

Contractual Structures and Consumer Misperceptions

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September 26, 2017

Abstract

We analyze how firms can design contracts to strategically induce consumer misperceptions. A fraction of consumers is naive and underestimates the costs of claiming a warranty payment in the event of product breakdown. This leads to an inference error that makes consumers prone to overpredict product quality, which a firm can profitably exploit. The channel persists under different market structures and can reduce the quality provision to sophisticated consumers. We argue that our results apply more generally to cases in which consumers are inattentive or illiterate with respect to contract fine print, and provide supporting evidence from TV infomercials.

JEL Codes: D18, D21, L15

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1 Introduction

In many situations, consumers do not observe the quality of a product before purchase. One common option for firms to signal high quality is to offer contract guarantees that apply in the event of product failure. However, consumers are often unable to fully understand all contract terms or do not pay attention to them.¹ A growing body of research studies how firms can design structures to profitably exploit existing consumer misperceptions, such as myopia with respect to add-on fees or time-inconsistent preferences (see, e.g., DellaVigna and Malmendier, 2004; Gabaix and Laibson, 2006; and Bar-Gill, 2007). A different question emerges in the quality context: why do consumers in some cases systematically overestimate the quality of certain products and even become susceptible to scams?²

In this paper, we argue that firms can design contracts not only to profitably exploit existing consumer misperceptions but also to strategically induce new misperceptions. We identify cases in which a firm can establish and exploit false consumer beliefs regarding product qualities by offering warranties that seldom apply or are costly to claim. This increases the consumers' overall willingness to pay for products and services, which makes them prone to overpay. The model predictions find support from the case of a knife set manufacturer that offers "lifetime warranties" and "30-day money back" policies to advertise its main product on televised infomercials while heavily devaluing these policies in the contract fine print.

Section 2 introduces our baseline model in which a manufacturing firm offers its products together with warranties that grant consumers a payment in the event of product breakdown. The firm can choose product quality in terms of reliability, which is unobservable to consumers and increasing in production costs. The firm can thus use a sufficiently high warranty to signal high product quality. Claiming a warranty payment is costly for consumers. These costs can

¹Sovern *et al.* (2015) show recent evidence suggesting that many consumers are unable to detect and process contract fine print in credit card contracts. Stark *et al.* (2013) find a high prevalence of unfair remedy clauses in apartment contracts and that many consumers are not aware of them.

²According to Kopalle and Lehmann (2006), there were a total of 627 cases in which the Federal Trade Commission found a company guilty of deceptive claims between mid-1996 and the end of 2002. Of these cases, 39 percent were scams, i.e., "fraudulent activity that is intentionally devised to cheat customers". The other cases consisted of misrepresentation (36 percent), unsubstantiated claims (12 percent), and false claims (13 percent). Only 25 percent of the companies that had been found guilty were listed on at least one out of five common business databases.

be both internal and external. Examples of internal costs are opportunity costs of time and the mental costs of securing the warranty reimbursement. Examples of external costs are shipping costs and the additional service fees that a firm charges in event of a return. We introduce a specific form of consumer naivete: some consumers underestimate the costs of returning a faulty product to claim a warranty payment. Given their cost assessments and the warranties offered, these consumers make inferences with respect to product quality, i.e., they use a correct inference mechanism based on false return cost premises. This provides the firm with a novel channel for increasing its profits: at relatively low warranty levels, at which the firm optimally produces a low-quality product, naive consumers falsely infer that the product is of high quality and are thus prone to overpay for it.

The following intuition applies. For any warranty offered, consumers ask themselves whether it is more profitable for the firm to produce a high- or low- quality product. Producing a high-quality product leads to higher production costs, while producing a low-quality product leads to higher warranty costs as a result of more frequent product breakdowns. Naive consumers' misperceptions of the return cost lead them to overestimate both the probability of returning a product after a breakdown and the firm's warranty claim costs. Consequently, there exist warranty levels for which the trade-off in costs still makes the firm prefer to produce a low-quality product, while naive consumers believe that it is better for the firm to produce a high-quality product. These consumers are willing to pay high-quality prices for low-quality products, which the firm can in some cases profitably exploit.

Our model provides an explanation for why naive consumers overpredict the quality of products and services in the presence of warranty or product return options. In particular, we contribute to the existing literature by showing how firms can use specific contract features as deceptive signaling devices to establish endogenous quality misperceptions in consumers while both the product price and quality are salient items for them.³ A firm can establish false consumer beliefs about product quality through warranty signaling to profitably exploit these

³See Kőszegi and Szeidl (2013) for a model of context-dependent preferences in which the utility weights of different characteristics depend on the size of the characteristic-specific utility differences among different choice options. Heidhues *et al.* (2016) show that if a firm cannot gain sufficiently from educating consumers about hidden add-on fees, its incentive for generating innovation to further exploit add-on fees can be higher than its incentives to innovate to develop higher value products.

beliefs rather than only exploiting time-inconsistent preferences via pricing schemes. Thus, a relatively small deviation from full consumer rationality can already lead to endogenous consumer quality misperceptions in a behavioral contracting setting. Specifically, our model implies that while some consumers underestimate their return costs, they nevertheless rely on inferring the underlying product quality given the warranties offered in the event of product breakdown. We see this as a weaker form of naivete compared to consumers always having full faith in a firm’s claims or advice. We find our main channel to be particularly applicable to manufacturers that directly sell their products to consumers without the use of retailers and substantially advertise guarantees to signal high product quality. This applies to many products sold via infomercials on TV, where the effects of reputation via repeated purchases play only a minor role. The model relates more generally to cases of consumer illiteracy or neglect with respect to contract fine print.⁴

To support our main modeling assumptions, we provide detailed information on the contract structure of a knife set manufacturer that offers “lifetime warranties” and “30-day money back” policies via infomercials. The return policies are associated with strong exclusion restrictions shown in fine print on the product website: as a result of these restrictions, less than 50 percent of the initial price is paid back to the consumer if a return claim arises. The warranty fine print states that a consumer has to pay a fee per knife plus shipping costs for replacing faulty knives. An underestimation of return costs in our model translates into non-salience of the additional costs or of the reduced benefits. Pairing the data on the firm’s contract structure with customer reviews for this product, we find that many reviewers anticipate neither the return costs nor the warranty and return exclusion terms. Reviewers who do not anticipate warranty and money return exclusion terms are likely to mention being surprised about the low product quality and often perceive the product to be a “scam”. The effects are consistent with our quality-misperception case. We further highlight how the observed patterns differ from the predictions in situations in which consumers are

⁴Prominent examples from this industry are various kitchen goods such as knife sets and frying pans, hair growth or weight loss products, as well as various products for cleaning or physical exercise. Other applications are financial products with underlying risks that are not initially well observed by certain consumers who overpay for the products relative to their risks because of nearly worthless contract guarantees.

loss-averse and thus pay relatively high insurance premiums relative to the exposed risk; see, for example, Chen *et al.* (2009) and Sydnor (2010).

Section 3 presents our theoretical results by deriving the firm’s optimal contracts for different market structures and by analyzing the consequences for consumer surplus. We first provide an analysis of the case in which a firm can only offer a single product for the isolated case that only involves naive consumers. When the savings in production costs outweigh the firm’s gains in warranty revenues from selling a high-quality product with a high warranty level, the firm sells a low-quality product at a high-quality price to naive consumers. In the opposite case, the firm makes use of naive consumers’ return cost misperceptions and sells a high-quality product together with a large and overpriced warranty.⁵ In both cases, the firm fully extracts naive consumers’ predicted utility, which is higher than their expected consumption utility, thus leading to “exploitative” outcomes. Consequently, the firm’s profits are higher than when facing only “sophisticated” consumers who correctly assess return costs.

To understand how the profitability of the different profit channels is affected by the presence of sophisticated consumers who correctly assess the market fundamentals, we proceed by characterizing a firm’s contract choices when it faces both consumer types and is able to offer multiple products and qualities. When the firm targets a high-quality product to sophisticated consumers, this reduces the option to also profitably sell exploitative contracts to naive consumers. In particular, it only sells a high-quality product to sophisticated consumers if the additional quality markup per sophisticated consumer reduces the lost exploitative markup per naive consumer, which prevents naive consumers from becoming exploited. In any other case, sophisticated consumers are only provided a low-quality product, which prevents the firm from having to pay “virtual rents” to naive consumers.

In Section 4 we show that while retail competition among multiproduct firms always leads to zero firm profits, it cannot prevent cases of consumer quality misperceptions and in some cases still leads to a negative expected consumption utility for naive consumers. Such

⁵This channel relates to cases in which consumers’ false beliefs or time inconsistencies make them prone to overpay for products of known quality; see, for example, DellaVigna and Malmendier (2004) and Eliaz and Spiegler (2006). Inderst and Ottaviani (2013) show that if consumers credulously believe a seller’s advice, cancellation rights can increase consumer surplus. In our companion paper Michel (2017), we study regulations for voluntary add-on contracts that can be sold by retailers at the point of sale under competition while product quality is observable.

a situation occurs if these consumers falsely infer high quality from a competitively priced low-quality product due to a sufficiently high warranty, while their willingness to pay for a low-quality product is lower than the product price.

Overall, our paper provides insight into the impact of contract features on the emergence of endogenous consumer quality misperceptions and shows that they can significantly affect market outcomes, while the full analysis is relegated to the online Appendix. Section 5 summarizes the findings from our supporting infomercial example. Section 6 concludes.

Related theoretical literature Our model contributes to the existing literature by showing that in the presence of consumer naivete about specific costs or contract terms, firms can design contracts to profitably induce false beliefs about product quality in consumers.

Spence (1977) formalizes a model in which consumers have exogenous quality misperceptions. Consumers vary in the degree to which they mispredict failure rates. Because of continuous, increasing, and convex marginal costs and perfect competition among firms, producer liabilities can serve as a quality signal and yield the first-best outcome. Our paper incorporates consumer belief formation that depends on the warranty contracts offered, which can lead to false quality perceptions by naive consumers.

Bordalo *et al.* (2016) study the effects of strategic product positioning on the salience of price and quality. Under product competition, firms' equilibrium product positioning can lead to cases in which consumers neglect quality in their decision making. In contrast, product quality in our model is always a salient feature, but it can be overestimated via false inference because of unanticipated return costs or neglected contract terms. We believe that this applies to cases in which firms attempt to convey that their products are of high quality via advertising guarantees that include devaluing exemption clauses.

Inderst and Ottaviani (2013) show that granting a cancellation right to rational consumers who foresee an adviser's self-interest can make his cheap talk credible. If all consumers are "credulous", i.e., neglect the advisor's self interest and believe every piece of advice he gives them, then the advisor always claims that a product is the most suitable for a consumer. One of our key contributions is to endogenize the belief formation of naive consumers to study which contracts allow a firm to profitably exploit induced quality misperceptions.

Eliasz and Spiegel (2006) analyze a setting in which a principal contracts with agents who differ in their degree of time-inconsistency. In equilibrium, at least some consumers always become exploited, while pooling can occur for less naive types. In our model, the consumer types differ in their ability to understand all relevant costs when making quality inferences.

Our paper is also related to the literature on shrouded add-on products and profitable deception; see, for example, Gabaix and Laibson (2006) and Heidhues *et al.* (2017). In our model, the warranty is always observable to consumers when they make their main product decision. This is reflected not only in an additional cost but also in a potential payment in the event of product breakdown. The warranty level yields information regarding the product quality, which naive consumers falsely process. In Michel (2017), we analyze the effects of different consumer protection policies when different retailers offer the same base product while product quality is observable to consumers and warranty contracts are initially not salient product features. Naive consumers overestimate the value of extended warranties at the point of sale. A consumer's option to buy multiple quantities of a base product can result in an endogenous price floor that can lead to positive industry profits. Inducing competition via independent warranty providers at the point of sale leads to zero firm profits and weakly increases consumer surplus, while a minimum warranty standard has ambiguous effects on consumer surplus. The results are broadly consistent with the effects of recent changes regarding extended warranty regulation by UK legislators.

More generally, there is a growing body of literature on industrial organization models with a behavioral economics foundation related to our work; see, for example, Grubb (2015), DellaVigna (2009), and Armstrong (2008) for broad literature reviews.⁶

The paper further relates to the literature on warranties in industrial organization. Grossman (1981) develops a model with a single firm that must signal its exogenous product quality. He shows that when all consumers make rational inferences about product quality, the firm is not able to mislead them. Mann and Wissink (1990) assess the effectiveness of money-back

⁶Armstrong and Chen (2009) show that when some consumers do not pay attention to the quality component of products when making their purchasing decision under firm competition, this can lead to positive equilibrium firm profits. Carlin (2009) shows that firms' incentives to endogenously increase the pricing complexity of their products are increasing in the number of competitors when complexity makes it harder for consumers to become informed. Also see Sandroni and Squintani (2007) for an insurance model of asymmetric information with overconfident consumers.

and replacement warranties, both when the product quality is observable and when it is not. They find that a money-back warranty is always better except for an intermediate range of replacement costs of the firm.

2 Baseline model

2.1 Model Setup

We consider a firm that offers a menu of n products to consumers. In our analysis, we study both the case in which the firm can only choose to offer a single product, $n = 1$, and the case in which it can choose to offer a menu of two distinct products, $n = 2$, to the different consumer types. For each product, the firm can choose individually whether to produce with high quality q_H or low quality q_L , where $0 \leq q_L < q_H < 1$. A product's quality reflects its probability of working without a defect. Consumers cannot observe this quality. Production costs are increasing in product quality. There are constant marginal costs of production, $c(q_H) = c_H$ for a high-quality product and $c(q_L) = c_L < c_H$ for a low-quality product.

For each product $i \in \{1, \dots, n\}$ of quality $q_i \in \{q_H, q_L\}$, the firm sets a price p_i and offers an individual warranty contract γ_i . A warranty contract $\gamma_i \equiv (x_i, w_i)$ grants a consumer a payment w_i in the event of product breakdown at an additional price x_i that is paid upfront with the product price p_i . We further assume that there is a finite maximum warranty level \bar{w} that the firm can offer.⁷

Consumers are risk neutral.⁸ They value the consumption of a properly working product with utility $I > 0$ and derive 0 utility from consuming a malfunctioning product. Thus, the expected utility from consuming a product of quality q is qI . Consumers receive disutility $-p - x$ from paying the product price p and a warranty price x . They only derive positive consumption utility from consuming a single product. We do not consider cases in which consumers can influence the breakdown probability. The firm's different quality options q_L and q_H and production costs c_L and c_H , respectively, are common knowledge.

⁷The upper bound on warranties may not be necessary, but it rules out outcomes in which the firm offers infinite warranty contracts. One natural boundary is $\bar{w} = I$, i.e., the maximum willingness to pay for a working product.

⁸The main results hold qualitatively when consumers are risk averse.

A key feature of our model concerns the warranty payment in the event of product breakdown that the firm can use to signal high product quality. To receive the warranty payment, a consumer must return the product to the firm, which incurs socially wasteful costs r for the consumer. Return costs are distributed according to the differentiable cumulative distribution function (henceforth, cdf) $F(r)$. For simplicity, we assume that the distribution of return costs does not depend on the specific warranty contract and thus cannot be influenced by the firm.⁹ The draw of r is unknown to each consumer prior to the purchase of both the product and warranty contract.¹⁰

There are two consumer types that differ in how they anticipate return costs. A fraction $1 - \theta$ of consumers is “sophisticated” in the sense that they correctly predict the distribution of return costs. The remaining fraction θ of consumers is “naive” in that they erroneously underestimate the costs of returning the product, i.e., the anticipated distribution of return costs. Despite having the same return cost cdf $F(r)$ as the sophisticated consumers, naive consumers believe that the distribution of return costs r in the whole population can be described by the differentiable cdf $\tilde{F}(r)$. We assume that F first-order stochastically dominates $\tilde{F}(r)$ for the full support of the functions, i.e., $\tilde{F}(r) \geq F(r)$ for all $r \in (0, \infty)$, with $\tilde{F}(r) > F(r)$ for $r \in (0, \bar{w}]$. This implies that naive consumers underestimate their return costs for all positive warranty levels and that there is always a positive probability of facing return costs $r > 0$. This formalization allows for relatively flexible consumer return patterns.¹¹ At the time of a product breakdown, consumers learn their true cost draw r . They claim the warranty payment when it is at least as high as the cost draw, i.e., when $w \geq r$.

We do not attribute the underestimation of return costs to a specific consumer bias. This behavior is consistent with several concepts from the behavioral economics literature, as we

⁹In reality, a firm can, for example, increase consumer return costs by including additional service fees that consumers must pay in the event of product return, or by increasing bureaucratic complexity of the return process.

¹⁰All consumers having the same return cost distribution F and the actual cost draw being unknown prior to product purchases rules out any selection effects from privately known consumer cost differences. Incorporating such effects would cause a second differentiation in the willingness to pay, but would not change the results qualitatively.

¹¹Using this specification regarding the cost distributions allows for both equilibrium warranty levels that are below the maximum warranty level \bar{w} and for consumers to return a product with positive probability in equilibrium. Although naive consumers still process contract features to infer quality, a relatively small deviation from rationality, i.e., the underestimation of return costs in the population, is thus sufficient for establishing quality misperceptions.

explain in Appendix B.

Consumer beliefs Consumers form beliefs about the probability of each product being of high quality, given the observable product prices and associated warranty contracts offered by the firm. We impose the condition that for each combination of prices and warranty contracts associated with a specific product, consumers believe that the firm selects the product quality that yields the highest profits for the firm. This condition rules out cases in which consumers form off-path beliefs that specifically depend on the product and warranty prices offered. This is similar to the implicit assumptions made by Spence (1977) and Emons (1988). The intuition is the following. From the firm's perspective, given a specific consumer demand, the revenue that it receives both from the product price p and from the price of a warranty x is independent of the product quality. The expected warranty costs that the firm incurs given a warranty payment w in the event of product breakdown are, however, decreasing in product quality. Consumers are aware of the tradeoff between lower production costs and higher expected warranty costs, even if naive consumers underestimate the return costs. The firm can make use of this tradeoff to signal a product's quality to consumers through the warranty level offered. Without this condition, in the presence of naive consumers one could generate off-path beliefs that are based on whether the combination of product price and warranty contract is the one expected by them given their beliefs about the return costs. Because the firm's warranty profits depend on the difference between anticipated and actual return costs, the optimal warranty contract for the firm differs from the optimal contract anticipated by naive consumers. Removing this condition can thus make different equilibria of the game possible, while all qualitative effects persist.¹²

The consumer types have the same preferences with respect to product quality and price, but they can differ in their utility predictions for each contract. This difference arises be-

¹²While our model is a game of imperfect instead of incomplete information, our belief condition nevertheless can be seen to have some parallels to the $D1$ criterion. Instead of asking which *quality types* (or sender) for a specific off-path deviation has the most to gain in terms of having the largest set of best responses as for $D1$, the question behind our condition is which *quality choice* q yields the highest profit for a specific warranty level w offered. See, for example, Wolinsky (1983) and Judd and Riordan (1994) for models in which the price signals product quality because of consumer learning.

cause naive consumers underestimate the return costs of all consumers, while sophisticated consumers correctly foresee the costs of all consumers, the fraction of naive consumers θ , and the naive consumers' beliefs about return costs. Thus, the firm and the sophisticated consumers fully agree about all fundamentals of the game. Naive consumers have a different belief about the world: they do not realize their naivete or recognize that there are also sophisticated consumers. We assume that naive consumers do not become suspicious of their own beliefs, when the menu of contracts offered by the firm does not reflect the firm's profit-maximizing menu of contracts from the naive consumers' perspective. The modeling assumptions imply that naive consumers underestimate the return costs of all consumers in the industry. All of our main results remain qualitatively unchanged if naive consumers underestimate the return costs of all naive consumers but have accurate beliefs about the return costs of sophisticated consumers.¹³

Equilibrium definition We search for the optimal set of product prices, product qualities, and associated warranty contracts that maximizes the firm's profit. We assume that the two consumer types are indistinguishable from one another before they make their purchase decisions. To solve this game of imperfect information, we use a modified version of the Weak Perfect Bayesian Equilibrium concept with an additional belief refinement.

Definition (Monopoly Equilibrium) An equilibrium under monopoly is a set of product qualities and prices $\{(q_i, p_i)\}_{i=1}^n$ and for each product $i \in \{1, \dots, n\}$, an associated warranty contract γ_i with the following properties:

1. *Optimal decision for sophisticated consumers and consistency of beliefs:* Sophisticated consumers make a product choice that yields the highest expected consumption utility. For each contract that has positive demand, their beliefs about product quality match the actual product quality. They claim a warranty payment when the payment is at least as high as their return costs.

2. *Hypothetical optimality for naive consumers and hypothetical consistency of beliefs:*

¹³The results do not hold, however, if naive consumers underestimate only their individual return costs but have correct beliefs about all other consumers in the market, including the other naive consumers.

Naive consumers make the product choice that yields the highest expected consumption utility in the virtual case in which all consumers' return costs are represented by the cdf \tilde{F} . For each contract that has positive demand, their beliefs about product quality match the product quality in the virtual case in which all consumers' return costs are represented by the cdf \tilde{F} . They claim a warranty payment when the payment is at least as high as their return costs.

3. *Firm profit maximization:* There is no menu of contracts that leads to a higher expected profit for the firm given the consumers' beliefs.

As under the regular Weak Perfect Bayesian Equilibrium concept, we require that sophisticated consumers have correct equilibrium beliefs. Unlike under the Weak Perfect Bayesian Equilibrium concept, we require the beliefs of naive consumers to be correct for the hypothetical case in which the naive consumers' predicted distribution of return costs is the true distribution, i.e., in which the naive consumers have true expectations about the distribution of the costs of returning the product. In our model, this deviation from rationality is crucial for establishing false beliefs about a product's quality.

Denote by $\Delta c \equiv c_H - c_L$ the difference in production costs and by $\Delta q \equiv q_H - q_L$ the difference in product quality between a high- and low-quality product, respectively. We assume that a consumer's net difference in willingness to pay for the two different product qualities exceeds the firm's difference in production costs. This implies that from a pure efficiency standpoint, it is best that the firm always produces only high-quality products. If a firm wants to sell high-quality products to consumers, it has to offer warranties to signal the product's quality. Because of return cost frictions, this can incur additional signaling costs when a consumer's valuation of a warranty is smaller than the firm's expected claim costs. We assume that the preference for high quality is sufficiently high to overcome potential cost inefficiencies caused by signaling high quality even to sophisticated consumers through a warranty and that it is feasible for the firm to set a sufficiently high warranty to signal high quality.¹⁴

¹⁴The first inequality of Assumption 1 can be rewritten as $\Delta q I - \Delta c > \frac{\Delta c}{\Delta q}$. This yields the minimum required difference between the willingness-to-pay differences and the cost differences between high- and low-quality products to ensure that a firm prefers to produce and signal a high-quality product when only facing sophisticated consumers.

Assumption 1. (Consumer preference for high quality) $\frac{\Delta q I}{1+\Delta q} > \frac{\Delta c}{\Delta q}$, and $F(\bar{w})\bar{w} > \frac{\Delta c}{\Delta q}$.

2.2 Consumer utility representation

A sophisticated consumer's expected utility from consuming a product of quality q at price p and the associated with warranty contract γ , $V_S(q, p, \gamma)$, can be written as

$$V_S(q, p, \gamma) = qI - (p + x) + (1 - q) \int_0^w [w - r]f(r)dr. \quad (1)$$

The first part on the right-hand side reflects the expected utility from consuming a product. The second part is the disutility that a consumer derives from the price of both the product and warranty. The third part is the expected utility from the warranty payment conditional on returning a defective product, where $f(r)$ is the return cost probability density function.¹⁵ Denoting by $\tilde{f}(r)$ a naive consumer's predicted return cost probability density function, the analogous expected consumption utility of a naive consumer can be written as

$$V_N(q, p, \gamma,) = qI - (p + x) + (1 - q) \int_0^w [w - r]\tilde{f}(r)dr. \quad (2)$$

Because a product's quality is unobservable to consumers prior to a purchase, they have to make quality inferences through the offered warranty. Let $\mu_i(\gamma)$ denote a sophisticated consumer's belief about the probability of product i associated with contract γ being of high quality. Let $\tilde{\mu}_i(\gamma)$ further denote a naive consumer's high quality belief about the same product i associated with contract γ being of high quality. Accordingly, $U_S(\mu_i(\gamma_i), p_i, \gamma_i)$ denotes a sophisticated consumer's predicted consumption utility from consuming product i that is associated with price p_i and warranty contract γ_i . This can be written as

$$U_S(\mu_i(\gamma_i), p_i, \gamma_i) = \mu_i(\gamma_i)V_S(q_H, p_i, \gamma_i) + (1 - \mu_i(\gamma_i))V_S(q_L, p_i, \gamma_i).$$

The predicted consumption utility for a naive consumer $U_N(\tilde{\mu}_i(\gamma_i), p_i, \gamma_i)$ can be written as

$$U_N(\tilde{\mu}_i(\gamma_i), p_i, \gamma_i) = \tilde{\mu}_i(\gamma_i)V_N(q_H, p_i, \gamma_i) + (1 - \tilde{\mu}_i(\gamma_i))V_N(q_L, p_i, \gamma_i).$$

We next establish implicit conditions for the two consumer types' beliefs about a product being of high quality. All consumers know that there is a tradeoff between lower production

The second inequality implies that the maximum warranty level \bar{w} is high enough to signal high product quality.

¹⁵Recall that a consumer claims a warranty after product breakdown only if $w > r$ and that $F(w)$ is a consumer's probability of claiming a warranty payment w in the event of breakdown.

costs and higher expected warranty costs in the production of a low-quality product. Sophisticated consumers believe that a product with positive consumer demand is of high quality when the overall additional expected warranty claim costs from producing a low-quality product at least offset the savings from producing with lower production costs. We can deduce that provided that there is positive demand for product i , sophisticated consumers believe it to be of high quality, i.e., $\mu_i(\gamma_i) = 1$, if and only if $F(w_i)w_i \geq \frac{\Delta c}{\Delta q}$. Naive consumers also make inferences about the product's quality. Given positive demand for product i , they believe it to be of high quality, i.e., $\tilde{\mu}_i(\gamma_i) = 1$, if and only if $\tilde{F}(w_i)w_i \geq \frac{\Delta c}{\Delta q}$.

3 Derivation of optimal contracts

In this section, we establish our main theoretical results, focusing on cases in which only a single firm is present.¹⁶ We first focus on the case in which each firm can only offer a single product. In particular, after introducing the baseline case in which all consumers are sophisticated, we show how the firm can increase its profits when only naive consumers are present by adjusting its contract structure. Most important, we show how the firm can profitably induce consumer quality misperceptions. This is followed by a characterization of the optimal multiproduct menu of contracts when both consumer types are present and the firm can offer different products to the different consumer types.

3.1 Efficiency benchmark under full sophistication

As a benchmark, we first seek to determine the efficient industry allocation when only sophisticated consumers are present in the market. By Assumption 1, it is optimal for the firm to produce a high-quality product. As any warranty return costs that consumers incur are detrimental to overall surplus, the firm attempts to minimize warranty costs while providing a high-quality product. Because consumers cannot observe product quality, the firm offers a high level of quality together with the warranty level that signals high quality to consumers while minimizing return costs. Recall the warranty level necessary and sufficient to signal high product quality to sophisticated consumers: $F(w)w \geq \frac{\Delta c}{\Delta q}$. Let w^* denote the warranty

¹⁶As an extension, we analyze how industry competition affects pricing and consumer surplus in Section 4.

level that satisfies this weak inequality with strict equality:

$$F(w^*)w^* = \frac{\Delta c}{\Delta q}. \quad (3)$$

When only sophisticated consumers are present, the firm offers a product with high quality q_H at a price $V_S(q_H, 0, w^*)$ and warranty level w^* . This yields full rent extraction for the firm and is summarized in Proposition 1.

Proposition 1 (Optimal contract in the presence of only sophisticated consumers).

Suppose that only sophisticated consumers are in the market: $\theta = 0$. Then, the firm produces a high-quality product, $q = q_H$, at price $p = Iq_H + (1 - q_H)F(w^)E[w^* - r | w^* > r]$. It offers the warranty contract $\gamma^* = (0, w^*)$, where w^* is defined by equation (3).*

3.2 Only naive consumers in the market

We next analyze the case in which only naive consumers are present in the market, i.e., $\theta = 1$. This illustrates the different channels for consumer misperceptions in our model. A firm has two potential options to extract rents from a naive consumer that exceed a sophisticated consumer's ex ante willingness to pay. First, the firm can produce a low-quality product while offering a warranty level such that naive consumers falsely believe the product to be of high quality. To our knowledge, this option is novel in the literature. Second, the firm can produce a high-quality product and exploit naive consumers overpredicting the value of high warranty levels because they underestimate their return costs. This option is similar to the workings of many exploitative contracting models in the literature. Overall, we call a contract exploitative if it leads to a negative expected consumer utility.

Exploitation of naive consumers' quality misperceptions For ease of notation, we define by π_N the difference between a naive consumer's predicted net revenue from the warranty and the firm's expected claim costs. Given warranty level w , a naive consumer's inferred product quality q_1 and actual product quality q_2 , this net revenue can be written as

$$\pi_N(q_1, q_2, w) \equiv (1 - q_1)\tilde{F}(w)\tilde{E}[w - r | w > r] - (1 - q_2)F(w)w,$$

where $\tilde{E}[w - r | w > r] \equiv \frac{1}{\tilde{F}(w)} \int_0^w [w - r]\tilde{f}(r)dr$ denotes a naive consumer's expected net utility from a warranty payment conditional on returning the product and conditional on

product breakdown. As naive consumers underestimate their return costs, they believe that a product is of high quality if $\tilde{F}(w)w \geq \frac{\Delta c}{\Delta q}$. Let \underline{w} denote the warranty level at which the above weak inequality holds with strict equality: $\tilde{F}(\underline{w})\underline{w} = \frac{\Delta c}{\Delta q}$. Because \tilde{F} strictly first-order stochastically dominates F , it follows that $\underline{w} < w^*$. Therefore, for any $w \in [\underline{w}, w^*)$, the firm can offer a low-quality product and sell it to naive consumers at a high-quality price. The firm can thus save production costs while being able to maintain a high-quality price when selling to naive consumers. In such a case, the firm sets a warranty level \tilde{w}^L to maximize warranty rents while ensuring that naive consumers believe that the product is of high quality:

$$\tilde{w}^L = \inf \left[\arg \max_{w \in [\underline{w}, w^*)} \pi_N(q_H, q_L, w) \right]. \quad (4)$$

Figure 1 shows the intuition of the firm's strategy using the functional forms $\tilde{F}(w) = 0.4\sqrt{w}$ and $F(w) = \max[0, 0.4\sqrt{w} - 0.4]$. We use an implied value of $\frac{c_H - c_L}{(q_H - q_L)I} = 0.4$ in the figure, and set $\bar{w} = 6.25$, such that $\tilde{F}(\bar{w}) = 1$. This results in the firm's optimal warranty levels $\tilde{w}^L = 1$ and $w^* \approx 2.15$ when exploiting naive consumers' quality misperceptions and when facing sophisticated consumers, respectively. From equation (3), it follows that if the firm offers a product with a warranty contract, the necessary warranty level to credibly signal high quality to sophisticated consumers must be at least w^* . However, naive consumers already believe a product to be of high quality when observing a warranty level of at least \tilde{w}^L . A different interpretation of the relatively low warranty level \tilde{w}^L is that naive consumers are inattentive to the exclusion terms that exempt a firm from needing to pay a warranty payment despite product breakdown. A minimum warranty level can then reflect a specific judicial regulation of viable exclusion restrictions from the producer side.

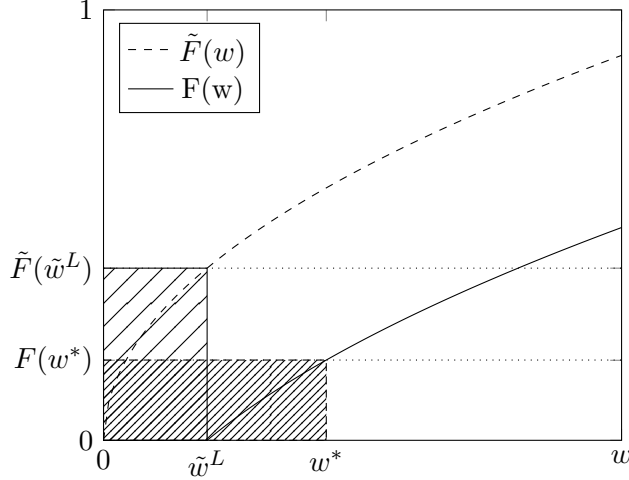


Figure 1: Minimum warranty level to signal high product quality for different consumer types

Exploitation of naive consumers’ overestimation of warranty valuations only The firm can exploit the overestimation of warranty valuations and profitably offer warranties that are potentially excessive from a social perspective. In such a case, it sets a warranty level equal to or above w^* in combination with a high product quality q_H . The profit-maximizing warranty level \tilde{w}^H maximizes the difference between the warranty revenue from selling to naive consumers and the expected warranty costs:

$$\tilde{w}^H = \inf \left[\arg \max_{w \in [w^*, \bar{w})} \pi_N(q_H, q_H, w) \right]. \quad (5)$$

Figure 2 illustrates this channel using the same functional forms as in Figure 1. This results in an optimal warranty level of $\tilde{w}^H = 4$ when exploiting naive consumers’ overestimation of warranty valuations. For a particular warranty level w , the areas below the two increasing functions show both consumer types’ predicted net warranty rents conditional on product breakdown. Because a naive consumer underestimates his return costs, this causes him to overestimate the value of a warranty for two different reasons. First, he overestimates the return frequency: for any positive and feasible warranty level w , i.e. for $0 < w \leq \bar{w}$, a naive consumer’s predicted return probability $\tilde{F}(w)$ is higher than the actual probability $F(w)$. Second, the naive consumer also overestimates the net return warranty payment because he underestimates return costs. This is reflected by the area between the cdf $\tilde{F}(w)$ and the x-axis being larger than the area between the cdf $F(w)$ and the x-axis. The return costs

conditional on product breakdown are represented by the rectangle defined by the warranty level \tilde{w}^H on the x-axis and the probability of returning the product conditional on breakdown $F(\tilde{w})$ on the y-axis. When this channel is optimal, the firm chooses the warranty level \tilde{w}^H to maximize the difference between the area of the naive consumers' predicted net warranty rent conditional on returning the product and the firm's expected warranty claim costs.

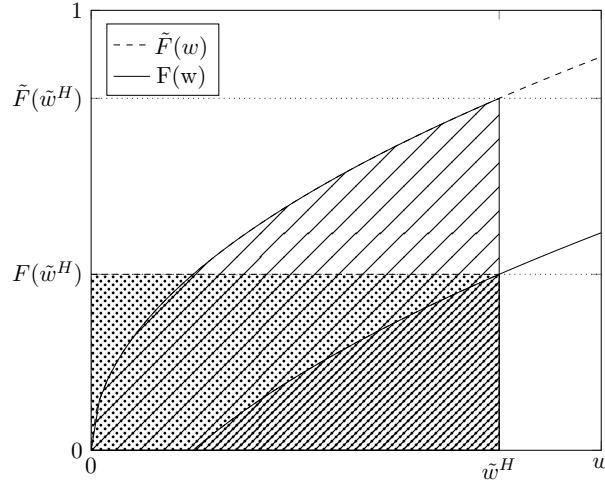


Figure 2: Consumers' predicted warranty rents conditional on breakdown and return

Optimal firm contract The firm chooses the form of exploitation that generates the highest profits. For both options, naive consumers believe that the product is of high quality. Therefore, the difference in the profitability of the two options stems from the difference in warranty profits and the difference in production costs. When selling a high-quality product, the firm incurs a potentially positive warranty profit $\pi_N(q_H, q_H, \tilde{w}^H)$ because of the overprediction of warranty valuations by naive consumers. When producing a low-quality product, the warranty profit $\pi_N(q_H, q_L, \tilde{w}^L)$ is more likely to be negative. This is because naive consumers underestimate the probability of product breakdown for a low-quality product and thus underestimate the expected warranty rent. However, in this case, the firm incurs savings in production costs relative to producing a high-quality product.

Proposition 2. *(Optimal symmetric contract when only naive consumers are present) Suppose that only naive consumers are in the market, $\theta = 1$.*

1. If $\pi_N(q_H, q_H, \tilde{w}^H) - \pi_N(q_H, q_L, \tilde{w}^L) < \Delta c$, the firm offers a low-quality product at price $p = Iq_H + (1 - q_L)\tilde{F}(\tilde{w}^L)\tilde{E}[\tilde{w}^L - r|\tilde{w}^L > r]$ with a warranty contract $(x, w) = (0, \tilde{w}^L)$. Naive consumers falsely infer a high quality from the warranty.
2. If $\pi_N(q_H, q_H, \tilde{w}^H) - \pi_N(q_H, q_L, \tilde{w}^L) \geq \Delta c$, the firm offers a high-quality product at price $p = Iq_H + (1 - q_H)\tilde{F}(\tilde{w}^H)\tilde{E}[\tilde{w}^H - r|\tilde{w}^H > r]$ with a warranty contract $(x, w) = (0, \tilde{w}^H)$.

From the proposition, it directly follows that if $\theta = 1$, naive consumers always pay more for a product and warranty contract than their true valuation given the correct return cost distribution. This occurs because these consumers overestimate either a product's quality or the value of a warranty conditional on product breakdown.

Corollary 1. *If $\theta = 1$, any equilibrium contract offered is exploitative.*

Minimum warranty standard Next, suppose that a policymaker introduces the requirement that, for each product, the firm must offer a warranty level of $w = w^*$. Under such a policy, it is no longer profitable for the firm to offer low-quality products. When the firm sells a low-quality product to naive consumers in the absence of such a minimum standard, the policy leads the firm to change its product offering to a high-quality product with warranty level \tilde{w}^H . If it offers a high-quality product in the absence of a minimum warranty standard, introducing the policy is useless.

Corollary 2. *Let $\theta = 1$. If $\pi_N(q_H, q_H, \tilde{w}^H) - \pi_N(q_H, q_L, \tilde{w}^L) < \Delta c$, a minimum warranty standard $w = w^*$ increases consumer surplus. Otherwise, it has no effect on the market outcome.*

3.3 Multiproduct firm

Firm maximization problem We next analyze the case in which a firm can sell different products to the different consumer types to maximize its profit. We restrict our analysis to cases in which the firm sells one product with an associated warranty contract per consumer type, which leads to $n = 2$. The firm cannot increase its profit by offering several distinct products per consumer type. This is because there is no further differentiation among consumers of the same type.

Observation 1.

The optimal set of product qualities $\{q_S, q_N\}$, product prices $\{p_S, p_N\}$, and warranty contracts $\Gamma = \{\gamma_S, \gamma_N\}$, for the sophisticated and naive consumers, respectively, are solutions to the following maximization problem:

$$\max_{\{p_S, q_S, \gamma_S, p_N, q_N, \gamma_N\}} \theta [p_N - c(q_N) + W_N(\gamma_N, q_N)] + (1 - \theta) [p_S - c(q_S) + W_S(\gamma_S, q_S)] \quad (6)$$

subject to the constraints

$$U_S(\mu_S, p_S, \gamma_S) \geq U_S(\mu_N, p_N, \gamma_N) \quad (IC_{SQ}),$$

$$U_N(\tilde{\mu}_N, p_N, \gamma_N) \geq U_N(\tilde{\mu}_S, p_S, \gamma_S) \quad (IC_{NQ}),$$

$$U_S(\mu_S, p_S, \gamma_S) \geq 0 \quad (PC_{SQ}),$$

$$U_N(\tilde{\mu}_N, p_N, \gamma_N) \geq 0 \quad (PC_{NQ}),$$

where

$$W_S(\gamma_S, q_S) \equiv (1 - q_S) \left[\frac{x_S}{1 - q_S} - F(w_S)w_S \right],$$

$$W_N(\gamma_N, q_N) \equiv (1 - q_N) \left[\frac{x_N}{1 - q_N} - F(w_N)w_N \right].$$

The first two conditions are incentive compatibility constraints for sophisticated and naive consumers, respectively. The third and fourth conditions are participation constraints for sophisticated and naive consumers, respectively. The last two equations give the expected net revenues from offering the warranties. These net revenues depend on the respective quality levels, the level and price of the warranty contract associated with a specific product, and the overall warranty claim costs of the firm.

To reduce the expositional complexity, we restrict our analysis in this section to cases in which $Iq_L \geq c_L$. If this does not hold, sophisticated consumers can end up not buying a product in equilibrium instead of buying a low-quality product. Otherwise, the results remain qualitatively unchanged.¹⁷ As in the $\theta = 1$ case, we again distinguish our exposition between the case in which it is more profitable to exploit naive consumers' quality misperceptions in the absence of sophisticated consumers, i.e., $\pi_N(q_H, q_H, \tilde{w}^H) - \pi_N(q_H, q_L, \tilde{w}^L) < \Delta c$, and the opposite case in which solely exploiting their return cost misperceptions is more profitable.

¹⁷In particular, consumer surplus and all prices of positively demanded products remain unchanged.

Proposition 3. (*Optimal multiproduct menu of contracts*) *The optimal menu of products and associated warranty contracts when the firm faces both naive and sophisticated consumers has the following characteristics.*

1. *Suppose that $\pi_N(q_H, q_H, \tilde{w}^H) - \pi_N(q_H, q_L, \tilde{w}^L) < \Delta c$. If the fraction of naive consumers θ is sufficiently low, the firm offers a high-quality product to sophisticated consumers and either a high- or low-quality product to naive consumers. If θ is sufficiently high, the firm offers two distinct low-quality products.*
2. *Suppose that $\pi_N(q_H, q_H, \tilde{w}^H) - \pi_N(q_H, q_L, \tilde{w}^L) \geq \Delta c$. If the fraction of naive consumers θ is sufficiently low, the firm offers high-quality products to the different consumer types. If θ is sufficiently high, the firm offers a high-quality product targeted at naive consumers and a low-quality product targeted at sophisticated consumers.*

Appendix A.3 derives the optimal product prices and warranty contracts in detail and establishes fully exhaustive thresholds for all cases. The firm's choice of product quality levels and warranty contracts critically depends on the share of naive consumers θ in the population. If the fraction of naive consumers θ is relatively high, the firm has an incentive to fully exploit the naive consumers' misperceptions. It does so by offering a low-quality product to sophisticated consumers. In this case, the firm does not have to give rents to any consumer type and thus chooses the profit-maximizing form of misperception for naive consumers, as in the case in which $\theta = 1$. When the fraction of sophisticated consumers is higher, the firm has an incentive to sell a high-quality product to sophisticated consumers to receive higher markups from them. In such a case, the presence of sophisticated consumers limits the degree of exploitation of naive consumers. This also affects the firm's quality choice towards naive consumers. Because selling a high-quality product to sophisticated consumers requires associating a warranty level of at least w^* to this fairly priced product, the virtual rents it has to give to naive consumers when exploiting quality misperceptions for a second product are so high that this case becomes very unlikely. Because the virtual rents that naive consumers receive are paid via a reduced product price and thus not prone to return cost frictions, this case can still persist in equilibrium when quality misperceptions

are highly profitable. However, it is relatively more likely at low values of θ to offer two distinct high-quality products to both consumer types.

The analysis of the case in which the firm can offer a menu of warranty contracts per product is relegated to the online Appendix. In this case, all of our main results and channels qualitatively prevail.

4 Industry competition

We next analyze a competitive model variant in which there are $M \geq 2$ firms that simultaneously set product qualities, product prices, and warranty contracts. As in the last section, each firm can again choose to produce multiple products of potentially different qualities.¹⁸ Recall the optimal warranty levels for the three different cases from the monopoly section: \tilde{w}^L , w^* , and, \tilde{w}^H . We define the sum of marginal costs of production and the expected warranty payments of a firm for a given warranty level as its quasi-marginal costs: $\hat{c}_L \equiv c_L + (1 - q_L)F(\tilde{w}^L)\tilde{w}^L$; $\hat{c}_S \equiv c_H + (1 - q_H)F(w^*)w^*$; $\hat{c}_H \equiv c_H + (1 - q_H)F(\tilde{w}^H)\tilde{w}^H$. We focus solely on pure strategy equilibria. To ensure the uniqueness of the equilibrium warranty levels, we assume in this section that with positive probability, consumers incur positive return costs that are sufficiently low to not prevent them from claiming a warranty payment, and with positive probability they incur return costs that prevent them from claiming a warranty payment.¹⁹

We define Λ as the difference in a naive consumer's predicted utility from consuming a high-quality product with warranty level \tilde{w}^H priced at the quasi-marginal cost and the utility of consuming a low-quality product with warranty level \tilde{w}^L priced at quasi-marginal costs:

$$\Lambda \equiv U_N(1, \hat{c}_H, \tilde{w}^H) - U_N(1, \hat{c}_L, \tilde{w}^L). \quad (7)$$

If Λ is below zero, naive consumers attribute higher expected value to a low-quality product at the overall price \hat{c}_L associated with warranty level \tilde{w}^L that they perceive to be

¹⁸The equilibrium quality levels, prices, and warranty levels would be unchanged in the event that each firm could only produce one product and there are at least $M = 4$ firms in the market.

¹⁹All equilibria without this assumption lead to identical consumer surplus, firm profits, and consumer quality choices; only the composition of the warranty contracts can differ. The assumption is satisfied if $0 < r < \tilde{w}^L$ and $r > \bar{w}$ both with positive probability.

of high quality compared with the value attributed to a high-quality product at price \hat{c}_H associated with warranty level \tilde{w}^H . Thus, in equilibrium, these consumers choose a low-quality product. This is captured in our next proposition.

Proposition 4. *(Competitive equilibrium) Let $M \geq 2$. Then, any equilibrium has the following properties.*

- i) If $\Lambda < 0$, at least two firms sell a high-quality product with warranty level w^* at price $p_S = \hat{c}_S$ to sophisticated consumers. At least two firms sell a low-quality product with warranty level \tilde{w}^L at price $p_{NL} = \hat{c}_L$ to naive consumers, where \tilde{w}^L is defined by eq. (4).*
- ii) If $\Lambda \geq 0$, at least two firms sell a high-quality product with warranty level w^* at price $p_S = \hat{c}_S$ to sophisticated consumers. At least two firms sell a high-quality product with warranty level \tilde{w}^H at price $p_{NH} = \hat{c}_{NH}$ to naive consumers, where \tilde{w}^H is defined by eq. (5).*

Irrespective of Λ , all firms make zero profits in equilibrium.²⁰ Sophisticated consumers buy a product that maximizes their utility, while all naive consumers choose a product that maximizes their predicted utility ex ante. When $\Lambda < 0$, naive consumers buy low-quality products in equilibrium, which is an ex post suboptimal quality choice. When $\Lambda > 0$, only high-quality products are produced. Naive consumers obtain the warranty coverage \tilde{w}^H , and sophisticated consumers obtain the warranty coverage w^* .

One example for the former case, i.e., when $\Lambda < 0$, is when some firms sell high-quality products at a high price together with a credible repair system, such as the presence of their own specialized stores, while other firms sell low-quality products at a low price together with a relatively low-value “lifetime warranty” advertised in a TV infomercial. If consumers’ willingness to pay for a low-quality product is below the marginal cost of production, then naive consumers would pay more in equilibrium than their willingness to pay.

Corollary 3. *If $\Lambda < 0$ and $c_L > Iq_L$, the competitive equilibrium outcome yields negative expected utility for naive consumers.*

Notably, this is not primarily due to return cost misperceptions but rather to the misleading quality signaling from a warranty. One way to crowd low qualities out of the market is to set a minimum required warranty standard $w \geq w^*$. If $\Lambda < 0$, then low-quality products

²⁰Recall that firms can offer menus of products, such that this already holds for $M = 2$.

are crowded out of the market, and naive consumers make the same warranty choice as in the $\Lambda > 0$ case.

Corollary 4. *Suppose that there is a minimum warranty standard $w \geq w^*$. If $\Lambda < 0$, then naive consumers are strictly better off compared to the case without a minimum warranty standard.*

Thus far, the analysis has not accounted for potential renegotiation between the firm and consumers at the point of sale. We show in the online Appendix that in some circumstances, renegotiation can be profitable for a firm and acceptable to consumers. Except for potential changes in the final warranty contracts, the results remain qualitatively unchanged.

5 Supporting example from a knife set manufacturer

In this section, we summarize the findings from a supporting example of a knife set manufacturer that uses warranty and money return policies to advertise its main product while writing exclusions in the contract fine print that substantially devalue these policies. We relegate the detailed analysis to the online Appendix.

The contract fine print states that the return policy allows for a repayment of the price excluding any initially paid fees and any costs of returning the product. This results in at most 40.4 percent of the initial price being reimbursed when claiming the policy because of substantial shipping and processing fees. When claiming the advertised lifetime warranty, a consumer has to pay an additional \$ 3.00 service fee per knife, plus all shipping costs. The non-reimbursement in the case of the return policy and additional fees in the case of a warranty claim can be translated into return costs in our model setting. The question is to what extent these costs are anticipated by consumers, and how they relate to consumers' quality perceptions.

We combine information on the contract terms with customer reviews of the product from an independent reviewer website. Consistent with our model, many consumers do not anticipate the contract fine print and underestimate their costs of returning a product. We further find that there is a high correlation between consumers being surprised about the advertised money return and warranty terms and having low quality perceptions.

In total, 42 percent of reviewers explicitly mention dissatisfaction with the product’s quality. We find a high correlation between consumers having a negative opinion of product quality and being surprised by hidden warranty or money return terms. Specifically, 67 percent of consumers who did not recognize the warranty terms *ex ante* also mention negative product quality, and 80 percent of those who did not anticipate the hidden return terms mention negative product quality. Conditional on at least one of the terms not being anticipated, negative product quality is mentioned 72 percent of the time. In these cases, consumers perceive the product to be a “scam” or “ripoff” 28 percent of the time. Unlike the money return and warranty terms, both quality and price seem to be salient items for most consumers in their decision making. This differs from them over- or underweighting an observable product quality in their decision-making process as in models of context-dependent decision making, see, e.g., Kőszegi and Szeidl (2013) and Bordalo *et al.* (2016).²¹

Relationship to loss aversion We next contrast the predictions of our quality misperception mechanism to the predicted effects of a model in which some consumers are loss-averse and show that the latter case is not consistent with our supporting example. Loss-aversion is often seen as one reason that consumers overpay for warranties or insurance given that they are exposed only to relatively modest risk; see, for example, Chen *et al.* (2009) and Sydnor (2010). A loss-aversion channel would be observationally equivalent to a case in which some consumers exogenously underpredict product qualities or to our second channel in which some consumers have a correct assessment of high product quality but misperceive the warranty valuations due to an underestimation of their return costs.

In all of these cases, the firm would have an incentive to offer extended warranty contracts to these consumers when it is allowed to do so. Either the overestimation of the claim rates, as in the latter two cases, or loss-aversion then leads to these consumers overpaying for extra warranties. The predictions of these models are not matched, however, by the reviews.

²¹The customer reviews further suggest that unanticipated initial shipment fees for processing and handling the product, which can be seen as basic shrouded add-on costs, do not play an important role in the formation of quality perceptions. Only in 13 percent of the cases in which such fees are mentioned do consumers complain about negative product quality. This is also consistent with our model, as these fees apply irrespective of the probability of a product working properly and thus cannot signal quality.

Rather, consumers are often surprised by low product quality, and the firm does not offer options to buy additional insurance against product failure, which are both consistent with the predictions of our quality misperceptions channel. Furthermore, consumers' underestimation of return costs together with an overestimation of quality is not consistent with a pure loss-aversion story in our supporting example.

6 Conclusion

This paper studies how firms can profitably induce the formation of incorrect consumer quality beliefs and emphasizes the associated consequences for market outcomes. In our model, the underestimation of return costs or the neglect of liability exclusion terms regarding a product warranty can lead to false quality inferences, which increases a consumer's willingness to pay for a product. This channel is consistent with the prominence of "lifetime" warranty policies as a marketing device for many products of relatively unknown companies.

Our supporting example from TV infomercials is consistent with firms strategically using warranty and money return policies to increase consumer quality perceptions while simultaneously concealing contract terms that substantially devalue these policies in the fine print. Hidden add-on fees alone cannot capture this effect, as they apply independent of product breakdown. We have ignored the possibility that firms strategically make product return more costly for consumers to decrease total claim payments. The customer reviews suggest that the firm in question indeed adopts strategies to make product return more difficult.

Another important question is how one can improve consumer literacy with respect to understanding contract details. In recent years, there have been attempts by both legal scholars and policy makers to simplify consumer contracts; see, for example, Siegel and Etzkorn (2013). Wilkinson-Ryan (2014) shows evidence of consumers being less critical of exclusion terms in contract fine print for relatively short contracts of approximately two pages in length than for long contracts of more than ten pages in length.

Shorter consumer contracts with simpler wording can increase the probability of consumers actually reading them before signing and can also increase the probability of consumers understanding the fine print. Nevertheless, promoting such a strategy cannot com-

pletely eliminate the possibility that firms will intentionally write long contracts that include strategic fine print to increase profits or that consumers will not understand the fine print. An important agenda for future research includes examining how legal contract standards can be most efficiently implemented to minimize the social costs of consumer misperceptions. This could lead to a better understanding of which contract terminologies and structures are most important in the formation of consumer quality perceptions.

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A Proofs

A.1 Proof of Proposition 1

From Assumption 1, it follows that it is always profitable for the firm to offer a high-quality product to sophisticated consumers, even when having to signal it via a positive warranty. To credibly signal high product quality, it has to offer a warranty level of at least w^* , as defined by equation (3). Because $E[w - r|w > r] \leq w$ for all $w > 0$ always holds, it follows that the firm cannot do better than offering the minimum warranty level w^* necessary to

signal high product quality. It extracts the full willingness to pay by offering this warranty level at a product price $p = Iq_H + (1 - q_H)F(w^*)E[w^* - r|w^* > r]$. This completes the proof.

A.2 Proof of Proposition 2

We first show that for the most profitable contract when setting a warranty level $w \in [w^*, \bar{w}]$, the firm can do no better than to offer a high-quality product together with a warranty level \tilde{w}^H defined by equation (5) at a product price $p = Iq_H + (1 - q_H)F(w^H)\tilde{E}[w^H - r|w^H > r]$. This follows because by using this contract, the firm extracts the full willingness to pay for the product and maximizes the difference between consumers' predicted warranty rent and the firm's claim costs, subject to the quality signaling constraint being met. Furthermore, from equation (3), given this warranty level, it is more profitable for the firm to produce a high-quality product than a low-quality product. Because of Assumption 1, this option is also strictly better than selling a low-quality product to naive consumers when they believe that the product is of low quality, which is the case when the warranty contract contains a warranty $w \in [0, \underline{w})$. Thus, the only other potential profit-maximizing option is to offer a low-quality product together with a warranty such that naive consumers believe that the product is of high quality. From definition of equation (4), it follows that when selling a low-quality product that naive consumers think to be of high quality, no warranty level within the set $[\underline{w}, w^*)$ can lead to a higher difference between consumers' predicted warranty valuations and a firm's expected claim costs than the warranty level \tilde{w}^L . At this level, the firm optimally extracts the full predicted rents from naive consumers, i.e., offers the low-quality product together with a warranty \tilde{w}^L at product price $p = Iq_H + (1 - q_H)\tilde{E}[w^L - r|w^L > r]$. Any higher price would yield zero demand, and any lower price would also lower revenues, which cannot be optimal. The difference in the firm's profits between the optimal high-quality and optimal low-quality contract is $\pi_N(q_H, q_H, \tilde{w}^H) - \pi_N(q_H, q_L, \tilde{w}^L) - c_H + c_L$. Whenever this difference is non-negative, the firm chooses the former option, i.e., sells a positive warranty contract together with a high-quality product. Otherwise, it chooses the latter option, i.e., sells a low-quality product at a high-quality price. This completes the proof.

A.3 Proof of Proposition 3

The proof proceeds in several steps. We first establish several helpful lemmas.

Lemma 1. *(High quality for both types) When a firm sells high-quality products to both naive and sophisticated consumers, it can do no better than setting product prices $p_S = Iq_H + (1 - q_H)F(w^*)E[w^* - r|w^* > r]$ and $p_N = Iq_H + (1 - q_H)\tilde{F}(\tilde{w}^H)\tilde{E}[\tilde{w}^H - r|\tilde{w}^H > r] - (1 - q_H)\tilde{F}(w^*)\tilde{E}[w^* - r|w^* > r] + (1 - q_H)F(w^*)\tilde{E}[w^* - r|w^* > r]$ and associated warranty contracts $\gamma_S = (0, w^*)$ and $\gamma_N = (0, \tilde{w}^H)$, respectively.*

Proof. Sophisticated consumers receive a high warranty product at the lowest warranty level w^* that is needed to signal high product quality. Any higher warranty level would increase the incentive compatibility constraint of naive consumers, which cannot be optimal. Since sophisticated consumers are the low type with respect to willingness to pay, they receive 0 utility from the contract and thus pay a product price $p_S = Iq_H + (1 - q_H)F(w^*)E[w^* - r|w^* > r]$. The profit-maximizing warranty level for naive consumers in this case is again \tilde{w}^H for a similar reason as in Proposition 2. Because naive consumers have a higher willingness to pay for a positive warranty, from their incentive compatibility constraint, it follows that they have to receive a compensatory virtual payment $(1 - q_H)[\tilde{F}(w^*)\tilde{E}[w^* - r|w^* > r] - F(w^*)E[w^* - r|w^* > r]]$ such that their constraint binds when being offered their product together with the optimal warranty level \tilde{w}^H . This completes the proof of the lemma.

Lemma 2. *(High quality for sophisticated consumers only) Suppose that $Iq_H + \pi_N(q_H, q_L, \tilde{w}^L) - \pi_N(q_H, q_H, w^*) > Iq_L + \pi_N(q_L, q_L, \tilde{w}^{LL})$. When a firm sells a high-quality product to sophisticated consumers and a low-quality product to naive consumers, it can do no better than setting product prices $p_S = Iq_H + (1 - q_H)F(w^*)E[w^* - r|w^* > r]$ and $p_N = Iq_H + (1 - q_H)\tilde{F}(\tilde{w}^L)\tilde{E}[\tilde{w}^L - r|\tilde{w}^L > r] - (1 - q_H)\tilde{F}(w^*)\tilde{E}[w^* - r|w^* > r] + (1 - q_H)F(w^*)\tilde{E}[w^* - r|w^* > r]$ and associated warranty contracts $\gamma_S = (0, w^*)$ and $\gamma_N = (0, \tilde{w}^L)$, respectively.*

Proof: The proof is analogous to that of Lemma 1.

Lemma 3. *(High quality for naive consumers only) When a firm sells a high-quality product to naive consumers and a low-quality product to sophisticated consumers, it can do no better than setting product prices $p_S = Iq_L$ and $p_N = Iq_H + (1 - q_H)\tilde{F}(\tilde{w}^H)\tilde{E}[\tilde{w}^H - r|\tilde{w}^H > r]$ and associated warranty contracts $\gamma_S = \{(0, 0)\}$ and $\gamma_N = (0, \tilde{w}^H)$, respectively.*

Proof: In such a case, the firm cannot do better than offering a low-quality product to sophisticated consumers without any warranty and extract the full willingness to pay Iq_L for

the product. Any higher warranty would not increase profits because of $E[w - r|w > r] \leq w \forall w > 0$ and the effects on incentive compatibility of naive consumers. For naive consumers, the firm extracts the full willingness to pay for the profit-maximizing high-quality contract. Because the sophisticated consumer's contract does not change the incentive compatibility constraint of the naive consumers, this contract is identical to the high-quality contract in Proposition 2, with an analogous proof. This completes the proof of the lemma.

Lemma 4. (*Low quality for both types*) Suppose that $Iq_H + \pi_N(q_H, q_L, \tilde{w}^L) > Iq_L + \pi_N(q_L, q_L, \tilde{w}^{LL})$. When a firm sells a low-quality product to sophisticated consumers and a different low-quality product to naive consumers, it can do no better than setting product prices $p_S = Iq_L$ and $p_N = Iq_H + (1 - q_H)\tilde{F}(\tilde{w}^L)\tilde{E}[\tilde{w}^L - r|\tilde{w}^L > r]$ and associated warranty contracts $\gamma_S = (0, 0)$ and $\gamma_N = (0, \tilde{w}^L)$, respectively.

Proof: The proof is analogous to that of Lemma 3 .

It cannot be optimal for the firm to sell a single low-quality product to both consumer types. In such a case, the contract is either not exploitative or both consumer types do not buy it, such that there is always an option for the firm to increase its profits.

We next begin with the characterization of the firm's optimal quality choices for the different consumer types. From Lemma 1 and Lemma 2, it follows that it is more profitable to sell a high-quality product to both consumer types instead of selling a high-quality product only to sophisticated consumers and a low-quality product to naive consumers if $\pi_N(q_H, q_H, \tilde{w}^H) - \pi_N(q_H, q_L, \tilde{w}^L) - \Delta c \equiv \Phi \geq 0$, while the converse holds in the opposite case. We define the excess profit from a naive consumer compared to a sophisticated consumer when selling a high-quality product by $\Delta\tilde{\pi}$: $\Delta\tilde{\pi} \equiv \pi_N(q_H, q_H, \tilde{w}^H) - \pi_N(q_H, q_H, w^*)$ if $\Phi \geq 0$, and $\Delta\tilde{\pi} \equiv \pi_N(q_H, q_L, \tilde{w}^L) - \pi_N(q_H, q_H, w^*) + \Delta c$ if $\Phi < 0$. Using Lemma 1 and Lemma 4, one can see that it is always more profitable to sell a high-quality product to sophisticated consumers instead of selling different low-quality products to the two consumer types if $Iq_H + \pi(q_H, w^*) + \theta\Delta\tilde{\pi} - c_H > \theta Iq_H + (1 - \theta)Iq_L + \theta\pi_N(q_H, q_L, \tilde{w}^L) - c_L$. This holds when $\theta < \theta^{1H,2L}$, where $\theta^{1H,2L}$ is defined by

$$\theta^{1H,2L} \equiv \frac{I\Delta q - \Delta c + \pi(q_H, w^*)}{I\Delta q - \Delta\tilde{\pi} + \pi_N(q_H, q_L, \tilde{w}^L)}. \quad (8)$$

Using Lemma 1 and Lemma 3, one can see that it is more profitable to sell high-quality products to both consumer types instead of selling a high-quality product only to naive con-

sumers and a low-quality product to sophisticated consumers if $Iq_H - c_H + \theta\Delta\tilde{\pi} + \pi(q_H, w^*) > \theta [I\Delta q - \Delta c + \pi_N(q_H, q_H, \tilde{w}^H)] + Iq_L - c_L$. This holds whenever $\theta \leq \theta^{1H,NH}$, where $\theta^{1H,NH}$ is defined by

$$\theta^{1H,NH} \equiv \frac{I\Delta q - \Delta c + \pi(q_H, w^*)}{I\Delta q - \Delta c - \Delta\tilde{\pi} + \pi_N(q_H, q_H, \tilde{w}^H)}. \quad (9)$$

Given the above thresholds, Proposition 3b provides the firm's optimal quality and contract combinations that relate to the different cases of Proposition 3 in the main text.

Proposition 3b (Optimal multiproduct menu of contracts with explicit thresholds)

The optimal menu of products and associated warranty contracts when the firm faces both naive and sophisticated consumers has the following characteristics.

1. Suppose that $\pi_N(q_H, q_L, \tilde{w}^H) - \pi_N(q_H, q_H, \tilde{w}^L) < \Delta c$. 1.1. If $\theta < \theta^{1H,2L}$ and $\Phi < 0$, the firm offers a low-quality product targeted at naive consumers and a high-quality product targeted at sophisticated consumers. 1.2. If $\theta < \theta^{1H,2L}$ and $\Phi \geq 0$, the firm offers a single high-quality product targeted at both consumer types. 1.3. If $\theta \geq \theta^{1H,2L}$, the firm offers two distinct low-quality products targeted at the different consumer types.
2. Suppose that $\pi_N(q_H, q_L, \tilde{w}^H) - \pi_N(q_H, q_H, \tilde{w}^L) \geq \Delta c$. 2.1. If $\theta \leq \theta < \theta^{1H,NH}$, the firm offers two distinct high-quality products targeted at the different consumer types. 2.2. If $\theta \geq \theta^{1H,NH}$, the firm offers a high-quality product targeted at naive consumers and a low-quality product targeted at sophisticated consumers.

We begin with point 1 of Proposition 3 (and of Proposition 3b), which applies when it is relatively more profitable to exploit naive consumers' quality misperceptions than return cost misperceptions, i.e., when $\pi_N(q_H, q_H, \tilde{w}^H) - \pi_N(q_H, q_L, \tilde{w}^L) < \Delta c$. In this case, it follows directly that it cannot be optimal for a firm to offer a high-quality product to naive consumers while selling a low-quality product to naive consumers. From the definition of the above thresholds, it follows that it is best for the firm to sell two different high-quality products to the different consumer types whenever $\theta < \theta^{1H,2L}$ and $\Phi \geq 0$. It sells a high-quality product to sophisticated consumers and a low-quality product to naive consumers when $\theta < \theta^{1H,2L}$ and $\Phi < 0$. This corresponds to the first two parts of point 1 in Proposition 3 (and points 1.1 and 1.2 in Proposition 3b). By the threshold definitions, it also follows directly that when

$\pi_N(q_H, q_H, \tilde{w}^H) - \pi_N(q_H, q_L, \tilde{w}^L) < \Delta c$, it is best for the firm to offer two different low-quality products to the different consumer types whenever $\theta > \theta^{1H,2L}$. This corresponds to the last part of point 1 in Proposition 3 (and point 1.3 in Proposition 3*b*).

We continue with point 2 of Proposition 3 (and Proposition 3*b*), which applies when it is relatively more profitable to exploit naive consumers' return cost misperceptions than quality misperceptions, i.e., when $\pi_N(q_H, q_H, \tilde{w}^H) - \pi_N(q_H, q_L, \tilde{w}^L) \geq \Delta c$. In this case, it follows that it can never be profitable for a firm to offer a low-quality product to naive consumers. This is because for any quality level targeted at sophisticated consumers, the firm can increase its profits by offering the optimal high-quality product and exploitative contract to naive consumers. By the threshold definitions, it follows that it is best for the firm to sell two high-quality products to the different consumer types whenever $\theta \leq \theta^{1H,NH}$. This corresponds to the first part of point 2 of Proposition 3 (and point 2.1 of Proposition 3*b*). It is best for the firm to offer a low-quality product to sophisticated consumers and a high-quality product to naive consumers whenever $\theta > \theta^{1H,NH}$. This corresponds to the second part of point 2 in Proposition 3 (and point 2.2 of Proposition 3*b*) and completes the proof.

A.4 Proof of Proposition 4

The proof proceeds in several steps. In step one, we show that in any equilibrium, there are only three possible quality-warranty combinations that can receive positive consumer demand: (q_H, w^*) , (q_L, \tilde{w}^L) , and (q_H, \tilde{w}^H) . In step two, we show that for all of these warranty-quality combinations, no equilibrium exists in which firms make positive profits. In step three, we prove that the candidate equilibrium in the proposition is indeed an equilibrium.

Step 1. We first show that there is no equilibrium in which firms have positive demand from sophisticated consumers for any contract that does not include the quality-warranty combination (q_H, w^*) . Similarly, we further show that there is no equilibrium in which firms have positive demand from naive consumers for any contracts other than those that include the quality-warranty combination (q_L, \tilde{w}^L) or (q_H, \tilde{w}^H) .

First suppose that there is a firm i that only obtains positive demand from sophisticated consumers by setting a single product with quality q' and contract (p', w') , with $(q', w') \neq (q_H, w^*)$. Recall that w^* is unique by the assumptions of Section 4. By the implicit definition

of w^* in equation 3, in combination with Assumption 1, given that firm i already has positive demand for the product, it follows directly that the firm can always find a combination q_H and (p, w^*) that leads to at least the same consumer demand and to higher per-consumer profits. In a similar fashion, using again Assumption 1 and the definition of \tilde{w}^L , if $\Lambda < 0$ and a firm already has positive consumer demand from naive consumers with quality q' and combination (p', w') such that $(q', w') \neq (q_L, \tilde{w}^L)$, it follows directly that firm i can always find a price p (together with an associated warranty price x) to increase profits per naive consumer while keeping demand at least constant by setting a quality- warranty combination (q_L, \tilde{w}^L) . With an identical argument this holds also for naive consumers and a quality-warranty combination (q_H, \tilde{w}^H) in the case in which $\Lambda \geq 0$.

We next proceed with the case in which a firm i has positive demand from both consumer types, $\Lambda < 0$ holds, and the firm is not selling two different products with the quality-warranty combinations $\{(q_H, w^*), (q_L, \tilde{w}^L)\}$. Recall that each firm can always offer a menu of products with potentially different product qualities. Then, it must be the case that either all other firms in the market must have the identical warranty contracts, or at least one firm $j \neq i$ must have zero demand from at least one consumer type. In both of these cases, by $\Lambda < 0$ and the definitions of w^* and \tilde{w}^L , it follows again directly that there is always a firm that can profitably deviate by selling two different products with quality-warranty combinations $\{(q_H, w^*), (q_L, \tilde{w}^L)\}$. Thus, at least one firm $j \neq i$ always has the option to change the two products to the type-specific, utility-maximizing quality-warranty combination. This implies that it can set prices for both products such that the utility from buying the type-specific products is always $\epsilon \rightarrow 0$ higher, such that it receives full demand for both products while obtaining higher aggregate profits. This is however a contradiction of firm i having positive demand in equilibrium. The proof that when $\Lambda \geq 0$, no firm can have positive demand for both products by selling two different products with the quality-warranty combinations $\{(q_H, w^*), (q_H, \tilde{w}^H)\}$ proceeds analogously. This completes step 1 of the proof.

Step 2. We next show that no equilibrium exists in which a firm makes positive profits. From step 1, it follows that when $\Lambda < 0$, in any equilibrium, any firm with positive demand has to set a quality-warranty combination (q_H, w^*) when selling to sophisticated consumers and (q_L, \tilde{w}^L) to naive consumers. Suppose now that firm i makes positive profits in equi-

librium when selecting these quality-warranty combinations. Then from a Bertrand-Nash pricing argument, it follows that there is always a firm $j \neq i$ that can set the same quality-price combinations as firm i and by undercutting i 's prices (or just one price if the other price is such that a firm makes 0 profits for this type) to capture all of firm i 's demand, which leads to a higher profit. The proof for the case of $\Lambda \geq 0$ proceeds analogous for the quality-warranty combinations (q_H, w^*) and (q_H, \tilde{w}^H) . This completes step 2.

Step 3. First, assume again that $\Lambda < 0$. From Proposition 2, it follows that the contract that maximizes naive consumers' predicted consumption utility subject to yielding at least 0 firm profits requires a firm to price the product at the marginal cost plus the expected warranty claim costs while offering a warranty level \tilde{w}^L . Following similar reasoning, sophisticated consumers cannot obtain a higher utility than from the contract that offers a high-quality product together with the lowest warranty level that can credibly signal a high-quality product w^* at marginal cost plus the expected claim costs. Any lower price would lead to negative profits for a firm. Provided that at least two firms set warranty levels \tilde{w}^L while offering a low-quality product at a price that equals quasi-marginal costs, and at least two firms offer a high-quality product at warranty level w^* at quasi-marginal costs, all of these firms always make zero profits. From the above, it follows that no firm can deviate to setting a different warranty level at the same quality to set a price such that it obtains both positive demand and non-negative profits. The proof for the case $\Lambda \geq 0$ again proceeds analogously. This completes both step 3 and the proof of the proposition.

B Microfoundations for the underestimation of return costs

There are several concepts from the behavioral economics literature that can be used to model the underestimation of return costs by certain consumers. The first is a simple model of non-salient extra return fees; see, for example, Bordalo *et al.* (2016). This is related to the existing literature on hidden add-on fees but differs from it in that the non-salience of the fees can lead to false quality inferences because it reduces the firm's costs when providing low quality. A second case is a state-dependent projection bias for an active state with low return costs in which consumers attribute too much weight to their current active state and in the future, thus underestimating their return costs; see, for example, Loewenstein

et al. (2003). A third case is time-inconsistency coupled with consumer naivete, such as in DellaVigna and Malmendier (2004), such that consumers initially hyperbolically discount both the return costs and the delayed warranty payments but after product breakdown face undiscounted return costs with still hyperbolically discounted warranty payments, which can lead to unexpectedly not returning the product in this period.

The return costs from our main specification can also be modeled as second-order loss-aversion. Suppose that consumers initially buy an extended warranty contract to secure “peace of mind”. However, once a product breaks down, the utility from a warranty benefit becomes reference-dependent with respect to expected warranty benefits provided that costly effort is required to return the product. If conditional on returning a product, consumers can still be non-eligible for an extended warranty payment with positive probability due to warranty exclusion restrictions, loss-aversion with respect to the expected gains from returning the product can lead consumers to exert no effort at all.

Online Appendix - For Online Publication Only
 “Contractual Structures and Consumer Misperceptions”
 by Christian Michel

C Further extensions

C.1 Type-asymmetric contracts

Menu of warranty contracts under full sophistication When allowing for a menu of warranty contracts being associated with each product, whenever the return cost cdf $F(r)$ is increasing over the interval $[w^*, \bar{w}]$ there exist equilibria that can lead to lower average return costs for consumers and can thus enhance efficiency. Consumers believe the product is of high quality if the warranty expenditures are sufficiently high. A higher warranty payment increases the probability of consumers returning a defective product. Thus, to credibly signal high product quality the firm needs to address fewer consumers when using a sufficiently high warranty level. The lowest number of consumers it has to attract is achieved by providing the maximum warranty level possible. Minimizing the number of consumers who buy a positive warranty subject to being able to credibly signal high quality minimizes return costs and maximizes overall welfare. Denote by Γ_i the menu of warranty contracts associated with product i . If two warranty contracts within the menu Γ_S for the same product have positive demand from sophisticated consumers, they must yield the same expected utility. Thus, a firm could sell a higher warranty to some consumers while selling a lower warranty that yields the same utility to other consumers. An advantage of such a contract is that it can potentially lead to a reduction in the expected return costs paid by all consumers. In the welfare-maximizing equilibrium the firm produces a single high-quality product $q = q_H$, at price $p_S = Iq_H$. It offers the menu of warranty contracts $\Gamma_S = \{\gamma_0 = (0, 0), \gamma_1 = ((1 - q_H)\tilde{F}(\bar{w})\tilde{E}[\bar{w} - r | \bar{w} > r], \bar{w})\}$. The demand for the positive warranty contract γ_1 is $\frac{\Delta c}{\Delta q F(\bar{w}) \bar{w}}$.

Only naive consumers present We next analyze type-asymmetric contracts in the monopoly case when only naive consumers are present, i.e. $\theta = 1$. As in the baseline case with only sophisticated consumers, firms try to minimize the return costs for a given warranty level.

This can imply giving high warranties only to a subset of naive consumers. Given that only a fraction $\alpha \in (0, 1)$ of consumers buy a warranty \tilde{w}^{AL} , for naive consumers to believe a product is of high quality requires that $\alpha F(\tilde{w}^{AL})\tilde{w}^{AL} \geq F(\underline{w})\underline{w}$. This turns to $\alpha \geq \frac{F(\underline{w})\underline{w}}{F(\tilde{w}^{AL})\tilde{w}^{AL}}$. The profit maximizing asymmetric equilibrium candidate when only facing naive consumers providing a low-quality product q_L consists of a product price $p = Iq_H$ and a menu of warranty products $\Gamma_{AL} = \{(0, 0); ((1 - q_H)\tilde{F}(\tilde{w}^{AL})\tilde{E}[\tilde{w}^{AL} - r | \tilde{w}^{AL} > r], \tilde{w}^{AL})\}$, and a fraction $\frac{F(\underline{w})\underline{w}}{F(\tilde{w}^{AL})\tilde{w}^{AL}}$ of consumers purchases the positive warranty contract, where \tilde{w}^{AL} is defined by

$$\tilde{w}^{AL} = \arg \max_{w \geq \underline{w}} \frac{w}{w} \pi_N(q_H, q_L, w) + \left(1 - \frac{w}{w}\right) \pi_N(q_H, q_L, 0). \quad (10)$$

Both warranty contracts yield the same predicted utility for a naive consumer. Therefore, some consumers can abstain from choosing the positive warranty contract while still believing that the product is of high quality.

The profit maximizing equilibrium when offering a high-quality product to only naive consumers is identical to the type-symmetric equilibrium whenever $\pi_N(q_H, q_H, \tilde{w}^H) \geq 0$. This is because in this case the firm makes a non-negative profit from selling positive warranty levels to naive consumers, and would weakly reduce the profits per consumer by offering consumers a 0 warranty contract instead. In the case in which $\pi_N(q_H, q_H, \tilde{w}^H) < 0$, the firm again potentially can gain by selling a positive warranty level only to a subset of the naive consumers. For the profit maximizing equilibrium candidate, the firm offers a high-quality product q_H to naive consumers at price $p = Iq_H$ together with a menu of warranties $\Gamma_{AH} = \{(0, 0); ((1 - q_H)\tilde{F}(\tilde{w}^{AH})\tilde{E}[\tilde{w}^{AH} - r | \tilde{w}^{AH} > r], \tilde{w}^{AH})\}$. A fraction $\frac{F(w^*)w^*}{F(\tilde{w}^{AH})\tilde{w}^{AH}}$ of consumers purchases the positive warranty contract, where \tilde{w}^{AH} is defined by

$$\tilde{w}^{AH} = \arg \max_{w \in [w^*, \bar{w}]} \frac{w^*}{w} \pi_N(q_H, q_H, w) + \left(1 - \frac{w^*}{w}\right) \pi_N(q_H, q_H, 0). \quad (11)$$

In case there is a multi-product firm and both consumer types are present, the firm under some circumstances again has incentives to reduce return costs. However, this has to be in line with all participation constraint and the incentive compatibility constraint. Especially in the case when the firm provides a high-quality product to both consumer types, the different constraint limit further reduction of return costs.

C.2 Renegotiation

Monopoly with single consumer type In this section we discuss effects of a firm being able to offer surprise warranty contracts when product quality is not observable. When only facing

one consumer type, for any equilibrium that includes the profit maximizing type-asymmetric menu of warranty contracts there is no profitable renegotiation. Sophisticated consumers correctly foresee the return cost, so by definition of the return cost-minimizing equilibrium there can be no Pareto improvement. When facing only naive consumers and offering a high-quality product, when $\pi_N(q_H, q_H, \tilde{w}^H) \geq 0$, by definition of \tilde{w}^H no other contract can increase the warranty profits per person while offering a high-quality product. Whenever $\pi_N(q_H, q_H, \tilde{w}^H) < 0$ and the firm offers the return cost minimizing menu of warranty contracts while setting a high product quality, naive consumers would still believe the product being of high quality when reducing the warranty level. However, such a reduction would make it more profitable to sell a low-quality product, which again increases return costs. When a firm targets a low-quality product to naive consumers, and privately offers a reduction in the warranty level, any consumer would anticipate that the product is of low quality, which makes any renegotiation in this case unprofitable.

The situation changes for type-symmetric equilibria. When offering a high-quality product either to sophisticated consumers or to naive consumers and $\pi_N(q_H, q_H, \tilde{w}^H) < 0$, the firm has an incentive to renegotiate to get more closely to the return-cost minimizing asymmetric equilibrium. When offering a low-quality product to naive consumers and $\tilde{w}^L > \underline{w}$, the firm again has an incentive to get more closely to the return cost maximizing asymmetric contract. When offering a low-quality product to naive consumers with $\tilde{w}^L = \underline{w}$, and when offering a high-quality product with $\pi_N(q_H, q_H, \tilde{w}^H) \geq 0$, there are always equilibria in which renegotiation is profitable for the firm.

Multiproduct Monopoly When targeting both consumer types while setting type-symmetric warranty contracts and selling products of different quality to the different consumer types, the firm again has an incentive to renegotiate to converge to the optimal type-asymmetric contract. When offering a high-quality product, it can be the case that the firm sets a warranty level $\tilde{w}^{EW} > \tilde{w}^H$ to naive consumers. In this case the firm always has an incentive to renegotiate with naive consumers. With the firm's possibility to renegotiate, the optimal contract for sophisticated consumers changes due to their anticipation of renegotiation between the firm and naive consumers.

D Assessing the model’s hypotheses using customer reviews

Product overview and contract terms One company that extensively uses TV infomercials to sell its main product –a knife set– is Ronco Knives.²² These infomercials advertise a 25-piece knife set for everyday use, which the firm provides with a knife block and a free second knife set as a bonus gift. Furthermore, in the infomercials, the knife set is advertised with a “lifetime warranty” and a “30-day money return policy.” Table 1 shows the detailed fee structure that is available from the product’s website. The firm advertises a price of \$39.99 for the product plus a \$43 shipping fee for “processing and handling”.²³

Part of contract	Fee	Fine print location	Interpretation
Product price	\$39.99		Advertised price
Product return	costs for certified mail + no reimbursem. of processing fees	Terms stated on bottom of main page	Potentially perceived as quality signal (return payment)
Lifetime warranty	\$3.00 per item (max. \$21.70) + costs for certified mail	Terms stated on separate subpage	Potentially perceived as quality signal (liability replacement)
Processing and handling	\$43.40	Fee stated on bottom of main page	No quality signal (add-on fee)

Note: Contract details were taken from www.roncocutlery.com on May 21, 2015.

Table 1: Contract structure and fee details

The contract fine print particularly details the product return policy and the lifetime warranty policy. The following is stated at the bottom of the main product page: “If you are not completely satisfied with your purchase, you may return it for a full refund of the product cost within 30 days of the date of delivery.” This wording implies that no handling and processing fees will be reimbursed, although they constitute more than half of the product price. On a subpage of the main webpage, the warranty terms state that in the event of a warranty claim, a consumer must pay an additional \$3.00 per item as a warranty processing fee. The old knives must be sent back through certified mail via the US postal service, which

²²www.roncocutlery.com.

²³An additional processing and handling fee of \$14.95 is charged for the “free” knife block. For a consumer, therefore, the cost of the knife set including the knife block is at least \$98.94, which is 247.41 percent of the advertised price. The additional fees are shown at the bottom of the main webpage

is more costly than standard delivery. These shipping costs must be paid by the consumer.

Both the money return and lifetime warranty policy can be translated into our model setting. The return policy allows for a repayment of the price excluding any initially paid fees and any costs of returning the product. Thus, at most 40.4 percent of the initial price is reimbursed when claiming the policy. Claiming the lifetime warranty option gives the consumer the value of a new knife compared to a used knife, minus the return and replacement costs. In this context, consumer naivete reflects consumers not anticipating that only a fraction of the initial price is being repaid in the event of return or that there are costs of replacing a faulty knife.

Information on customer reviews To gain a better understanding of consumers' initial perceptions of the knife set and its contract structure described in section 5, we analyze customer reviews posted on the website www.consumeraffairs.com/homeowners/ronco_knives.html. This consumeraffairs.com website is explicitly designed to provide customer reviews and details on warranty and service terms for different firms. We find 91 reviews for this product from April 29, 2008, through April 30, 2015. All reviews were manually searched through for topics. Each review can contain multiple topics. Below we list the content required to be listed as a specific review topic and using our number ordering also the reviews that mention the respective topics.

1. Negative product quality: Reviews indicate a low product quality, product failures such as rust stains, broken knives, broken handles; or consumers unhappy with quality.
2. Satisfaction with product quality: Reviews indicate a satisfaction with the respect to the quality, or at least relative to the price.
3. Refund problems: Reviews indicate problems with stopping the purchasing process after getting to know shipment costs, other product cancellation problems, not being able to get a hold of customer support or support not calling back when previously indicated, and not receiving refund or replacement after having send back the product.
4. Return costs surprise for money return policy: Reviews indicate consumer surprise with respect to costs of money return policy.
5. Warranty terms surprise: Reviews indicate consumer surprise with respect to warranty terms, such as extra handling and shipment costs for the lifetime warranty.

6. Surprise with respect to initial shipment and handling costs: Reviews indicate consumer surprise with respect to positive shipment and handling costs on top of the product price.
7. Perceived ripoff / scam: Reviews indicate the product being perceived as a “scam” or “ripoff”, or firm behavior being perceived as intentionally misleading or immoral.

Customer review analysis We check each of the reviews for the different topics mentioned. These topics are satisfaction and dissatisfaction with respect to product quality, problems with customer support regarding reimbursement, replacement, or product cancellation, failure to anticipate shipment fees, surprise or dissatisfaction with warranty terms, surprise or dissatisfaction about additional costs in case of claiming a money return policy, and the perception of the product as a ripoff or scam.

Table 2 lists five main hypotheses regarding quality misperceptions and the general predictions of our model and summarizes the descriptive evidence from the customer reviews.

Hypothesis	Summary of descriptive evidence
H1: Surprise about low product quality	42% of customer reviews mention disappointment w.r.t. low quality
H2: Underestimation of return costs and joint surprise about low product quality	High conditional frequencies of quality disappointment mentioned cond. on unforeseen warranty (67%) / return (80%) terms
H3: Return costs lead to consumers not claiming warranty / not returning product	Several customer reviews mentioning warranty / return claim not worth effort given terms
H4: Initially hidden shipment fees do not affect quality perception	Low conditional frequency of low quality (13%) cond. on surprise at unforeseen shipment terms
H5: Product perceived as scam by consumers ex post	35% of customer reports explicitly mention product being perceived as scam

Table 2: Summary of descriptive evidence

An important issue is how to interpret the reviews with respect to unforeseen contract terms. We find clear evidence that extra shipment fees and costs stated in the warranty and money return terms are not anticipated by most consumers who mention these topics.²⁴

²⁴For example, reviewers mention “[...] and finding out it costs \$ 2.50 per knife to send back is totally not worth

Another important topic is how to interpret customer reports of negative product quality.²⁵ One interpretation of negative quality could be that a consumer has simply obtained a bad draw, i.e. a product with a specific failure, and that the customer would be content with a replacement. In such a case, complaining about negative product quality would not suggest that consumers initially overestimated product quality; rather, it implies that they simply have “bad luck” regarding a specific outcome. However, 32 percent of the consumers complaining about product quality explicitly mention that they perceive the product as being a “ripoff” or “scam”. Others mentioned that the quality is much lower than knives that can be bought at a comparable price. For these reasons it seems reasonable to interpret consumers mentioning negative product quality as being surprised about the average quality rather than discontent about an idiosyncratic product defect.

Table 3 shows the frequency of the different topics mentioned. 42 percent of reviewers mention dissatisfaction with the product’s quality. This supports our hypothesis H1 in that many consumers are negatively surprised about product quality. The most common complaints in this case were rust stains early after purchase, broken knives, and cracked plastic handles. 5 percent of reviewers explicitly mention being satisfied with the quality for the price they paid. 32 percent of reviewers mention problems with getting a cancellation or refund. Many mention problems with getting reimbursed, or even acknowledgment for being eligible for reimbursement from the firm. Other issues include the firm’s support never calling back

it” or “Their guarantee says a cost of \$ 2.50 per knife to ship and return the knives to them, which is unreasonable. This company totally misrepresents their product and the price and related charges.” Some cases were less clear, such as “I called the company and they said to send them back with \$ 2.50 per knife”; we still interpret such cases as consumers failing to anticipate these costs. In case of a relatively detailed customer remark, we do not count the review as an unanticipated term topic. For unanticipated warranty terms, this occurred exactly once. The reviewer who mentioned the fee structures in a sophisticated manner also noted that he is still waiting for a replacement.

²⁵An inherent selection problem can arise when employing customer reviews as a proxy for overall consumer satisfaction. People who are dissatisfied with a product might be much more likely to post a review than satisfied consumers would be. In such a case, we would not be able to use reviews to make inferences about the unconditional overall product satisfaction and the degree of sophistication with respect to the specific contract structure. However, the reviews nevertheless enable an analysis of the topics mentioned by our potentially overly dissatisfied sample of consumers and particularly to analyze which topics are jointly mentioned in their reviews. This does not exclude the possibility of a potentially larger population of sophisticated consumers who have accurate quality expectations and do not exhibit disappointment.

Review topic	# of times mentioned	frequency h
<i>nq</i> : negative quality	38	.42
<i>q+</i> : satisfied with quality	5	.05
<i>cp</i> : cancellation or reimbursement problems	28	.32
<i>wt</i> : unforeseen warranty terms	15	.16
<i>mt</i> : unforeseen money return terms	10	.10
<i>st</i> : unforeseen shipment terms	15	.16
<i>sc</i> : perceived ripoff / scam	32	.35
<i>wt or mt</i>	25	.27
conditional frequency $h(nq wt \text{ or } mt)$.72
Total number of reviews	91	

Note: Customer reviews were taken from www.consumeraffairs.com/homeowners/ronco_knives.html on May 21, 2015. There are an overall 91 reviews in a time span from April 29, 2008 until April 30, 2015. All reviews were manually searched through for topics. Each review can contain multiple topics.

Table 3: Topics mentioned in customer reviews

or not being reachable. 16 percent of reviewers appear to not correctly foresee warranty terms and often articulate discontent with these terms, especially about a lifetime warranty being costly. 10 percent of reviewers mention either surprise or discontent about the the money return terms. Some mention that the costs compared to the gains of return are so high or the probability of being refunded so small that they do not plan to send the product back.²⁶ This is in line with our hypothesis H3: some consumers do not return products due to the high return costs compared to the benefits. 16 percent of consumers explicitly mention high or unforeseen shipping charges. Several of them complain about the lack of possibility to cancel the contract over the phone once they had heard about the shipping costs. Finally, 35 percent of reviewers mention that they perceive the firm’s behavior as a “scam”, a “ripoff”, or as “immoral”. The customer reviews suggest that besides mentioning additional handling fees and their non-refundability only in the contract fine print, the firm’s sluggish response behavior further increases return costs.

In terms of overall customer satisfaction, the website has a five-star rating system, where 1 star represents the lowest, and 5 star represents the highest rating. Overall, 72 percent of the respondents gave the lowest rating.²⁷

²⁶For example, one reviewer states “I’m not going to bother contacting them, it will cost me more in shipping & handling, than what a replacement would cost. Never again!” Another one states “[.] if I return my set, at my cost, and then pay three bucks for each new knife she sends me back. Now that is their 100% promise on the knife set. Hogwash, that would cost me way more than I paid for it to start with.”

²⁷The five-star ranking system was introduced on this website at a later date after the first reviews in our sample; thus, only 82 out of 91 reviews are rated.

Our belief condition implies that the product price does not act as a signal of product quality to consumers. We find evidence supporting this hypothesis in the reviews and the firm’s behavior. Many customer reports mentioned a negative product quality assessment. Meanwhile, the firm explicitly advertises on its website that “This super set would cost \$850 if all pieces were purchased separately. But you get the entire set for an astounding low price.” If we consider the consumers who are surprised about negative product quality to be naive, then such advertising is consistent with the implication that price is not a signal of quality for these consumers.

All of the above results are consistent with our model. We subsequently examine at the correlation between different topics in our sample to obtain a better understanding of how frequently specific contract terms are associated with product quality.

	<i>nq</i> : neg. qual.	<i>cp</i> : cancell. probl.	<i>wt</i> : warranty terms	<i>mt</i> : return terms	<i>st</i> : shipm. terms
<i>nq</i>	1	$h(cp nq) = .26$	$h(wt nq) = .26$	$h(mt nq) = .24$	$h(st nq) = .05$
<i>cp</i>	$h(nq cp) = .34$	1	$h(wt c) = .28$	$h(mt cp) = .03$	$h(st cp) = .24$
<i>wt</i>	$h(nq wt) = .67$	$h(cp wt) = .53$	1	$h(mt wt) = 0$	$h(st wt) = 0$
<i>mt</i>	$h(nq mt) = .80$	$h(cp mt) = .09$	$h(wt mt) = 0$	1	$h(st mt) = .03$
<i>st</i>	$h(nq st) = .13$	$h(cp st) = .47$	$h(wt st) = 0$	$h(mt st) = .20$	1

Note: A table entry $h(i|j) = \frac{h(i,j)}{h(j)}$ gives the conditional frequency of a specific review topic i being mentioned in the sample, given that topic j is mentioned. Topics are categorized as in Table 3.

Table 4: Conditional customer review topic frequencies

Joint topics mentioned by consumers To further assess our hypotheses against alternative predictions, we focus on the frequency of a certain review topic being mentioned conditional on a different topic being mentioned. Table 4 presents these frequencies for all combinations of five different topics. A relatively clear separation is visible in the content of negative reviews. These reviews are related either to quality issues or to discontent with hidden shipment fees but rarely to both at the same time. In fact, 47 percent of the consumers who mention hidden shipment fees also note problems with cancellation or refund issues. These observations suggests that consumers who complain about these issues do not pay attention to shipment fees before making a purchasing decision.

However, negative product quality as the most frequently mentioned topic in our sample is only rarely associated with negative shipment and handling terms. Only in 13 percent of the cases in which shipment terms are mentioned, consumers also complain about negative

product quality. This observation suggests first that shipment costs as a basic shrouded add-on attribute do not play a significant role in the formation of quality perceptions, which is also consistent with our hypothesis H4. One way to interpret consumers who complain about product quality but not about shipment costs is that these consumers are sophisticated with respect to the role of shipment fees but not with respect to the warranty and return terms. Because shipment fees are common with home shopping products, many experienced consumers may know that such fees account for a significant portion of the final price.

In contrast, there is a high correlation between consumers having a negative opinion about product quality and not anticipating hidden warranty or money return terms. 67 percent of consumers who did not foresee all warranty terms also mention negative product quality, and 80 percent of those who mention unforeseen return costs mention negative product quality. Conditional on at least one of the topics (return costs or warranty terms) being mentioned, negative product quality is also mentioned 72 percent of the time, which is consistent with Hypothesis H2. Notably, reviewers mentioning negative product quality typically do not reflect discontent about product failure, but indicate a general discontent with respect to the quality of a knife set even if it is working.²⁸

²⁸For example, one reviewer states as follows: “When we saw it on TV, [w]e thought it was pretty good. If they would work half as good as advertised, then it still should be good. But we are very disappointed. You can’t cut straight with the cut and serving knives. The other knives are dull- no use on sharpening them. [...] We learned not to buy things advertised on TV. It’s not worth it. Money wasted.” Another reviewer makes the following comment: “I tried to cut a lemon and it wouldn’t even break the rind. My husband tried to sharpen the knives with no success. I called Customer Service to return them and now we have to pay the shipping and handling on these things to return them? I feel like we shouldn’t have to pay anything since they clearly made a mistake and sent me the non-cutting knives instead of the ones that ‘cut through paper, even bone!’”