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Product Reliability, Consumers' Complaints and Market Performance: The case of Consumers' Associations

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Abstract

In their dealings with retailers and suppliers, regulations and warranties ensure that consumers can seek a repair, a replacement or a refund if the good they have purchased is faulty. The evidence, however, indicates that few consumers pursue any form of compensation, suggesting that, for most consumers, transaction costs are high and providing a rationale for the role that consumers' associations play. In this paper, we analyze the monopolist's pricing and product reliability problem when consumers are entitled to product replacement and assess the implications of a decrease in consumers' transaction costs. Our results suggest that the appearance of the consumers' associations could, instead, lower product reliability. We draw empirical evidence from the pattern of recalls and complaints in the U.S. car market around 1995 (the year in which the National Highway Traffic Safety Administration (NHTSA) incorporated on-line filings) and find that it appears consistent with this prediction.

Keywords: product reliability, consumers' association, consumers' claims, liability cost.
JEL Classification: K42, D71, D42, D21, L12.

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1 Introduction

In their dealings with retailers and suppliers, regulations and warranties ensure that consumers can seek a repair, a replacement or a refund if the good they have purchased is faulty. The evidence, however, indicates that few consumers pursue any form of compensation (Best and Andreasen, 1977; Huppertz, 2007), suggesting that, for most consumers, claiming costs are high (see Huppertz (2007), which is based on Hirschmann (1970)) and providing a rationale for the role that consumers' associations play in helping consumers channel their complaints. In this paper, we analyze the monopolist's pricing and product reliability problem when consumers are entitled to product replacement and we assess the implications of a decrease in consumers' claiming costs due to, for instance, the appearance of consumers' associations. Our results suggest that consumers' associations could, instead, lower product reliability.

Our results hinge on how the firm deals with the replacement decision of consumers. In its choice of failure rate, the firm internalizes three effects. On the one hand, the failure rate affects directly the cost of production, through the manufacturing cost, and indirectly, through the number of units it must produce to replace the claimed faulty ones (including the associated indirect cost per replacement). On the other hand, the failure rate affects the expected utility of consumers because it modifies the probability of consuming a non-faulty good either when buying or when receiving a replacement of a faulty unit. When choosing the failure rate, the firm's trade-off among these three effects depends on the consumers' claiming cost. A decrease in the claiming cost implies more units being replaced and thus a higher cost of production, and a higher expected utility both from complaint and consumption, which implies a higher demand. Alone, the manufacturing cost of the replacement units would make the firm increase the level of its product reliability, but the presence of the expected utility effect may yield opposite results.

To study the effect of a reduction in the consumers' claiming cost on the firm's decisions, we construct a model with a monopolist choosing the price and reliability of the product it manufactures. The product's reliability is defined by the probability that the product is defective. Replacing a faulty product, and providing a more reliable one are costly actions for the firm. Consumers derive a high utility from consumption when the good does not break down, and a low utility otherwise. If the good is faulty, consumers choose whether to seek a replacement, incurring a claiming cost. Consumers differ in their cost to file a complaint. Within this set-up, we propose a comparative static analysis to understand the impact of the consumers' associations (as a way to reduce the claiming costs) on market performance. We show that the monopolist can optimally respond to a decrease in transaction costs by decreasing the product's reliability.

In our environment, there is sorting of consumers: those with low claiming costs are the ones with high willingness to pay and the ones who are prompt to complain if the product fails. Those with high claiming costs are the ones with low willingness to pay and the ones who do not complain when receiving a defected unit. The firm will follow either a high-pricing strategy, allowing only consumers with high willingness to pay to purchase the product, or a low-pricing strategy, allowing all consumers to buy the product. The dispersion of the consumers' willingness to pay is negatively related with the consumers' claiming cost, and, in line with Johnson and Myatt (2006), in this setting "*firm's profits are a U-shaped function of dispersion [of consumers' willingness to pay]. High dispersion is complemented by niche production [and high price] and low dispersion is complemented by mass-market supply [and low price].*" (brackets added)

On the one hand, low consumers' claiming cost is associated with high dispersion of consumers' willingness to pay, high price, and low demand. Firm's profit and product's failure rate are decreasing functions of consumers' claiming cost. The claiming cost is an unavoidable transaction cost affecting all consumers. When it is low, a marginal increment in transaction cost generates a reduction in consumers' willingness to pay which is compensated by an increase in product's reliability. Both effects reduce firm's profit. On the other hand, high consumers' claiming cost is associated with low dispersion of consumers' willingness to pay, low price, and high demand. Firm's profit and product's failure rate are increasing functions of consumers' claiming cost. When it is high, a marginal increment in claiming cost generates a reduction in consumers' willingness to complain, reducing the firm's liability cost and thus its unit cost. That is, a higher consumers' claiming cost reduces the number of complaints and the unit cost, making the failure rate to go up.

The result that product's reliability may decrease when consumers' claiming cost decreases arises when the firm changes its strategy as an optimal response for a discrete reduction in consumers' claiming cost. This result is more likely when the firm's cost of receiving complaints is sufficiently low: the lower the firm's cost of receiving complaints, the lower the liability cost associated to replacements and the higher the weight the firm puts on consumer's willingness to pay.

One way to reduce consumers' claiming cost is with the entry of consumer protection agencies, e.g., consumers' associations. In the 1960s, consumers' associations (hereafter, CAs) became more common.[1] Since then, CAs have been bridging between consumers, firms, and law makers: they have demanded to pass laws that add rights to consumers, they have provided more reliable information to consumers, and they have represented the consumers' interests by direct action. With the appearance of internet, some independent websites started to provide devices to help consumers to voice their complaints and to help to mediate between consumers and firms.[2] Consumers participate in the CAs as a substitute or a complement to costly direct legal actions. Some governmental agencies, like the National Highway Traffic Safety Administration (NHTSA) in the US car market, also play the role of protecting consumers' rights: they collect information about automobiles (cars, trucks, motorbikes, etc) and force companies to issue recalls to repair, replace, or repurchase the defective automobiles.

In the US car market, the NHTSA is the governmental agency that rules and controls safety standards. In 1995, the NHTSA introduced on-line complaints, lowering significantly consumers' claiming costs. Data from the NHTSA shows that the number of car complaints and the number of recalls issued have

[1]The first two organizations to focus on consumers' rights were the National Consumer League founded in 1899 and the Consumer Union founded in 1936. It was not until the 60s, however, that consumers' associations became popular and common in a number of countries.

[2]For instance, the website getsatisfaction.com is used by more than 40.000 firms to handle complaints and mediate between consumers and firm. Other websites are fearlessrevolution.com in US, miqueja.es, quejasonline.com and reclamacionesconsumidor.com in Spain.

substantially increased since 1995. Firms could have adjusted product reliability after 1995 as a response to this change. However, internet filings were permitted for cars manufactured both before and after 1995. This allows us to interpret the difference in the number of recalls for cars manufactured before and after 1995 as a change in product's reliability. The evidence appears consistent with a reduction in the firm's choice of reliability.

Although the CAs have become increasingly common, the theoretical and empirical literatures have not analyzed their effects on market performance. Few exceptions are Inderst and Ottaviani (2009), showing that the imposition of minimum post-sale return policies on sellers improves welfare and consumers' surplus when the proportion of credulous buyers is high, and Xinyu (Forthcoming JLEO), showing that when firm's product liability is duty to recall there is a higher rate of consumers' response to recall but the firm has fewer incentives to make these recalls voluntarily. Simon (1981) studies the impact of costly litigation and imperfect information about product quality and the outcome of a lawsuit on the existence of negligent firms. In her environment, a reduction in consumers' litigation cost fosters firms to increase product reliability. She models imperfect information about product quality in consumer side, while we introduce asymmetric information about consumer's valuation or consumer's claiming cost in the firm side. She also ignores the possibility of not buying, banning the demand effect.

Our paper also relates to other strands of literature. First, to the vast literature on product liability. Murthy and Djamaludin (2002) and Huang, Liu, and Murthy (2007) analyze how warranties may affect the firm's choice of product reliability and demand.[3] Oi (1973) analyzes how a change in product's liability from consumer to producer can affect quality negatively. Daughety and Reinganum (2008) work on the relation between signaling price and information disclosure when product's safety is private information. Daughety and Reinganum (1995) study the relation between R&D phase and product's safety when price may work as a signal of product's safety. Daughety and Reinganum (2005) analyze the relation between safety, R&D and confidential settlements. My contribution is to endogenize the number of claimants among buyers as a function of price. The relationship between price and claimants is translated to the firm's expected marginal cost and to the optimal choice of product's reliability.

Second, our paper also relates to the literature on consumers' complaint behavior (CCB), which focuses on the consumers' reaction to dissatisfaction (Chebat, Davidow, and Codjovi, 2005; Owens and Hausknecht, 1999). In our paper, we focus on complaints filed against the firm or third parties (CAs). We do assume that the firm undergoes an additional transaction cost when the consumer files a complaint and the information becomes public. We contribute to this literature showing that the number of complaints is endogenously determined and that the product's reliability can either increase or decrease when reducing the consumers' claiming cost.[4]

[3] Spence (1977) analyzes the effect of consumers' misperceptions on product quality and characterizes the conditions under which a warranty can work as a signal of product quality. He suggests different types of interventions to solve the subprovision of quality. However, he ignores any type of consumers' claiming cost.

[4] There are other ways to affect the consumers' claiming cost, such as Class Action Lawsuits (Hensler, 2001; Klement and Neeman, 2004) and Small Courts (Best and Andreasen, 1977). Also, there are other mechanisms to motivate a provision of reliability. Klein and Leffler (1981) study the choice of product reliability by the firm in a dynamic framework. Repeated purchases, reputation, and brand name may ensure the provision of high quality goods by the firm. Finally, Greif, Milgrom,

The paper is structured as follows. Section 2 introduces the model and explains the firm's strategies. Section 3 states the equilibrium and the main proposition. Section 4 illustrates the main results with a numerical example. Section 5 provides evidence about the effect of reducing claiming cost in the US car market. Finally, Section 6 concludes.

2 Model

We consider the problem of a monopolist choosing its product's price p and failure rate $x \in [0,1]$ to maximize its profit, while anticipating that consumers may request a replacement if the product they have purchased is faulty. The firm grants all replacement requests (there is binding legislation) by exchanging faulty products for new ones. Consumers are heterogeneous in their cost of requesting a replacement, which may lead to some consumers scrapping faulty products. Obviously, a replacement itself may fail as well and the consumer may again request a replacement, which will, again, be granted.[5]

2.1 Consumers and Demand

Consumers are indexed by i and are heterogeneous in their cost of requesting a replacement, $k_i \in \mathbb{R}_+$. We assume k is exponentially distributed, with cumulative distribution $G(k,\lambda)$.[6] Consumers derive utility $v \geq 0$ from consuming one unit of a non-faulty good. If the good is faulty or the consumer chooses not to purchase it, the consumer derives a utility of 0.[7] Each consumer i makes two sequential decisions, whether to purchase one unit of the product and whether to pursue a replacement if the product breaks down. The consumer pursues a replacement if $v(1-x) - k_i \geq 0$. Notice that the consumer's replacement decision is the same independent of whether the product being replaced is the original product or a replacement. This implies that the expected utility consumer i derives from replacing faulty products is given by

$$x\frac{\max\{v(1-x)-k_i,0\}}{1-x}. \tag{1}$$

Then, given (1), the consumer purchases one unit of the product if

$$EU_i(p,x) = v(1-x) - p + x\frac{\max\{v(1-x)-k_i,0\}}{1-x} \geq 0. \tag{2}$$

and Weingast (1994) describe how merchants create guild to improve the terms of trade, such as the level of product quality/reliability. We work on a static model with perfect information where reputation does not guarantee the provision of product reliability.

[5] Our model resemblesBar-Isaac, Caruana, and Cuñat (2010). In their paper, a marketing strategy transmits, prior to purchasing, information to the consumer about how suitable the product is, informing him whether the match is good or bad. The consumer learns the result of the match after purchasing. Here the consumer anticipates that the product can work (good) or fail (bad) and the buyer chooses to request a replacement or not after buying.

[6] We can generalize our results for any family of continuous and differential distributions with increasing reverse hazard rate that can be ranked according to the reverse hazard rate criteria.

[7] Our results also hold if, instead, $v \sim U[0,1]$ and $k \in \mathbb{R}_+$. The proofs are available upon request.

Figure 1.a depicts the maximum willingness to pay of each consumer type k_i given a failure rate x. It shows that those consumers who purchase the good and then request replacements are those with lowest k, while those with highest k prefer to purchase the good and will not replace it if it is faulty. The characterization of the actual consumption choice depends on p. If p is high (e.g., equal to p_H in the figure), all consumers who purchase replace the product if it is faulty, with their willingness to pay only depending on x by the expected replacement cost. Instead, if p is low (e.g., p_L), some consumers purchase and replace while others purchase and scrap.

We next obtain the demand function. We aggregate the consumers' choices for all k, but separate them into two groups, depending on whether they will request a replacement if the good results to be faulty. Those consumers with $k_i \leq v(1-x)$ anticipate replacing a product if it is faulty. We label them *claimants*. Among these consumers, those with $k_i \leq (v-p)(1-x)/x$ purchase the product. Instead, the consumers with $k_i \geq v(1-x)$ anticipate not replacing a faulty product. We label these *non-claimants*. All consumers who are non-claimants make the same purchasing decision. If $v(1-x) \geq p$, all non-claimants purchase the product, while otherwise, all non-claimants do not. (Notice that the difference in thresholds $v(1-x)$ and $(v-p)(1-x)/x$ can be rewritten as $(1-x)(p-v(1-x))/x$, which implies that the demand cut-offs are solely determined by the comparison of p and $v(1-x)$.) That is, the demand function of claimants, Q^C, and non-claimants, Q^{NC}, is given, respectively, by

$$Q^C = \begin{cases} G(\frac{(v-p)(1-x)}{x}, \lambda) & \text{if } p > v(1-x), \text{ and} \\ G(v(1-x), \lambda) & \text{if } p \leq v(1-x). \end{cases} \qquad Q^{NC} = \begin{cases} 0 & \text{if } p > v(1-x), \text{ and} \\ 1 - G(v(1-x), \lambda) & \text{if } p \leq v(1-x). \end{cases}$$

Exponential distributions are ordered by λ. A distribution with a higher λ is first order stochastically dominated by another distribution with a lower λ. If λ is higher, the exponential distribution moves to the left and consumers have lower claiming costs. Also, an exponential distribution with a higher λ is dominated in terms of reverse hazard rate by another exponential distribution with lower λ. This property guarantees that the firm charges a higher price to a population of consumers with lower claiming costs. We next turn to the problem of the firm.

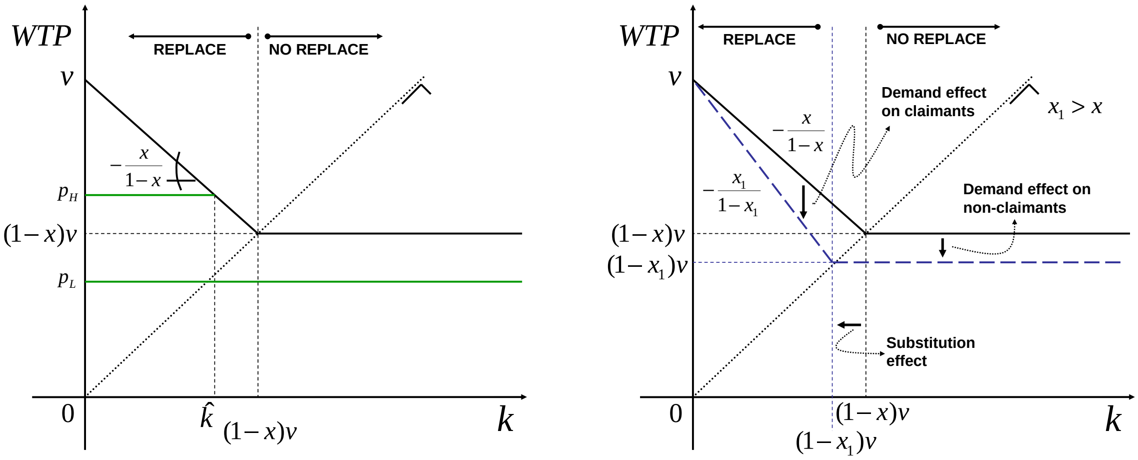
2.2 Monopolist's Problem

We let $c(x)$ denote the marginal cost of production, which is constant for a given x. We assume $c(x) > 0$, $c'(x) < 0$ and $c''(x) > 0$. We also assume that $xc(x)$ is weakly increasing in x. This assumption implies that $xc(x)/(1-x)$, i.e., the expected cost of manufacturing replacement units is increasing in the failure rate.[8] When serving replacement requests, the firm also incurs a per-unit replacement cost $c_r \geq 0$.[9] This implies that the cost of selling one unit of the good to a claimant consumer is $c(x) + x(c(x) + c_r)/(1-x)$, while selling the same unit to a non-claimant is only $c(x)$.

To ensure that a solution to the firm's maximization problem exists, we assume there exists a $c_r > 0$

[8]The family of functions $c(x) = \frac{\beta}{x^\alpha}$, with $\alpha \in [0,1]$ and $\beta \in \mathbb{R}_+$, satisfies this assumption.

[9]The parameter c_r may account for a variety of costs, from administrative/shipping and handling costs to reputational losses.



(a) Maximum willingness to pay.

(b) Demand and substitution effects.

Figure 1: Willingness to pay (a) and demand and substitution effects (b).

such that, for some $x \in [0,1]$, $v(1-x) - c(x) - x\frac{c(x)+c_r}{1-x} > 0$. This assumption says that the firm can make positive profits if it sells to all consumers, including those with lowest willingness-to-pay $v(1-x)$.

Then, given the demand function in (3), the monopolist's maximization problem is given by

$$\Pi(p,x) = \begin{cases} \left[p - c(x) - x\frac{c(x)+c_r}{1-x}\right]\left[1 - e^{-\lambda\frac{(v-p)(1-x)}{x}}\right] & \text{if } p > v(1-x), \text{ and} \\ p - c(x) - x\frac{c(x)+c_r}{1-x}\left[1 - e^{-\lambda v(1-x)}\right] & \text{if } p \le v(1-x). \end{cases}$$

We say that the firm follows a high-pricing strategy if p and x are such that $p > v(1-x)$; otherwise, we say that the firm follows a low-pricing strategy. Notice that $p = v(1-x)$ dominates all other p and x that constitute a low-pricing strategy as the objective function depends positively on p.

The firm faces a trade-off in its choice of price and failure rate. When following a low-pricing strategy the marginal consumer is a non-claimant whose willingness to pay is low and depends only on the probability of buying a non-defected unit; reducing the failure rate increases considerably his willingness to pay. This effect defines the demand effect on non-claimants in Figure 1.b. The marginal cost of selling this unit, however, is only its production cost, which increases as failure rate decreases. In contrast, when following a high-pricing strategy the marginal consumer is a claimant whose willingness to pay is high and depends both on the failure rate and on his own claiming cost. Reducing the failure rate increases his willingness to pay but this increment decreases as his claiming cost decreases. This effect defines the demand effect on claimants in Figure 1.b. The marginal cost of selling this unit incorporates a production cost and a replacement cost and it increases as the failure rate decreases.[10]

[10] The unit cost that incorporates the production and replacement costs has a U-shaped function of product's failure rate, i.e., $c(x) + x(c(x)+c_r)/(1-x)$ has a U-shaped function of x. When following a high-pricing strategy the firm always chooses a failure rate in the decreasing part.

3 Equilibrium

We next find the monopolist's optimal strategy for a given distribution of consumers' claiming cost and then analyze the effect of a reduction in the consumers' claiming cost, i.e., the effect of an increase in λ.

The firm's optimal choice of p and x depends crucially on the parameter λ. The intuition is as follows. If λ is such that consumers have low claiming costs, they are more likely to complain when receiving a defected unit and there is high dispersion in the consumers' willingness pay. If this is the case, the firm does not find rewardable to reduce the price to $v(1-x)$ so as to increase demand and it follows a high-pricing strategy. If, instead, consumers have high claiming costs, there is low dispersion in consumers' willingness pay, and the firm finds rewardable to reduce the price to $v(1-x)$ to increase demand and thus follows a low-pricing strategy. The next proposition characterizes the cut-off in the expected consumers' claiming cost above which the firm chooses to follow a low-pricing strategy.

Proposition 1. *There exists a cut-off in the parameter values characterizing the consumers' claiming cost distribution, $\hat{\lambda}$, such that the firm follows a low-pricing strategy if the consumers' claiming costs are sufficiently high ($\lambda < \hat{\lambda}$) and follows a high-pricing strategy otherwise. The firm's profit function has a U-shaped relation with λ, with a minimum value at the cutoff $\hat{\lambda}$.*

The demands of claimants and non-claimants are the only terms in the firm's profit function that depend on the distribution of the consumers' claiming cost. If the firm follows a high-pricing strategy, only claimants purchase the product and the demand increases when the distribution of consumers' claiming cost is moved to the left, i.e., when λ increases. For this reason, when following a high-pricing strategy, firm's profits are increasing in λ. If, instead, the firm follows a low-pricing strategy, both claimants and non-claimants purchase the product and increments in the consumers' claiming cost do not affect the number of units sold. At most, a claimant may become non-claimant (only the substitution effect in Figure 1.b). In this case, when following a low-pricing strategy, the firm saves part of the liability cost and the firm's profit decreases in λ. Under certain conditions, there is a cut-off where the firm's profits coincide with both strategies.

Proposition 1 provides a rationale for the firm's optimal strategy when subject to product replacement. If the firm follows a low-pricing strategy, its profit increases when consumers have higher claiming costs. If it were possible for the firm to affect consumers' claiming costs, the firm would have clear incentives to provide a tiresome procedure for requiring its customer service to discourage consumers from complaining. If, instead, the firm follows a high-pricing strategy, we observe the opposite result. The firm's profit decreases with the consumers' claiming cost and the firm would provide devices to aid consumers complain.

We argue in the Introduction that the empirical evidence shows that many buyers do not request a replacement despite having received a defective product. In our environment, this evidence is consistent with the firm following a low-pricing strategy so that non-claimants also purchase the product. In Proposition 2, we show that, if the firm's cost of receiving complaints is not too high, the firm may reduce its product's reliability when the consumers' claiming cost is reduced.

Proposition 2. *If the firm's liability cost of receiving complaints is not too high, there exists a reduction in the consumers' claiming cost to which the firm responds by reducing the level of its product's reliability.*

The intuition behind the formal proof is as follows. If consumers' claiming costs are infinitely high (λ is low), there are only non-claimants. If this is the case, the firm follows a low-pricing strategy and the product's reliability is determined by $-c'(x) = v$. The failure rate monotonically decreases with consumers' claiming cost. On the other hand, if the consumers' claiming cost is zero ($\lambda \to +\infty$), there are only claimants. If this is case, the firm follows a high-pricing strategy and the product's reliability is determined by $-c'(x) = (c(x_a)+c_r)/(1-x_a)$. The failure rate monotonically increases with consumers' claiming cost. The change in the strategy from low-pricing to high-pricing at the cut-off $\hat{\lambda}$ implies that the failure rate has a U-shaped function of consumers' claiming cost. If $\frac{c(x_a)+c_r}{1-x_a} < v$, for any λ, there exists a $\lambda' < \lambda$ such that $x(\lambda') > x(\lambda)$, which means that there exists a reduction in consumers' claiming costs, represented by moving the distribution from λ to λ', for which the firm reduces product's reliability.

To understand this result, we consider first a marginal reduction in the consumers' claiming cost. Under a high-pricing strategy, the consumers claiming cost represents a transaction cost. A marginal reduction in consumers' claiming cost generates a reduction in transaction cost. The firm increases the price and reduces the product's reliability, making both demand and profits increase. Under a low-pricing strategy, a marginal reduction in the consumers' claiming cost generates an increment in complaints and in the firm's costs. The firm increases product reliability and price and the mark-up and profit decrease.

However, for a discrete reduction in consumers' claiming cost, we have a new insight. For a high pricing strategy, there is nothing new. For a low-pricing strategy, a discrete reduction in consumers' claiming cost leads to a change in the firm's strategy, from low to high-pricing. This non-local increment in price generates a reduction in demand, a change in product reliability, and a change in profits. For a large enough discrete reduction in consumers' claiming costs, the firm's profit increase and the product reliability decreases. The reason is that once consumers have an inexpensive way of guaranteeing a well-functioning product, either because the good does not fail or because it is replaced at a low cost, reliability loses its value for consumers.

Proposition 2 states a clear result: a discrete reduction in consumers' claiming cost might generate a reduction in product's reliability and an increase in firm's profit. The policy implication of Proposition 2 is that any policy that helps consumers to file complaints pursues to increase product reliability but it could get exactly the opposite effect.

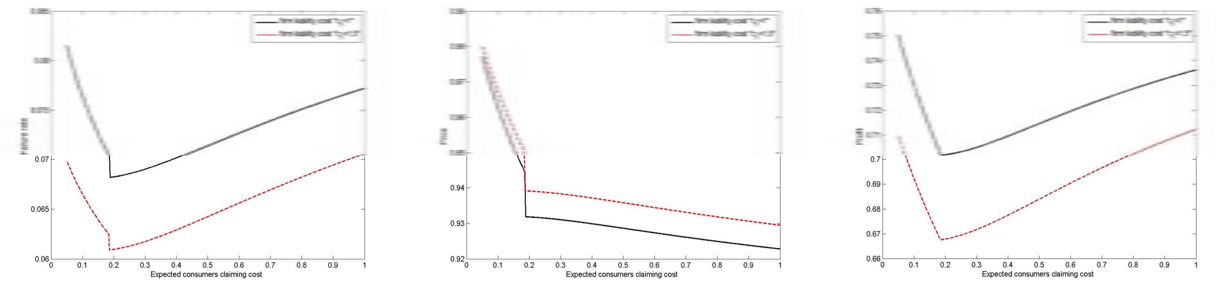
This result, that product reliability can decrease when there is a reduction in consumers' claiming cost, is more likely when the firm has a low cost of receiving complaints. Under a high-pricing strategy, the replacement effect is what motivates the firm to increase product reliability. While the demand effect is only determined by consumers' willingness to pay, the replacement effect is determined by the firm's cost of facing complaints. When the firm has a low liability cost, it has more incentives to reduce reliability if consumer' claiming cost decreases.

4 Example

In this section we run a numerical example assuming that $v = 1$ and that the unit production cost function is $c(x) = \frac{\beta}{x}$, with $\beta = 0.01$.[11] In Figures 2.a, 2.b and 2.c we plot product's failure rate, price, and firm's profit, as a function of consumers' claiming cost for different values of c_r, i.e., the black line for $c_r = 1$ and the red dashed-line for $c_r = 1.5$. First, note that the optimal price decreases when the expected consumers' claiming cost increases (Figure 2.b). Moreover, both firm's profit and product's failure rate are U-shaped functions of expected consumers' claiming cost (Figures 2.a and 2.c). The lowest level of both functions coincides with the threshold above which the firm follows a low-pricing strategy.

From this example we can quantify our effect. Assume that firm's liability cost is 1, i.e., $c_r = 1$, and that on average the consumers' claiming cost is 60% of their valuation of a non-defected product. If this is the case, any reduction of more than 75% on consumers' claiming cost will generate an increment in product's failure rate. For instance, a reduction of 80% of consumers claiming cost generates an increment in product's failure rate of around 3%. This increment in failure rate jumps to 5.2% for a reduction of 83% of consumers' claiming cost.

This example highlights that the introduction of consumer associations, or any device that helps consumers voice their complaints, leads to either a reduction or an increase in the failure rate.[12] This change in failure rate depends on the magnitude of consumers' claiming cost reduction and on the level of firm's liability cost.



(a) Product failure rate (b) Price (c) Profit

Figure 2: Failure rate, price and profit as a function of consumers' claiming cost.

[11] The cost function $c(x) = \frac{\beta}{x}$ satisfies technical specifications according to Huang, Liu, and Murthy (2007).

[12] As pointed out in the introduction, consumers' associations have been working for consumers' sake in different dimensions. One of them is to decrease consumers' claiming cost helping them to exercise their rights. In our setup a CA affects consumers in two different ways: i) by moving consumers' claiming cost distribution downward, and ii) by providing a "legal" help when a problem arises (which is equivalent to provide a lower claiming cost). In this paper, these two effects are not distinguished.

5 The Effect of Claiming Cost Reductions in the US Car Market

The National Highway Traffic Safety Administration (NHTSA) is a US governmental agency that has the authority to issue vehicle safety standards and to require manufacturers to recall vehicles that have safety-related defects or do not meet Federal safety standards.[13] Consumers use the NHTSA service as an additional device to voice their complaints. When a car company does not attend their complaints, consumers can either privately sue the firm, file a complaint with a consumers' association, file a complaint with the NHTSA, or do nothing.

In 1995, the NHTSA introduced two important modifications to its filing process, which significantly decreased the consumers' claiming costs: it released an electronic mailing address to which consumers could mail complaints and it launched a website application that allowed consumers to file their complaints on-line.[14] Since then, the number of complaints and the number of recalls have increased, and the correlation between them is positive.

Figure 3 plots the number of recalls and complaints per car model-year accumulated since the year the car was manufactured until 2008.[15] For instance, cars produced in 1994 suffered 50 recalls and cars produced in 1995 suffered 78 recalls until 2008. Notice that the on-line devices had been available since 1995 for those consumers who had bought a car before and for those who bought it after 1995. The figure shows that the accumulated number of recalls for cars produced after 1995 is substantially higher than for those cars produced before 1995. The increment in recalls for cars produced after 1995 may be consistent with the following effects: car companies have decreased cars' reliability, consumers' complaints help disclose more information, car companies have introduced new car models (i.e., new car segments like Minivan), the NHTSA has tightened its controls and/or standards, or, more likely, a combination of all of the above. The informational and reliability change effects are more likely to dominate because we have not found evidence of a change in the NHTSA's regulations and, although we do not have data on the number of models in the market, it is quite unlikely that it changes discontinuously in a particular year.

We provide evidence consistent with the existence of informational and reliability change effects. A clear way to see if there is a reliability effect is to compare the number of recalls for cars sold immediately before and after 1995. Notice that the reduction of consumers' claiming cost is available for consumers who bought a car either in 1994 or 1995. The data, however, show that the number of recalls were much more higher in 1995 with respect to 1994. If cars' reliability is the same along the whole period, we must observe, ceteris paribus, the same number of recalls for cars produced in 1994 and 1995. This fact is consistent with our predictions that a reduction in consumers' claiming cost can motivate the firm to

[13]See Rupp and Taylor (2002) for a detailed explanation of a recall process.

[14]These on-line devices were available since the end of 1994.

[15]2008 is the last year of data available. The data correspond to the six largest US automobile manufacturers: Ford, General Motors, Chrysler, Toyota, Nissan and Honda. Since 1970, these companies have accounted for around 90% of US car market. However, this aggregated share has been slightly reduced since mid 2000. The NHTSA provides data of complaints as from 1984 but it was not until 1995 that consumers' complaints became sizable. The evolution of complaints and complaints/sales have the same pattern. For robustness, we should control recalls by the number of car models. However, we do not have this data yet.

Table 1: Number of recalls per model and its distribution over time.

		time elapsed since model launched			
cars produced in	recalls	same year	1-5 years	6-10 years	rest
1977-1982	**248**	73.39%	22.58%	**3.63**%	0.40 %
1983-1988	**234**	52.14%	39.32%	**8.12**%	0.43 %
1989-1994	**252**	44.05%	40.87%	**12.70**%	2.38 %
1995-2000	**429**	50.12%	44.76%	**5.13**%	-

decrease the reliability of the product manufactured.

To reinforce our analysis, in Table 1 we report the number of recalls for car models-year aggregated in periods of 6 years and its distribution over time. Cars produced between 1995 and 2000 suffered 429 recalls; half of them took place in the same year that these new cars were launched.[16] Given that the car's life expectancy is around 10 years, we expect that cars produced before 1982 received no effect of the introduction of on-line devices, while cars produced between 1983 and 1994 received only an informational effect. For this reason, cars produced between 1989-1994 are a control group that captures only the informational effect. Cars produced in 1995 or after have received an informational and reliability change effect.

We first provide evidence of our claim that consumers' complaints help to disclose more information. Consistent with our statements, for cars produced in the period 1977-1982, around 4% of recalls took place six years after new cars were launched or later (See column 5 and 6 in Table 1). This proportion raises to 8.5% and 15% for cars produced in 1983-1988 and 1989-1994, respectively. Note that the accumulated number of recalls of cars produced after 1983 may have captured an informational effect when the NHTSA introduced the on-line devices to complain. The difference in the proportion of recalls that took place six years after manufacture or later for subperiods 1977-1982 and 1989-1994 is statistically significant at standard levels, showing that the on-line devices helped to disclose some additional information.[17] This new information allowed many recalls that would have not been done otherwise.

We now provide evidence of the reliability change effect. Aggregating in subperiods and comparing the trend in recalls for cars produced before (between 1989-1994) and after (1995-2000), the increment in the number of recalls after the NHTSA introduced on-line applications to file consumers complaints is statistically significant.[18] This evidence is consistent with our theoretical results.

Concluding, we observe that there is clear evidence of the effect of the NHTSA's website applica-

[16]Since the average car life expectancy is 10 years, the serie is truncated for car models in the subperiod 1995-2000. The number of recalls is higher in spite of this truncation. However, this does not constitute a problem because the introduction of internet devices has helped disclose information earlier.

[17]The statistic comparing the proportion in the period 1983-1988 (which captures only partially the information effect) with 1977-1982 is $|t| = 2.05$ and comparing the period 1989-1994 with 19877-1982 is $|t| = 5.11$. If we consider only recalls initiated in the first 5 years since launched, the increment in recalls from 1989-1994 to 1995-2000 is from 214 to 409 recalls, almost 100%.

[18]The statistic of testing that the means of recalls are the same for subperiods 1989-1994 and 1995-2001 is $|t| = 4.7$, rejecting the hypothesis that they are equal (a one tail test is also rejected). Assuming that there is only an informational effect for cars produced in the subperiod 1989-1994, and a combination of informational and reliability change effects in the subperiod 1995-2001, the test is consistent with the existence of a reliability change effect.

tion and e-mail on complaints and recalls. These inexpensive devices to voice consumers' complaints generate an increment in recalls. We claim that these increments are due to more information disclosure and to a reduction in cars' reliability. The increment in the number of recalls per year-model after 1995 conciliates our theoretical results.[19]

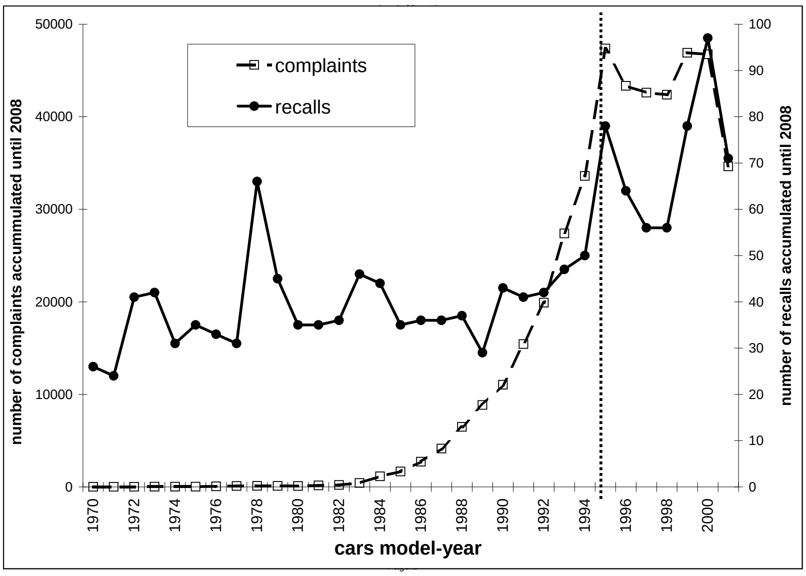


Figure 3: Number of recalls and complaints accumulated until 2008 in the U.S. car Market per model-year.

6 Conclusion

Consumers' associations goals are, among others, to help consumers voice their complaints and enforce the provision of reliable products. In this paper, we show that these goals may not be aligned: the firm may decide to produce a less reliable product if more consumers request a replacement of a defected product.

The evidence from U.S. car market shows that after a reduction in claiming costs in 1995, the number of complaints and recalls has clearly increased. Complaints were permitted for the cars manufactured before that year, but the number of recalls increased much more for cars produced after 1995. The evidence appears inconsistent with the firms' choice of reliability increasing or being constant, even when controlling for the effect of more information disclosure. All this evidence goes in the direction of our results.

[19] We are aware of the limitations of the data. We have made some controls by unit sold and the results remain the same. However, we could not get any control by number of models sold by each company. As mentioned above, even when the new models may account for part of the change in complaints and recalls, it is unlikely that there is a discontinuous change in the number of models. Finally, we must be cautious when interpreting the data with our theoretical findings since our model lacks the strategic interaction among firms that is present in the U.S. car market.

The main contribution in terms of policy implication of this paper is to warn consumers' associations that reliability is an endogenous decision. Product reliability depends on both consumers' claiming costs and firm's replacement costs. An increase in consumers' complaints may be followed by a reduction in product's reliability, which in turn generates additional complaints. Then, observing a sharp increment in complaints is not necessarily a good market signal. This paper also points out that the expected number of complaints is endogenously determined by the price and product reliability.

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7 Appendix

7.1 Change of Variable for High-pricing Strategy

To find the solution when $p > v(1-x)$ we make a simple transformation: define $k = \frac{(v-p)(1-x)}{x}$ implying that $p = v - \frac{xk}{1-x}$. Since $p \in [0,v] \subset \mathbb{R}_+$ and $x \in (0,1]$, then $k \in \mathbb{R}_+$. The problem is re-expressed as

$$\max_{k,x} \Pi(k,x) = \left[v - \frac{xk}{1-x} - c(x) - x\frac{c(x)+c_r}{1-x}\right]\left[1 - e^{-\lambda k}\right]. \tag{3}$$

This expression allows us to find, first, the optimal choice of x as a function of k, and second, the value of k that maximizes firm's profit. For any k there exists $x_k(k) = \arg\min\left[\frac{c(x)+x(c_r+k)}{1-x}\right]$ with $x'_k(k) < 0$, i.e., if k increases x_k decreases. The minimum of $\frac{c(x)+x(c_r+k)}{1-x}$ is increasing in k. The value of k is defined by the first order condition of equation (3),

$$\frac{1-x}{x}\left[v-c(x)-x\frac{c(x)+c_r+k}{1-x}\right]=\frac{\left[1-e^{-\lambda k}\right]}{\lambda e^{-\lambda k}}. \tag{4}$$

The left hand side is decreasing in k if $c(x)$ is sufficiently convex.[20] The right hand side is increasing in k. The value of k is uniquely defined. Finally, the second order condition respect to k is

$$\Pi_{kk}=-\frac{2x}{1-x}\lambda e^{-\lambda k}-\lambda^2 e^{-\lambda k}\left[v-c(x)-x\frac{c(x)+c_r+k}{1-x}\right]<0. \tag{5}$$

7.2 Proof of Proposition 1

Proof. The exponential distribution has the following properties: if $\lambda \to +\infty$, $G(k,\lambda)$ is degenerated in $k=0$, and, if $\lambda \to 0$, the cumulative is $G(k,\lambda) \sim 0$ for any $k < +\infty$ (consumers have a k too high and never complain).

For any $0<\lambda<+\infty$, the profit function is discontinuous at $p=v(1-x)$. However, we can consider the expressions under a low-pricing strategy and under a high-pricing strategy separately. By the envelope theorem $\Pi(p=v(1-x),\lambda)$ is decreasing in λ and $\Pi(p>v(1-x),\lambda)$ is increasing in λ. For details of the high-pricing strategy see Appendix 7.1.

Note that if $\lambda \to 0$ there is only non-claimants and $\Pi(p=v(1-x))>0=\Pi(p>v(1-x))$. If $\lambda \to +\infty$ there is only claimants and $0<\Pi(p=v(1-x))<\Pi(p=v-\varepsilon)$, for some $\varepsilon \geq 0$. Assumption A1 guarantee an equilibrium with positive profits that is characterized by at least one these two strategies for any λ. The existence of the cutoff $\hat{\lambda}$ such that $\Pi(p=v(1-x),\hat{\lambda})=\Pi(p>v(1-x),\hat{\lambda})$ is guaranteed. □

7.3 Proof of Proposition 2

Recall that higher λ implies lower consumers claiming cost.

Proof. We show that x is a decreasing function of λ when the firm follows a low-pricing strategy, i.e., $p=v(1-x)$, and x is an increasing function of λ when the firm follows a high-pricing strategy, i.e., $p>v(1-x)$. Finally, we guarantee conditions such that $x(\lambda \to 0)$ under a low-pricing strategy is lower than $x(\lambda \to +\infty)$ under a high-pricing strategy, such that there exists an increment in λ (i.e., a reduction in consumers claiming cost) that generates an increase in the failure rate.

Since the objective function is submodular in x and λ when the firm follows a low-pricing strategy, the failure rate is decreasing in λ.[21] When the firm follows a high-pricing strategy, we state the monotonicity

[20] Recall that $x'(k)<0$, which depends on $c''(x)$. The condition for the left hand side to be decreasing in k is that $\frac{v-c(x)-x\frac{c(x)+c_r+k}{1-x}}{x^2(1-x)c''(x)}-1<0$. It is sufficient that the slope $x'(k)=-\frac{1}{(1-x)c''(x)}$ not to be so steep, i.e., $c''(x)$ sufficiently high. Note that the mark-up can not be too high in this equilibrium, given that if v is high, the firm would prefer to expand demand choosing a price $p=v(1-x)$.

[21] Assumption that $xc(x)$ is non-decreasing in x is sufficient condition. The cross derivative is $\frac{\partial^2\Pi}{\partial x\partial\lambda}=-ve^{\lambda v(1-x)}[\lambda vx(c(x)+c_r)+(c(x)+c_r)+c'(x)x]\leq 0$, which is guaranteed if $(c(x)+c_r)+c'(x)x>0$.

x respect to λ from the first order condition respect to k in equation (4) and from the monotonicity of $x'(k) < 0$. The right hand side in equation (4) increases in λ since the derivative of the reverse hazard rate respect to λ is positive, i.e., $-\frac{e^{k\lambda}}{\lambda^2}\left(1-e^{-k\lambda}-k\lambda\right) > 0$, since $1-e^{-k\lambda}-k\lambda < 0$. Any increment in λ generates a reduction in k and thus an increase in x. There is a monotonic relationship between λ and x, i.e., the higher the λ the higher the x.

In the limit, if $\lambda \to +\infty$, consumers have zero claiming cost: the firm chooses $k \to 0$ and $p = v - \varepsilon$ for some $\varepsilon \geq 0$; and the failure rate is determined by $-c'(x_a) = \frac{c(x_a)+c_r}{1-x_a}$. On the other hand, if $\lambda \to 0$, most consumers have extremely high claiming cost: the firm chooses $p = (1-x)v$ and the failure rate is determined by $-c'(x_b) = v$. $x_a \leq x_b$ if and only if $\frac{c(x_a)+c_r}{1-x_a} \geq v$. Note that, since $c'(x) < 0$ and $c''(x) > 0$, the expression $\frac{c(x)+c_r}{1-x}$ has a global minimum at x_a for a given c_r. This minimum $\frac{c(x_a(c_r))+c_r}{1-x_a(c_r)}$ is increasing in c_r and x_a is decreasing in c_r. Since v is constant and $\frac{c(x_a(c_r))+c_r}{1-x_a(c_r)}$ is increasing in c_r, there exists $\hat{c}_r(v) \in \mathbb{R}_+$ such that $\frac{c(x_a)+\hat{c}_r(v)}{1-x_a} = v$ for which $x_a = x_b$. Then, $x_a < x_b$ if and only if $c_r > \hat{c}_r$. The threshold $\hat{c}_r(v)$ is increasing in v.

Concluding, the product's failure rate has a U-shaped relation with λ, with a jump in the minimum x at $\hat{\lambda}$. There exists a cutoff $\hat{\lambda}$ such that the firm follows a low-pricing strategy if $\lambda < \hat{\lambda}$. Finally, it is guaranteed for $c_r < \hat{c}_r(v)$ that there exists a reduction in consumers claiming cost, i.e., $\Delta\lambda > 0$, such that product reliability decreases, i.e., $\frac{\Delta x}{\Delta \lambda} > 0$. The proof is complete. □