered are *ex ante* efficient. Although the initial sales price presumably varies across liability regimes, the homogeneous consumers all purchase the product initially (as they should).

nine percent of the time the manufacturer learns that the product is “safe” and that just 0.1 percent of users will suffer injuries. In this case, the expected harm to a consumer from using the product is  $(.001)(\$10,000) = \$10$ . One percent of the time, however, the manufacturer learns that the product is “dangerous” and that 6.0 percent of users will suffer harm, an expected harm of  $(.06)(\$10,000) = \$600$  per unit sold. (Note that, at the time of the sale, the expected level of harm associated with a single unit of the product is  $(.01)(\$10) + (.99)(\$600) = \$15.90$ .)

We will assume that consumers derive a gross value from continuing to use product. Half of the consumers value the product at \$500 while the other half of the consumer population value the product at \$300.<sup>23</sup> These valuations are privately observed by the consumers – although the manufacturer knows the distribution of valuations, he cannot tell one consumer from another. It is socially efficient for all consumers to continue using the product if the product is “safe.” When the chance of an accident is just one in a thousand, the consumers’ private valuations of \$300 and \$500 swamp the associated expected harm of \$10. When the product is dangerous, however, then the expected harm is \$600 and all of the consumers should stop using the product. In a perfect world (and assuming that the cost of notifying consumers is not too high), the manufacturer would issue a warning to consumers when the product was found to be dangerous, and consumers would discontinue their product use.<sup>24</sup> If the product is safe, no warnings are issued and the consumers continue to use the product. This is the first-best outcome.

---

<sup>23</sup> These numbers represent the consumers’ gross valuations; their net valuations would include any uncompensated losses associated with product use.

<sup>24</sup> Alternatively, notifications could be issued when the product was unusually safe, thereby letting consumers know that they should continue using the product. If the consumer failed to receive the notification, they would assume that the product was dangerous and discontinue using the product. This alternative disclosure rule is undesirable since safe products are the norm rather than the exception (99% versus 1%). When it is expensive to notify consumers, notification should be reserved for relatively rare events.

Suppose that the manufacturer is held strictly liable for product injuries and must compensate consumers for 100% of the harms that they suffer in accidents. It is easy to see that strict liability, absent buybacks or warning defenses, will not lead to efficient behavior. Since consumers are “made whole,” they have little incentive to curtail their use of the product after they learn that the product is dangerous. This implies that the manufacturer has little incentive to warn consumers of the impending dangers – what is the point of warning a consumer if the consumer won’t respond to the warning?

Private incentives improve, however, when the manufacturer is strictly liable but also has the option to repurchase the product from consumers. Recall that half of the consumers value the product at \$300 while the other half value it at \$500. After discovering that the product is dangerous, the manufacturer has two viable choices. First, the manufacturer could offer to buy the product back for \$500 per unit. All 100 consumers would accept this offer, and the manufacturer would face no future risk of liability. The manufacturer’s expected payments in this case are \$50,000. Paying \$50,000 for the return of the product is better than having 6% of consumers suffer serious harm, exposing the manufacturer to liability payments of \$60,000. The manufacturer can do even better, though: he can offer to pay consumers \$300 per unit. Since this offer will be accepted by half of the consumers, the manufacturer’s expected payments are even lower:  $(50)(\$300) + (50)(\$600) = \$45,000$ .<sup>25</sup>

Several remarks are in order. First, product buybacks serve an important social purpose. When manufacturers face liability, buybacks are a decentralized mechanism for removing a dangerous product from public use. Product buybacks leads to distortions relative to the first-best outcome, however. First, the buyback price offered by the manufacturer offers is too low.

---

<sup>25</sup> In other words, the manufacturer pays \$300 to half of the consumers through the buyback and \$600 to the other consumers in expected liability payments.

Just as a monopolist chooses a selling price that is excessively high, our manufacturer – a monopsonist – selects a buyback price that is excessively low. When the manufacturer offers a price of \$300, the consumers who value the product at \$500 refuse to sell it back. Society would be better off if the manufacturer offered to buy the product back for \$500 instead. If the buyback price were set at \$500, all consumers would return the product and the accident losses would be avoided. Compared with the first best outcome, strict liability with product buybacks leads to a social loss of  $\$600 - \$500 = \$100$  per high-valuation consumer when the product is dangerous, or an *ex ante* expected social loss of  $(.01)(50)(\$100) = \$50$ .<sup>26</sup>

Consider instead a liability rule where manufacturers can avoid liability by simply contacting and disclosing the product's risks to consumers. We will call this rule strict liability with a warning defense. This rule has the desirable feature that, once warned, consumers will internalize the harm associated with product use. In our example, if the manufacturer warns consumers that the product is "dangerous" and will cause harm to 6 percent of users then all consumers will voluntarily choose to stop using the product since the expected level of harm from a dangerous product, \$600, exceeds the consumers' private valuations of \$300 and \$500. If the manufacturer warns consumers that 0.1 percent of users will be harmed (so the product is relatively safe, with an expected harm of only \$10) then all consumers will continue to use the product (as they should).

---

<sup>26</sup> In this simple two-type example, the private incentive to initiate a buyback corresponds to the social incentive. The manufacturer saves  $\$600 - \$300 = \$300$  on each unit that is returned, which exactly equals the social value of the return. Conditional upon the buyback price (which is undoubtedly too low) the manufacturer will initiate a buyback if and only if it is cost justified in a social sense. If there were more types of consumers, then this would no longer be true. Consumers would receive some surplus in a buyback, and as a consequence the manufacturer's incentives to initiate a buyback would be too low.

The downside of the warning defense is that it generates excessive incentives for manufacturers to warn consumers. Suppose, for example, that it costs just \$0.40 to disclose the product's risk to a consumer – the approximate cost of a first-class postage stamp. The manufacturer will choose to pay this cost, of course, when the product is dangerous, since a \$0.40 postage stamp is very cheap compared to the expected harm of a dangerous product (which were assumed to be \$600). The manufacturer will also pay this cost when the product is relatively safe with a risk of only 0.1 percent, since the expected liability of \$10 per unit exceeds the \$0.40 postage stamp. But notifying consumers that the product has a 0.1 percent risk of causing an accident is socially wasteful – consumers continue to use the product, with or without this warning, as they should. The warning defense performs better than product buybacks when the cost of disclosure is small relative to the pricing distortion in the buyback market. When contacting old customers is expensive, however, then product buybacks will lead to a higher level of social welfare than the warning defense.<sup>27</sup>

Social welfare is maximized by a post-sale duty to warn where the manufacturer is held liable only when he fails to take “cost-justified” actions. In our example, the manufacturer should be held liable when the product is dangerous and he fails to pay the \$0.40 to warn consumers of this fact. Paying \$0.40 in postage is cost-justified in this example because of the subsequent change in consumer behavior and the reduction in accident losses. Warning consumers is not cost-justified when the product is relatively safe, however. If the product is safe, then warning consumers is a waste of a postage stamp since consumers will not (and should

---

<sup>27</sup> Compared with the first-best outcome, the social cost here is  $(.99)(\$40) = \$39.60$ . This is smaller than \$50, the social cost of the product buyback. If the cost of contacting old customers was \$1 instead of \$.40, then the social cost of the warning defense would rise to  $(.99)(\$100) = \$99$ . In this case, the product buyback is socially preferred.

not) change their behavior in response to the new information. Therefore the manufacturer should be immune to lawsuits in when the product is found to be relatively safe.<sup>28</sup>

### 3. The Model

A potentially harmful product is produced and sold by a manufacturer with unit production cost  $c$ . The mass of consumers is normalized to 1. Each consumer uses at most one unit of the good. Consumers are homogeneous at the time of their initial purchase with an expected valuation of  $v_0$ , but learn their idiosyncratic valuations for the product following their purchase.<sup>29</sup> A consumer's *gross* valuation for the product is  $v$  which is drawn from an integrable density function  $g(v)$  which is positive on the support  $[\underline{v}, \infty)$  and zero elsewhere.<sup>30</sup> We make the standard assumption that the hazard rate  $G(v)/g(v)$  is strictly increasing on  $[\underline{v}, \infty)$ .<sup>31</sup> The consumer's *net* valuation for the product is the gross value less any uncompensated harm or injuries associated with the product's use. The expected harm associated with a unit of the

---

<sup>28</sup> Disclosing just the high risks and remaining silent about the small risks is socially desirable here since the high risks are relatively rare, occurring only 1 percent of the time. The same consumer behavior could be achieved by disclosing risks when the risks are very low and remaining silent when the risks are high. But the former occurs 99 percent of the time, so the costs of postage would be almost two orders of magnitude higher if warnings were made for the relatively safe products.

<sup>29</sup> The assumption of *ex ante* homogeneous consumers with unit demand simplifies the analysis. Importantly, there is no *ex ante* deadweight loss from monopoly pricing. Polinsky and Shavell's (2006) analysis of disclosure prior to a sale explicitly takes these distortions into account.

<sup>30</sup> The fact that the distribution is unbounded above implies that some consumers should continue to use the product for any finite product risk. The assumption that the distribution is bounded below facilitates the characterization of the social welfare benchmark and will be discussed in greater detail later.

<sup>31</sup> This assumption will imply that the manufacturer's profit function is single peaked, giving a unique and well-behaved buyback price. Many commonly known distributions satisfy this monotone hazard rate assumption, including the normal distribution and the uniform distribution.

product,  $h$ , is drawn from the density  $f(h)$  on the support  $[0, \infty)$  with mean  $h_0$ . This harm level is assumed to be the same for all buyers.

Following the production and sale of the product, the consumers privately learn their valuations,  $v$ , and the manufacturer privately observes the expected level of per unit harm,  $h$ . In this post-sale phase, the parties can take actions to mitigate the future losses from product injuries. A consumer can simply stop using the product, foregoing his valuation  $v$ .<sup>32</sup> The manufacturer can issue a post-sale product warning, disclosing the level of future harm,  $h$ , to existing consumers. It is assumed that disclosures are accurate; the manufacturer cannot understate or overstate the accident risks in the product warning. In addition, the manufacturer can make an offer to buy the product back from consumers for a price  $p$ , which is endogenous.<sup>33</sup>

Contacting old customers is assumed to be costly. The parameter  $\Delta > 0$  represents the costs of identifying and notifying past purchasers of the product. In practice,  $\Delta$  would include the direct costs of postage and paperwork, the costs of reviewing previous records and registrations, and the transactions costs of coordinating with retailers and distributors (who may have more direct access to information about consumers).

---

<sup>32</sup> This framework could be extended to allow for durability, where the consumer consumes the product both before and after learning his preferences. Allowing the consumer to purchase a replacement product from the same manufacturer would, of course, complicate the analysis considerably.

<sup>33</sup> There is a small literature on returns policies when consumers learn their valuations after purchase. In Che (1996), returns policies where consumers can return products at the price paid may be privately and socially desirable in order to avoid inefficient consumption (when a consumer values the product less than the cost of the product) and to avoid unnecessary risk (when consumers are risk averse). In his model, disclosure is irrelevant (because the seller does not learn anything) and the seller can commit to the returns policy *ex ante*. Without commitment, Che's seller would not take returns. In our model, the seller has a private *ex post* incentive to buy back the product to avoid liability payments. Matthews and Persico (2005) consider menus of contracts and consumers' costly acquisition of information about their private valuations.

We will assume throughout the paper that  $v_0 - c - h_0 - \Delta > 0$ , so it is socially efficient for the product to be produced and sold even when post-sale warnings are routinely issued (at cost  $\Delta$ ) and consumers disregard all warnings and continue to use the dangerous product. This assumption, together with our earlier assumption that consumers are *ex ante* identical, implies that the different liability rules all lead to the same *ex ante* level of sales. Although the price that the monopolist initially charges for the product would presumably differ under the different liability regimes, there are no *ex ante* distortions arising from a failure to warn. All consumers purchase the product, as they should. The liability rules differ, however, in their effects on the post-sale usage. This post-sale phase is the main focus of the paper.

#### 4. The Social Welfare Benchmark

We will first characterize the optimal policy of a social planner who can control both the manufacturer's decision to disclose the information about product harms (the "disclosure rule") and each individual consumer's decision about whether to continue to use the product (the "consumption rule"). Formally, the disclosure rule partitions the different manufacturer types into two groups, one that discloses product harms to consumers ( $\Omega_D$ ) and the other that remains silent ( $\Omega_{ND}$ ). Given the available information, the consumption rule dictates which *ex post* consumer types will be permitted to use the product and which consumers must stop.

More formally, suppose that  $h \in \Omega_D$  so the product harm  $h$  is disclosed to consumers at cost  $\Delta$ . In this case, the consumption rule can depend on the true level of harm  $h$ . The optimal consumption rule would allow consumers with sufficiently high valuations ( $v \geq h$ ) to continue to use the product but would require consumers with sufficiently low valuations ( $v < h$ ) to discontinue their use. If  $h \in \Omega_{ND}$ , on the other hand, the consumption rule cannot depend on the

true level of harm. It can, however, depend on the *average level of harm* for this group  $h_{ND} = E(h|h \in \Omega_{ND})$ .<sup>34</sup> With non disclosure, the socially optimal consumption rule allows consumers with valuations above the expected harm conditional upon nondisclosure ( $v \geq h_{ND}$ ) to continue to use the product. Consumers with valuations below the expected level of harm would be required to stop.

Taking the socially optimal consumption rule as given, social welfare can be written as a function of the disclosure rule,  $\Omega_D$  and  $\Omega_{ND}$  :

$$\int_{\Omega_{ND}} \int_{h_{ND}}^{\infty} (v-h)g(v)f(h)dv dh + \int_{\Omega_D} \int_h^{\infty} (v-h)g(v)f(h)dv dh - \int_{\Omega_D} \Delta f(h)dh. \quad (1)$$

The first term of equation (1) represents the *ex post* social surplus associated with the set  $\Omega_{ND}$ .

When  $h \in \Omega_{ND}$  consumers with valuations  $v > h_{ND}$  continue to use the product and the social surplus for these consumers  $v-h$ . The second term of equation (1) is the *ex post* social surplus associated with the set  $\Omega_D$ . When  $\pi \in \Omega_D$  then consumers with valuations  $v > h$  continue to use the product (as they should) giving a social surplus of  $v-h$ . The third term is the cost of disclosure.

Lemma 1 tells us that, in general, the socially optimal decision rule could involve three regions: a middle region where disclosure does not take place ( $\Omega_{ND}$ ) and a high and a low region (together forming  $\Omega_D$ ) where the product risks are disclosed. Intuitively, when harms are close to  $h_{ND}$  then the social value of disclosure is small. When  $h = h_{ND}$  then the consumption rule under disclosure is exactly the same as the consumption rule without disclosure (the consumer

---

<sup>34</sup> Bayesian consumers would rationally form this expectation following non disclosure.

will consume the product if and only if  $v > h_{ND}$ ). When the level of risk is far from  $h_{ND}$ , however, then disclosure can significantly change behavior and increase social welfare.

Lemma 1: In general, the socially optimal disclosure rule can involve two cutoffs,  $h'$  and  $h''$ , where  $0 \leq h' < h''$ ,  $\Omega_{ND} = [h', h'']$  and  $\Omega_D = [0, h') \cup (h'', \infty)$ .

Proof of Lemma 1: Take a particular risk type,  $h$ , from the set  $\Omega_{ND}$  and move this type to the set  $\Omega_D$ . The marginal social cost of this change is simply the cost of disclosure,  $\Delta$ . The marginal social benefit, however, depends on the particular value of risk  $h$ . When  $h = h_{ND}$  (the average value in the set  $\Omega_{ND}$ ) there would be *no social benefit* from moving  $h$  from the set  $\Omega_{ND}$  to the set  $\Omega_D$ . When  $h = h_{ND}$ , consumers would use the product in a socially desirable way, with or without disclosure. If  $h > h_{ND}$ , however, then a group of consumers who would have used the product when  $h$  remained in the set  $\Omega_{ND}$  are subsequently required to stop. In particular, any consumers with valuations between  $h_{ND}$  and  $h$  stop using the product following the disclosure that the social harm is  $h$  instead of  $h_{ND}$ . Since these consumers shouldn't be consuming the product, this leads to a social benefit of:

$$\int_{h_{ND}}^h (h - v)g(v)dv.$$

Conversely, if  $h < h_{ND}$  then a group of consumers who may have otherwise foregone the use of the product before disclosure are subsequently permitted to use the product, namely the consumers with valuations between  $h$  and  $h_{ND}$ . This would generate a social benefit, too, since consumption is socially desirable for these consumers,

$$\int_h^{h_{ND}} (v - h)g(v)dv.$$

In both cases, the social benefit of disclosing information about  $h$  rises when  $h$  moves farther away from  $h_{ND}$  and is negligible when  $h = h_{ND}$ . Therefore if the socially optimal rule has disclosure at all, it will happen when the harm level is either very low or very high.

Q.E.D.

Requiring a manufacturer to pay large sums of money to contact old consumers to notify them that the products that they own and use are unusually *safe* is not typical in tort law. In reality, liability may be imposed on manufacturers when they fail to warn consumers that their

products are unusually *dangerous*. This fact is not inconsistent with the properties of our model. Analytically, the lowest region described in the Lemma disappears when average harm level in the population,  $h_0$ , is sufficiently small. When accidents are rare and expected harms are low from an *ex ante* perspective, then there is very little to be gained from revealing that the product is unusually safe. The following assumption, which we maintain throughout the paper, will guarantee that it is socially desirable to disclose information when the product is especially hazardous but not otherwise.

Assumption 1:  $h_0 < \underline{v}$ .

Assumption 1 tells us that all consumers – even those who like the product the least – still value the product at above the *ex ante* expected harm,  $h_0$ . If the product risks remained unknown, the social planner would allow all consumers to use the product. This is not unreasonable, especially in light of the fact that these consumers presumably valued the product enough to buy it in the first place.<sup>35</sup> More generally, this assumption implies that there is social value from disclosing product risks when the probability of harm is high but not when the probability of harm is low. This allows us to state and prove a very intuitive social welfare benchmark.

Proposition 1: (Social Welfare Benchmark). Under Assumption 1, the socially optimal disclosure rule is characterized by a single cutoff,  $h^*(\Delta)$ , implicitly defined by:

---

<sup>35</sup> In reality, some people dislike products and stop using them shortly after purchasing them and never bother to return them. This paper deliberately abstracts from these types of consumers in order to focus instead on the situation where recalls change behavior.

$$\int_{\underline{v}}^{h^*(\Delta)} [h^*(\Delta) - v]g(v)dv = \Delta \quad (2)$$

where  $h^*(\Delta)$  is an increasing function of  $\Delta$  with  $h^*(0) = \underline{v}$  and  $h^*(\Delta) > \Delta$ .

- (i) If  $h \leq h^*(\Delta)$  then the harm is not disclosed and all consumers use the product.
- (ii) If  $h > h^*(\Delta)$  then the harm is disclosed and only consumers with valuations  $v > v^*(h) = h$  continue to use the product.

This result may be understood intuitively. Suppose that the expected future harm is *exactly* at the cutoff, so  $h = h^*(\Delta) > \underline{v}$ . What is the marginal social benefit of using this piece of information? If the harm is not disclosed, then  $h_{ND} < h_0 < \underline{v}$  all consumers will continue to use the product. A group of these consumers – namely the ones with valuations between  $\underline{v}$  and  $h^*(\Delta)$  – should in fact discontinue using the product. The marginal social benefit associated with disclosing this harm to consumers is that the consumers with valuations in this interval will stop using the product, saving society  $h^*(\Delta) - \underline{v}$ . The cutoff  $h^*(\Delta)$  in equation (2) is defined to be the level of harm for which the marginal social benefit of disclosing the information to consumers is exactly equal to the marginal social cost,  $\Delta$ .

**Proof of Proposition 1:** The cutoffs  $h'$  and  $h''$  in Lemma 1 are the solutions to the following program:

$$\begin{aligned} \text{Max}_{0 \leq h' < h''} \int_0^{h'} \int_h^\infty (v-h)g(v)f(h)dv dh + \int_{h'}^{h''} \int_{\rho(h',h'')}^\infty (v-h)g(v)f(h)dv dh \\ + \int_{h''}^\infty \int_h^\infty (v-h)g(v)f(h)dv dh + [1 - F(h'') + F(h')] \Delta, \end{aligned}$$

where  $\rho(h', h'') = E(h | h \in [h', h''])$  the expected level of harm in the non-disclosure range. Holding  $h''$  fixed for a moment, differentiating this expression with respect to  $h'$  gives the first-order condition:

$$\int_{h'}^{\rho(h',h'')} (v-h')g(v)dv \leq \Delta \text{ and will equal } \Delta \text{ if } h' > 0,$$

It is easy to check that the left hand side of the first condition is *weakly decreasing* in  $h'$ , implying that the social value of raising the threshold  $h'$  is highest when  $h' = 0$ . If the left hand side of this condition is strictly smaller than  $\Delta$  when  $h' = 0$ , then it must be strictly smaller than  $\Delta$  for all  $h' > 0$ . Evaluating the left side of the first condition at  $h' = 0$  gives  $\int_0^{\rho(0,h'')} vg(v)dv \leq \int_0^{h_0} vg(v)dv = 0$ . This first inequality follows from the fact that  $\rho(0,h'') \leq h_0$  for all  $h''$ . The second inequality follows from Assumption 1. Therefore  $h' = 0$ . The second first-order condition is:

$$\int_{\rho(0,h'')}^{h''} (h''-v)g(v)dv = \Delta.$$

Since  $h_0 < \underline{v}$  by assumption, we know that  $\rho(0,h'') \leq h_0 < \underline{v}$  and so this condition becomes  $\int_{\underline{v}}^{h''} (h''-v)g(v)dv = \Delta$  and we denote the implicit solution to be  $h^*(\Delta)$ .

Q.E.D.

Note that the optimal threshold  $h^*(\Delta)$  in equation (2) is rising in the cost of disclosure. When the disclosure cost  $\Delta$  rises, the social planner discloses information less often. When the cost of disclosure falls then the threshold  $h^*(\Delta)$  falls; the social planner is disclosing information more often. Note that, in the limit,  $h^*(0) = \underline{v}$ . When the product risks are very low,  $h < h^*(0) = \underline{v}$ , then there is no social value to be gained from disclosing  $h$  to consumers. The expected harm is negligible compared to the value that the lowest valuation consumer gets from the product. Therefore there is a range of harm levels,  $h \in [0, \underline{v}]$ , that are *never disclosed to consumers*, even when the cost of disclosure is arbitrarily small.<sup>36</sup>

---

<sup>36</sup> Our assumption that  $\underline{v}$  was bounded away from 0 is of course important for this result. If  $\underline{v} = 0$  and  $\Delta$  was arbitrarily small, then the socially optimal decision rule would involve disclosure of both very high and very low harms. (In the limit, all harms except the point  $h = h_0$  would be disclosed.) The social welfare benchmark in this case would be unattainable by all realistic liability rules. An alternative modeling strategy, where  $\underline{v} = 0$  but  $\Delta$  is sufficiently

## 5. Liability Rules

### 5.1. No Manufacturer Liability

Suppose that the consumers are held responsible for their own product-related injuries, and that the manufacturer bears no liability for the injuries themselves or for any failure to warn consumers of the risks that they face. It is clear that the manufacturer has no incentive to pay the costs of disclosure in this setting. There is nothing to be privately gained from a warning per se, and there is no incentive for the manufacturer to buy the product back.<sup>37</sup> Consumers know this, of course, but believe (correctly) that the product risks are low on average. Under Assumption 1 all consumers would continue to consumer the product. The social welfare associated with this regime is therefore given by

$$SW^{NL} = v_0 - h_0 > 0.$$

Note that consumers are making the socially correct decisions in this regime to use the product, *conditional upon their lack of information*. The consumers are less informed here, however, since the manufacturer has no incentive to disclose information about product risks. This leads to losses relative to our benchmark since the low valuation consumers are unable to restrict their usage decisions when the product poses significant hazards.

---

bounded away from zero, would yield similar results to those derived here but the restrictions are less intuitive.

<sup>37</sup> If the manufacturer learned information before selling the product, then the manufacturer would have an incentive to disclose that the product was safe in order to extract a higher sale price. See Polinsky and Shavell (2006).

Proposition 2: (No Manufacturer Liability.) If manufacturers are not held accountable for product injuries then no warnings are issued and no product buybacks offered. Consumers make the socially efficient usage decision (conditional on having no information) and continue to use the product.

## 5.2. Strict Manufacturer Liability.

Now suppose instead that the manufacturer is forced to bear full responsibility for all product-related injuries, regardless of the warnings that he has issued. Consumers have no intrinsic reason to stop using the product in this case – consumers expect to be fully compensated for their harms if injured. Consequently, strict liability by itself provides little incentive to the manufacturer to disclose product risks. Although the manufacturer has little incentive to warn consumers per se, the manufacturer might still find it profitable to contact consumers in order to solicit the return of the product. Indeed, the manufacturer would derive a private benefit from a product buyback so long as the price he pays for a unit of the good,  $p$ , is less than the manufacturer's expected liability payments associated with that unit,  $h$ . The manufacturer also has an incentive to warn consumers when the warning itself may serve as a defense against liability. We will explore each of these possibilities in turn.

### ***Product Buybacks***

This section derives the manufacturer's equilibrium buyback policy under strict liability and considers its social desirability. To start, consider a consumer with valuation  $v$  facing an offer from the manufacturer to buy the product back for a price  $p$ . If the consumer keeps the good, he derives value  $v$  from consumption. The consumer's valuation does not depend on the

expected harm because the consumer is made whole under strict liability – any harm that the consumer suffers will be fully compensated. It follows that the consumer would return the product to the manufacturer if and only if  $v < p$ .

If he stages a buyback, the manufacturer would choose the buyback price  $p$  to simply minimize his expected future payments,

$$\text{Min } pG(p) + h[1 - G(p)] + \Delta .$$

The first term represents the buyback payments to those consumers who choose to return the product, and the second term represents the expected liability payments to those consumers who do not comply with the recall and choose to retain and use the product. The third term reflects that the manufacturer cannot tell the low and high valuation consumers apart, so all consumers are contacted in a buyback. Differentiating this expression gives the following first-order condition:

$$[h - p^B]g(p^B) = G(p^B). \quad (3)$$

When the manufacturer raises the buyback price slightly the benefit is that it pays  $p^B$  instead of  $h$  to the marginal consumer who decides to return the product rather than continue to use it. The manufacturer's marginal benefit is therefore  $[h - p^B]g(p^B)$ . The manufacturer's marginal cost associated with the slightly higher buyback price is that he ends up paying a higher buyback price to consumers who would have sold the product back to the manufacturer at the lower price,  $G(p^B)$ . The manufacturer's privately optimal buyback price equates the marginal benefit with the marginal cost.

Importantly, one can see that the buyback price  $p^B$  will typically be less than the unit harm,  $h$ . The manufacturer is a *monopsonist*, a single buyer with market power when it comes to repurchasing its own products in order to avoid liability payouts. Just as a *monopolist* extracts profits from buyers by charging a price above marginal cost, our *monopsonist* manufacturer

extracts rents from past consumers by offering a buyback price that is less than the manufacturer's opportunity cost of not having the product returned,  $h$ . Note that the socially optimal buyback price is exactly equal to the harm level,

$$p^*(h) = v^*(h) = h. \quad (4)$$

At this price, consumers would make the socially correct usage decision.

Lemma 2: When  $h \geq \underline{v}$  the manufacturer's best buyback price (if he chooses to do a buyback),  $p^B(h)$ , is the implicit solution to equation (3). In this range,  $p^B(h)$  is strictly increasing in  $h$  with  $p^B(\underline{v}) = \underline{v}$  and  $p^B(h) < p^*(h) = h$  for all  $h > \underline{v}$ . When  $h < \underline{v}$  the manufacturer cannot benefit from a buyback (so  $p^B(h) < \underline{v}$  and no buyers accept).

Proof of Lemma 2: If  $h < \underline{v}$  then the least a consumer is willing to accept,  $\underline{v}$ , exceeds the manufacturer's maximal willingness to pay,  $h$ . The manufacturer cannot profit from a buyback in this case and they will not arise in equilibrium. If  $h > \underline{v}$  then the buyback price is implicitly defined by equation (3) above, or  $p^B + G(p^B)/g(p^B) = h$ . When  $h = \underline{v}$ , this equation is satisfied by  $p^B = \underline{v}$ . The monotone hazard rate assumption guarantees that the left hand side is an increasing function of  $p^B$ . Therefore  $p^B(h) < h$  is increasing in  $h$ .

Q.E.D.

When the expected liability exceeds the valuation of the lowest consumer type,  $h > \underline{v}$ , the manufacturer may find it profitable to pay the fixed cost  $\Delta$  to stage a product buyback. The manufacturer would pay a total of  $p^B(h)G(p^B(h)) + h[1 - G(p^B(h))] + \Delta$  if he offers to buy the product back where  $p^B(h)$  is implicitly defined in equation (3). If the manufacturer does not stage a buyback, the consumers will all continue to use the product and the manufacturer will pay a total of  $h$ . The manufacturer will therefore stage the buyback when

$$\Delta < [h - p^B(h)]G(p^B(h)). \quad (5)$$

Proposition 3: (Strict Liability with Product Buybacks.) Suppose that the manufacturer is held strictly liable for product injuries and *can initiate a product buyback*. There exists a cutoff,  $h^B(\Delta)$ , implicitly defined by:

$$[h^B(\Delta) - p^B(h^B(\Delta))]G(p^B(h^B(\Delta))) = \Delta, \quad (6)$$

where  $h^B(\Delta)$  is an increasing function of  $\Delta$  with  $h^B(0) = \underline{v}$ .

- (i) If  $h \leq h^B(\Delta)$  then there is no buyback offered and all consumers continue to use the product.
- (ii) If  $h > h^B(\Delta)$  then the manufacturer offers to buy the product back for  $p^B(h)$  and consumers continue to use the product when  $v \geq p^B(h)$ .

Proof of Proposition 3: Combining equations (3) and (5), the manufacturer will stage a buyback when

$$\Delta < [h - p^B(h)]G(p^B(h)) = G(p^B(h)) \left( \frac{G(p^B(h))}{g(p^B(h))} \right) = \Psi(p^B(h)).$$

Let  $h^B(\Delta)$  be the level of harm that satisfies this expression with equality, or

$$\Delta = \Psi(p^B(h^B(\Delta)))$$

Totally differentiating this expression and rearranging terms,

$$\frac{dh^B}{d\Delta} = \left( \frac{d}{dp^B}(\Psi(p^B)) \frac{d}{dh^B}(p^B(h^B)) \right)^{-1}.$$

The derivative of  $\Psi(p^B)$  is positive because we assumed that the hazard rate,  $G(v)/g(v)$ , was monotone and the cumulative distribution function,  $G(v)$  is of course monotone as well. The derivative of  $p^B(h^B)$  is also positive by Lemma 2. Therefore we have that  $h^B(\Delta)$  is an increasing function as well. When  $\Delta = 0$  the manufacturer will stage a buyback for all  $h > \underline{v}$  and, from the previous lemma,  $p^B(\underline{v}) = \underline{v}$ . We have  $h^B(0) = \underline{v}$ .

Q.E.D.

We will now prove that the private benefit to the manufacturer of staging a buyback is smaller than the social benefit when  $h > \underline{v}$ . The manufacturer's private benefit from the buyback is  $[h - p^B(h)]G(p^B(h))$ . The manufacturer saves  $h - p^B(h)$  when a consumer returns the product, and the volume of returns is  $G(p^B(h))$ . We can write this private benefit as:

$$\int_{\underline{v}}^{p^B(h)} (h - p^B(h))g(v)dv. \quad (7)$$

We will use this expression in a moment. There is an important externality at play: the manufacturer doesn't take consumer surplus into account when thinking about his private benefit of a buyback. A consumer with valuation  $v < p^B(h)$  who returns the product gains consumer surplus of  $p^B(h) - v$ . The social gain from a buyback is the sum of producer and consumer surplus,  $(h - p^B(h)) + (p^B(h) - v) = h - v$ . Aggregated over all consumers, the social benefit of the product buyback is

$$\int_{\underline{v}}^{p^B(h)} (h - v)g(v)dv. \quad (8)$$

The social benefit of a product recall would be even higher still if consumers with valuations between  $p^B(h)$  and  $h$  stopped using the product. This does not happen because the firm is a monopolist and so  $p^B(h) < h$  for all  $h > \underline{v}$  (by Lemma 2). We have established the following result. The socially optimal buyback policy would feature a price  $p^*(h) = v^*(h) = h$  and a buyback whenever  $h > h^*(\Delta)$  as defined in the social welfare benchmark in equation (2).<sup>38</sup>

---

<sup>38</sup> These ideas are familiar from the standard monopoly problem. There, a monopolist charges too high a price and fails to capture the consumer surplus. Consequently, a monopolist may decline to sink fixed costs of entry even when entry is socially efficient.

Proposition 4: (Strict Liability with Product Buybacks.) The manufacturer selects a buyback price that is too low,  $p^B(h) < p^*(h) = h$ , and initiates a buyback too infrequently,  $h^B(\Delta) > h^*(\Delta) > \underline{v}$  when  $\Delta > 0$ .

The outcome with strict liability and product buybacks diverges from socially optimal behavior in two important respects. First, when buybacks are offered there are some consumers who continue to use the product even though it would be socially desirable for them to stop. This latter distortion arises because the buyback price is smaller than the expected harm,  $p^B(h) < p^*(h) = h$ . Second, the manufacturer's private incentive to engage in a buyback is too small. The reason is simple: consumers benefit from the buyback *ex post* (since they have the option to return or keep the product) and the manufacturer does not internalize the increase in consumer surplus that results from the buyback.

### ***The Warning Defense***

We now suppose instead that the manufacturer is strictly liable for all product-related injuries if he fails to warn consumers of the product's risks, but can totally avoid liability by contacting and warning consumers and disclosing the probability of harm. If the manufacturer fails to issue a warning, consumers expect to be fully compensated for their future harms and therefore continue to use the product without regard for the risks. Therefore if the manufacturer does not issue a warning he will be forced to compensate all consumers for their entire loss,  $h$ . If the manufacturer does issue a warning and discloses  $h$ , then responsibility shifts to the

consumers. Comparing the manufacturer's private benefit of disclosure (the liability savings  $h$ ) to his private cost of disclosure ( $\Delta$ ) gives the following result.

Proposition 5 (Strict Liability with a Warning Defense.) Suppose that the manufacturer is held strictly liable for product injuries if he does not issue a warning but can totally avoid liability by disclosing  $h$ . This rule implies a cutoff,  $h^W(\Delta) = \Delta$ , where:

- (i) If  $h \leq h^W(\Delta) = \Delta$  then no warning is issued and all consumers continue to use the product.
- (ii) If  $h > h^W(\Delta) = \Delta$  then the manufacturer issues a warning and consumers continue to use the product when  $v \geq h$ .

The rule of strict liability with a warning defense has the desirable feature that, once the consumers are warned, they will use the product if and only if their valuations exceed the expected level of harm. Although the private and social incentives are aligned conditional upon the disclosure of risk, they deviate from each other in another important respect. With a warning defense, the manufacturer has an *excessive incentive* to disclose risks to consumers. To see why this is true, suppose that the level of harm is exactly at the threshold,  $h = h^W(\Delta) = \Delta$ . The manufacturer's private benefit from disclosing the risk is  $h$  because, in the absence of disclosure, all consumers would use the product (since they are made whole absent disclosure) and the manufacturer would be forced to compensate each and every consumer for his or her injuries. The social benefit of disclosure is that, once this harm level is disclosed, any consumers with valuations below  $h$  will stop using the product – a marginal social benefit of

$\int_{\underline{v}}^h (h-v)g(v)dv$ . When  $h < \underline{v}$ , the social benefit is zero. When  $h > \underline{v}$ , this social benefit is positive but smaller than the private benefit of disclosure,  $h$ . In either case, the manufacturer warns the consumers too often.

Proposition 6: (Strict Liability with a Warning Defense.) The manufacturer chooses to warn consumers too frequently,  $h^W(\Delta) = \Delta < h^*(\Delta)$ . Conditional upon their information, however, consumers use the product when it is socially efficient for them to do so.

As the disclosure cost  $\Delta$  approaches zero then  $h^W(\Delta)$  approaches zero too – the manufacturer discloses all product risks in the limit, even those that will have no effect on consumer behavior. Interestingly, the warning defense approximates our earlier benchmark level of welfare when  $\Delta$  approaches zero. Although the manufacturer issues too many warnings,  $0 = h^W(0) < h^*(0) = \underline{v}$ , the aggregate cost of the excessive warnings becomes vanishingly small.

### 5.3 The Duty to Warn

Suppose that the court is well informed about the distribution of product harms and the nature of demand, and can design a liability rule that is sensitive to the manufacturer’s realized information about harm,  $h$ .<sup>39</sup> If the court could observe  $h$  *ex post*, then the court could implement the social welfare benchmark with a “duty to warn” requirement with a negligence standard  $h^*(\Delta)$  defined in the social welfare benchmark equation (2). Under this regime, the

---

<sup>39</sup> The court can potentially infer this harm level *ex post* by observing the prevalence and the magnitude of consumer injuries. If the manufacturer had private information about the aggregate probability of harm, however, then the realized harms are a very imperfect indicator of the information held by the manufacturer in the post-sale phase.

manufacturer will not be held liable for product-related injuries if he discloses information to consumers (issues a post-sale warning). The manufacturer will be held liable, however, if he fails to warn consumers of the risks and, in addition, the court determines that  $h > h^*(\Delta)$  (so a warning is cost-justified).

It is not hard to see why this rule leads to the socially correct consumer and producer behaviors. A consumer, believing that the manufacturer has complied with the standard, bears the full brunt of his own product-related injuries. Therefore the consumer will make the socially correct decision, conditional upon the information that is provided to him. This rule also gives the manufacturer the incentive to comply with the standard. Suppose that the manufacturer observes that the level of risk is just slightly above  $h^*(\Delta)$ , the duty-to-warn standard. The manufacturer prefers to disclose the risk to consumers rather than remain silent because his expected liability payments from non-disclosure are larger than the cost of disclosure,  $h^*(\Delta) > \Delta$ . This follows from equation (2) in Proposition 1. It follows that the manufacturer will comply with the standard when  $h = h^*(\Delta)$  and will also comply with the standard when  $h > h^*(\Delta)$  since the manufacturer's liability from not disclosing is increasing with his true type,  $h$ , but his costs remain fixed at  $\Delta$ .

Proposition 7: (The Duty to Warn.) A negligence rule that imposes a duty to warn on the manufacturer when the product risk is above a threshold,  $h > h^*(\Delta)$ , but no such duty when the product risk is below the threshold,  $h \leq h^*(\Delta)$ , implements the social welfare benchmark.

This negligence-based duty to warn might be difficult to implement in practice for several reasons. First, it would require the court to determine “reasonable” behavior on the part

of the manufacturer. In order to calculate  $h^*(\Delta)$  the court would need to know the characteristics of consumer demand,  $g(v)$ , the cost of disclosure,  $\Delta$ , the distribution of risks,  $f(h)$ , and the manufacturer's observation of the parameter  $h$ . See equation (2). While some of these features may be roughly observable to a court, others would require a significant degree of expertise. Eliciting information about the true level of the parameter  $h$  might prove troubling as well. The court does not observe this probability directly, of course, and the manufacturer has every incentive in the post-injury stage to keep this information to himself. In practice, the court would need to rely on the evidence elicited through pretrial discovery and litigation.

#### 5.4. Comparison of Liability Regimes.

The next proposition ranks the different liability regimes.

Proposition 8: (Comparison of Liability Regimes.) For any positive cost of disclosure,  $\Delta > 0$ , the Duty to Warn achieves higher social welfare than Strict Liability with Product Buybacks, which in turn achieves higher social welfare than No Liability. Strict Liability with a Warning Defense achieves higher social welfare than Strict Liability with Buybacks when the disclosure cost  $\Delta$  is small.

#### Proof of Proposition 8:

Strict liability with buybacks clearly does not implement the benchmark since  $p^B(h) < p^*(h) = h$  as described in Proposition 4. Strict liability with buybacks performs better than no liability at all, however. Following a recall, consumers with valuations  $v < p^B(h)$  return their products. These consumers who actively return the product are making the socially correct decision since  $p^B(h) < h$ . Although the manufacturer does not stage buybacks often enough (because the social value of a buyback exceeds the manufacturer's private value), the social value generated by the recalls is clearly higher than not having recalls at all.

When the cost of disclosure approaches zero, the social surplus associated with strict liability and product buybacks remains bounded away from the benchmark. Although the manufacturer's decision to stage a recall corresponds to the benchmark when the disclosure costs are negligible,  $h^B(0) = h^*(0) = \underline{v}$ , the buyback price remains suboptimal,  $p^B(h) < h$ . In contrast, the social surplus associated with strict liability with a warning defense approaches the benchmark when disclosure costs fall. When  $\Delta$  approaches zero, all harms are disclosed according to Proposition 6. Although  $h^W(0) = 0 < h^*(0) = \underline{v}$ , there is no loss of welfare associated with excessive disclosure in this case. The aggregate disclosure costs are zero in the limit for both the benchmark and for the warning defense. Both the benchmark and the warning defense lead consumers to discontinue their usage of the product when  $v < h$ . By continuity it must therefore be the case that the warning defense achieves higher levels of social welfare than strict liability with buybacks when the disclosure costs are sufficiently small.

Q.E.D.

## 6. Extensions

This paper has deliberately abstracted away from important *ex ante* issues in order to focus on the post-sale behavior of firms. This section discusses several implications for manufacturer behavior prior to selling the product and suggests how the post-sale duties and liabilities of manufacturers might be augmented to improve pre-sale activities.

### 6.1 Manufacturer Incentives to Design Safer Products

The analysis took the distribution of product harms,  $f(h)$ , as exogenous. While some risks are, in practice, beyond the control of manufacturers at the product design stage, other risks can be mitigated through better manufacturer precautions. Manufacturers of pharmaceutical products, for example, can invest more in clinical testing before releasing drugs on the general market. Similarly, manufacturers of automobiles can invest more in crash testing their vehicles and on other safety-related investigations.

While the post-sale duty to warn described in section 5.3 achieves the socially efficient levels of post-sale disclosure by manufacturers and product usage by consumers, it provides at

best weak incentives for the manufacturer to design safer products *ex ante*. The social cost of a harmful product includes both the harms to the consumer,  $h$ , and the costs to the manufacturer of staging the recall,  $\Delta$ . Under the post-sale duty to warn, the manufacturer bears the latter cost but not the former (since liability is averted when the manufacturer discloses information to consumers). It follows that the manufacturer will take suboptimal precautions to reduce the incidence of harm at the *ex ante* stage.<sup>40</sup>

Strict liability with a warning defense and strict liability with product buybacks may provide better *ex ante* incentives than the post-sale duty to warn. Recall that the warning defense led to excessive post-sale warnings – the manufacturer incurred the disclosure cost  $\Delta$  too frequently. The prospect of additional costs of disclosure could serve as a valuable deterrent for the manufacturer at the *ex ante* stage, generating higher a higher level of precautions to reduce the risk of needing to stage a recall in the future. Similarly, product buybacks are *ex post* costly for the manufacturer (since they pay consumers to return the product), creating an incentive to design safer products to begin with. It should be made clear, however, that these liability rules will fall short of full social efficiency. The improved *ex ante* deterrence is coupled with the very same *ex post* distortions identified earlier.

If we, as a society, are concerned that manufacturers are investing too little in precautions to reduce the future harms caused by their products, then it would make sense to adopt additional instruments to encourage these investments. Regulations that mandate product testing (as in the automobile and pharmaceutical industries) or negligence rules for *ex ante* care levels would be valuable supplements to the post-sale duties analyzed earlier. A full formal analysis combining

---

<sup>40</sup> The manufacturer's precautions could be optimal if they were observable to consumers, however.

pre-sale and post-sale issues could be an interesting exercise but is beyond the scope of this manuscript.

## 6.2 Product Risks Known by the Manufacturer at the Time of Sale

The earlier analysis focused exclusively on product risks that became known to the manufacturer after consumers had already purchased the product. This section extends the analysis to consider harms that are known to the manufacturer at the time of the initial sale of the product. The economic issues and the appropriate remedies are quite different in this setting.

To start, suppose that the manufacturer knows the product harm,  $h$ , before he sells the product to consumers and – importantly – that consumers know that the manufacturer has access to this information. Let us suppose further that disclosing the information to consumers at the pre-sale stage is very cheap – the manufacturer can costlessly put a warning label directly on the original package and need not resort to the costly recall methods described earlier. These assumptions are admittedly stark, but they will help us to ground our thinking.

It isn't hard to see that manufacturer liability is unnecessary in this setting – manufacturers will voluntarily disclose the product harms, even without laws or regulations requiring them to do so. This follows from traditional unraveling arguments (see Grossman, 1981; Verrechia, 1983; Shavell, 1994; Polinsky and Shavell, 2006). Suppose that the manufacturer will not be legally responsible for future harms to consumers, and consider a consumer's willingness to pay for one unit of the product. This willingness to pay is the consumer's expected valuation from consuming the product in the future,  $E(v|\bullet)$ ,<sup>41</sup> minus any

---

<sup>41</sup>  $E(v|\bullet)$  could be much lower than  $v_0$  since the consumer may stop using the product following a warning or a recall.

uncompensated expected harm,  $E(h|\bullet)$ . Suppose that the manufacturer learns prior to the sale that the product is totally safe,  $h = 0$ . If the manufacturer credibly reveals this to the consumers, he can command a price of  $p = v_0$ . This is an excellent price – the highest price the manufacturer could ever hope to receive. If he remains silent, on the other hand, the consumers would believe that the product is less safe and wouldn't be willing to pay as much. The inferences made by consumers when the manufacturer is silent put pressure on the manufacturers of slightly less safe products to disclose the product's harm as well. In the absence of manufacturer liability, all of the information would come to light and the manufacturer's price would perfectly reveal the harm to consumers. Moreover, armed with the information about the true level of harm, the consumers would make the appropriate product usage decisions *ex post* when they learn their valuations, consuming when  $v \geq h$  but not otherwise. The first-best outcome is achieved.

In this stark setting, imposing strict liability on manufacturers is worse than having no manufacturer liability at all. Suppose for a moment that product buybacks are impossible. If consumers expected to be fully compensated by the manufacturer for their harms *ex post*, then they would have no incentive to modify their consumption patterns after learning that their valuations are in fact low. In addition, consumers would not be willing to pay a premium for safer products to begin with. It follows that manufactures would have no incentive to warn consumers about the product risks. The possibility of a later recall and buyback would complicate the analysis, of course, but would not achieve the first-best outcome due to the monopsony distortion discussed earlier.<sup>42</sup>

---

<sup>42</sup> Allowing for a warning defense (or a defense of contributory negligence as discussed below) could restore incentives to disclose information and improve on consumer incentives to use the

This discussion has highlighted a fundamental difference between product harms that are known at the time of a sale and those that are only discovered later after the product has been sold. In the former case, the economic incentives created by the market lead to information disclosure and efficient product usage. These incentives may not be perfect – disclosure at the time of sale may be costly and the acquisition of information may be expensive, leading to partial disclosure and incomplete revelation to consumers (Polinsky and Shavell, 2006) – but they still provide a market-based source of value. When harms are discovered by the manufacturer only after the product has been sold, these fundamental market incentives are missing. When product risks are discovered only after the sale of the product, manufacturer liability is necessary to create proper incentives for disclosure.

## **7. Conclusion**

This paper considered the problem of encouraging manufacturers to adequately warn consumers of product dangers, while at the same time encouraging consumers to make prudent decisions about continuing to use dangerous products. Under a regime of strict liability, the manufacturer may find it profitable to contact consumers and offer to repurchase the product. By doing so, the manufacturer can avoid the future liability associated with product injuries. Although this regime performs better than having no liability at all, the private incentives of the manufacturer fall short of the social welfare benchmark. The manufacturer does not internalize the surplus that his buyback creates for consumers, and therefore does not stage a recall often enough and makes a buyback offer that is too low. It was shown that strict liability with a warning defense creates an excessive incentive to recall products, but achieves a higher level of

---

products appropriately, but such rules could never perform better than simply having no manufacturer liability at all.

social welfare when the cost of contacting and warning consumers is sufficiently small. A negligence-based duty to warn, where the manufacturer is held liable if and only if he fails to take cost-justified measures, achieves the social welfare benchmark (but may be difficult to implement).

Future research on this topic might explore the efficacy of other legal instruments as well. Punitive damages, for example, could improve the outcome under strict liability. Increasing the manufacturer's liability for product harms would in turn increase the price that the manufacturer offers to buy the product back from consumers, helping to align the private and social incentives. Alternatively, a regulator might step in and directly influence the buyback price that the manufacturer offers, rather than allowing it to be discretionary. (The manufacturer's decision to stage the buyback may still be suboptimal with a regulated price, however.) Finally, the excessive incentive to disclose information created by the warning defense might be mitigated by having a damage multiplier that is smaller than one, or even theoretically by taxing the manufacturer's expenditures on product recalls.

This paper abstracted from the effect of product recalls on the future sales and activities of manufacturers. When products are long-lived and the quality of products is correlated over time, the decision of a manufacturer to recall a product can have the long run effect of chilling demand for the manufacturer's product and potentially encouraging additional lawsuits that otherwise would not have been brought (as in Ben-Shahar, 2005). It would be interesting to model these future reputational concerns in addition to the corrective benefits of product recalls considered here. Another important issue is the manufacturer's decision to repair existing dangerous products rather than to simply repurchase them. These issues are beyond the scope of the current manuscript but could be fruitful areas for future research.

## 8. References

- Ben-Shahar, O. 2005. "How Liability Distorts Incentives of Manufacturers to Recall Products," available at SSRN: <http://ssrn.com/abstract=655804>.
- Ben-Shahar, O. 2006. "The Legal Pains of Vioxx: Why Product Liability can Make Products More Dangerous," *The Economists' Voice*, Vol. 3. No. 2, Article 6.
- Ben-Shahar, O. 1998. "Should Products Liability Be Based on Hindsight?" *Journal of Law, Economics, and Organization*, 14: 325-357.
- Che, Y-K. 1996. "Customer Return Policies for Experience Goods," *Journal of Industrial Economics*, 44: 17-24.
- Consumer Reports, 2004. "The Trouble With Recalls," *Consumer Reports Magazine*, August.
- Darlin, D. 2006. "Reluctance and Silence on Recalls," *The New York Times*, October 28, 2006.
- Daughety, A. F., and J. F. Reinganum, 1995. "Product Safety: Liability, R&D, and Signaling," *American Economic Review*, 85: 1187-1206.
- Dye, Ronald A., 1985. "Disclosure of Non Proprietary Information," *Journal of Accounting Research* 23, 123-145.
- Federal Document Clearing House (FDCH), "CPSC Chairman Awards Safety Commendation to Williams-Sonoma," *FDCH Regulatory Intelligence Database*, October 17, 2001.
- Finley, B., 2002. "Word of Recalls Rarely Gets Very Far – Only 15 to 30 percent of Products in Question are Recovered," *The Star-Ledger Newark*, November 24, 2002.
- Grossman, S. J., 1981. "The Informational Role of Warranties and Private Disclosure of Product Quality," *Journal of Law and Economics*, 24: 461-484.
- Hartman, R.S. 1987. "Product Quality and Market Efficiency: The Effect of Product Recalls on Resale Prices and Firm Valuation," *The Review of Economics and Statistics*, 69:367-372.

- Hoffer, G.E., Pruitt, S.W. and Reilly, R.J. 1988. "The Impact of Product Recalls on the Wealth of Sellers: A Reexamination," *Journal of Political Economy*, 96:663-670.
- Hoffer, G.E. Pruitt, S.W., and Reilly, R.J. 1994. "When Recalls Matter: Factors Affecting Owner Response to Automotive Defects," *Journal of Consumer Affairs*, 28: 96-106.
- Jarrell, G. and Peltzman, S. 1985. "The Impact of Product Recalls on the Wealth of Sellers," *Journal of Political Economy*, 93:512-536.
- Kronman, A. 1978. "Mistake, Disclosure, Information, and the Law of Contracts," *Journal of Legal Studies*, 7: 1-34.
- M2 Presswire. 2000. "CPSC, Williams-Sonoma Inc. Announce Recall of Portable Gas Grills," *M2 Presswire*, August 11, 2000.
- Mathios, A. D. 2000. "The Impact of Mandatory Disclosure Laws on Product Choices: An Analysis of the Salad Dressing Market," *Journal of Law and Economics*, 43: 651-677.
- Matthews, S. A. and Persico, N.G. 2005. "Information Acquisition and the Excess Refund Puzzle," *PIER Working Paper No. 05-015* or at SSRN: <http://ssrn.com/abstract=694606>.
- Matthews, S. and Postlewaite, A. 1985. "Quality Testing and Disclosure," *RAND Journal of Economics*, 16: 328-340.
- Marino, A. M. 1997. "A Model of Product Recalls with Asymmetric Information," *Journal of Regulatory Economics*, 12:245-265.
- Milgrom, P. R. 1981. "Good News and Bad News: Representation Theorems and Applications," *Bell Journal of Economics*, 12: 380-391.
- Polinsky, A. M. and Shavell, S. 2006. "Mandatory versus Voluntary Disclosure of Product Risks," Stanford Law and Economics Olin Working Paper No. 327.

- Rupp, N.G. and Taylor, C.R. 2002. "Who Initiates Recalls and Who Cares? Evidence from the Automobile Industry," *The Journal of Industrial Economics*, 50:123-149.
- Shavell, S. 1994. "Acquisition and Disclosure of Information Prior to Sale," *RAND Journal of Economics*, 25: 20-36.
- Verrecchia, R.E., 1983. "Discretionary Disclosure," *Journal of Accounting and Economics*, 5: 179-194.
- Welling, L. 1991. "A Theory of Voluntary Recalls and Product Liability," *Southern Economic Journal*, 57: 1092-1111.