Consumer Resistance[*]

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Abstract

This paper shows that reference-dependent preferences trigger consumer resistance and studies how such consumer behavior impacts pricing and cost communication. We show that consumer resistance reduces the pricing power and profit of the firm. We also show that consumer resistance may provide an incentive for the firm to engage in cost transparency. While cheap communication does not affect consumer behavior, we demonstrate that persuasive communication may increase sales and profit. Finally, we establish that a firm can benefit from operational transparency if cost is monotone increasing in the quality of the production process.

Keywords: Reference-dependent preferences, fairness, pricing, cost communication, operational transparency

1 Introduction

It is common sense that firms want consumers to know the price that they charge. It is less clear, though, why firms inform consumers about their cost.[1] Why should a firm strive for cost transparency? Answering this question challenges our understanding of firm behavior, as a firm cannot benefit from cost disclosure when consumers care for price alone. This paper argues that a firm might want to disclose cost if consumers have reference-dependent preferences and may thus decide not to purchase even though their valuation of the product exceeds the price—our notion of "consumer resistance." In such a setting, consumers do not care for price alone, and cost communication may allow the firm to deal more effectively with consumer resistance than pricing alone.[2]

The starting point of our analysis is the observation that consumers often evaluate products not only in terms of their acquisition utility (the valuation net of price), but also in terms of their transaction utility (the "psychological loss") triggered by deviations from a reference point (Thaler 1985; Kőszegi and Rabin 2006).[3] Price changes thus have a dual impact on product evaluation: they affect both acquisition utility and transaction utility. Cost communication, in turn, cannot affect acquisition utility, but may well affect transaction utility. We develop a model in which a profit-maximizing firm sets the price and may disclose the unit cost to consumers, who then decide whether or not to purchase. This analytical framework allows us to study optimal pricing and cost communication under consumer resistance.

This paper derives several key results that have marketing implications. First, we show that when consumers know the firm's unit cost, consumer resistance forces the optimal price and profit down. Intuitively, the psychological loss triggered by a costly deviation

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[1]For instance, *Everlane*, an online fashion retailer, communicates price and cost for each of its products to consumers. On everlane.com, this approach is advertised as "radical transparency." Likewise, *Tesla* communicates price and cost of its *Model S* to consumers in China, see https://www.tesla.cn/en/blog/fair-price.

[2]Mohan, Buell, and John (2016) find in an experiment that cost transparency improves firm performance.

[3]More broadly, reference dependence gives rise to "fairness considerations." Kahneman, Knetsch and Thaler (1986a, b), Bolton, Warlop and Alba (2003), and Bolton and Alba (2006) argue that fairness is tied to cost.

from the reference point drives some consumers out of the market, which forces the firm to lower the price. A key driver of the price reduction is the sensitivity of the "perceived price"—the purchase price plus the psychological loss—in response to a change in the purchase price. As a limiting result, we obtain that consumer resistance forces the optimal price down to cost if the perceived price is highly sensitive with respect to a change in the purchase price. That is, consumer resistance may be strong enough to achieve the competitive outcome in a monopoly market. An important managerial implication is that ignoring consumer resistance reduces sales and even causes outright "market failure" if demand at the standard purchase price turns out to be zero. Put differently, ignoring consumer resistance may lead managers to price themselves out of the market.

Second, we show that a firm may benefit from engaging in cost transparency when cost affects transaction utility but is unknown to consumers. In particular, we demonstrate that persuasive communication (Milgrom 2008)—whereby firms truthfully reveal verifiable cost information to consumers—increases profit. In the unraveling equilibrium, a firm with high cost voluntarily provides cost information, whereas a firm with low cost is forced to provide such information to distinguish itself from firms that have even lower cost. Cheap communication about cost, in turn, cannot affect consumer behavior in equilibrium. The reason is that, for any price above cost, the firm wants to overstate cost, thereby inducing consumers to purchase more.

Finally, we show that a firm may benefit from engaging in operational transparency when consumers care about the quality of the production process.[4] If so, a firm may benefit from disclosing prominent features of the production process such as "made in the USA" that serve as a proxy for unit cost. More specifically, if the unit cost is monotone increasing in the quality of the production process, the relevant cost information can be conveyed by cost transparency or operational transparency.

Our paper contributes to two related strands of literature. First, we formalize the notion of consumer resistance and introduce it into the pricing literature. We build on the concept

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[4]Janssen and Roy (2015) analyze incentives to disclose product quality rather than the quality of the production process.

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of transaction utility (Thaler 1985) and show how the price is endogenously determined by the interplay of firm and consumer decisions. Our analysis of optimal pricing goes beyond reference prices (Mazumdar, Raj and Sinha 2005; Krishna 2009) and also allows for reference margins (Kahneman, Knetsch and Thaler 1986a, b) and reference surplus shares (Fehr and Schmidt 1999; Bolton and Ockenfels 2000; Guo 2015).[5] Our analysis also includes optimal pricing when fairness concerns are governed by the principle of dual entitlement (Kahneman, Knetsch and Thaler 1986a; Xia, Monroe and Cox 2004).

The papers most closely related to our analysis are Rabin (1993) and Guo (2015). While Rabin (1993) studies fair pricing in a bilateral monopoly, we allow for a population of consumers and analyze optimal pricing and cost communication. Guo (2015) focuses on pricing and cost disclosure in a setting with (disadvantageous) inequity aversion. The key difference to this paper is that we introduce consumer heterogeneity—both with respect to valuations and reference-dependent losses—which is indispensable for endogenously determining consumer resistance. In addition, we consider a broader class of reference-dependent preferences that allow for reference prices, reference margins, and (possibly inegalitarian) reference surplus shares. Our paper is also related to Heidhues and Kőszegi (2008) and Karle and Peitz (2014) who study pricing implications of consumer loss aversion. These authors use the concept of "personal equilibrium," which treats reference points as endogenous expectations based on the recent past. Instead, we focus on exogenous reference points to study pricing *and* cost communication in a parsimonious framework that nests standard monopoly pricing as a special case.

Second, we contribute to the recent literature on cost transparency (Jiang, Sudhir, and Zou 2017) and operational transparency more broadly (Mohan, Buell, and John 2016; Buell, Kim and Tsay 2017). We show that in the presence of consumer resistance, the possibility to engage in costless persuasive communication (Milgrom 2008) may force a firm to reveal cost information even if it decreases profit. Such unprofitable cost disclosure

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[5]We focus on selfish consumers who suffer from a loss when the outcome is worse than the reference outcome and ignore that consumers may suffer from guilt if the outcome is better than the reference outcome (Levine 1998; Fehr and Schmidt 1999; Sobel 2005; Rotemberg 2011).

would not occur in the absence of consumer resistance. We also show that persuasive communication may lead to operational transparency if consumers care about the quality of the production process.

The remainder of the paper is organized as follows. Section 2 introduces the model and defines the notion of consumer resistance. Section 3 studies optimal pricing in a monopoly setting where consumers know cost, and provides a reference price example to illustrate the impact of consumer resistance. Section 4 extends the pricing rule to a setting where consumers do not know cost, and shows how the firm can use persuasive communication to resolve the information asymmetry in the marketplace. Section 5 addresses operational transparency. Section 6 studies pricing with consumer resistance in a competitive market. Conclusions and directions for future research are provided in Section 7.

2 The model

We first introduce the decision makers in our model: the firm and consumers. In particular, we explain how consumers evaluate products not only in terms of their acquisition utility, but also in terms of their reference-dependent transaction utility. Next, we formalize the notion of consumer resistance and derive demand. Finally, we provide examples of common reference points that are nested into our analytical framework.

2.1 The firm

We consider a monopoly firm that offers a product (or service) to consumers. The firm chooses the (purchase) price p at which it sells the product. The constant unit cost to provide the product is denoted by $c \geq 0$, which may or may not be known to consumers. The fixed costs of operation are normalized to zero as they do not affect the choice of the price.

2.2 Consumers

There is a unit measure of consumers who have valuation v for the product, which is drawn independently from a distribution with density function $f(v)$ and cumulative distribution function $F(v)$ on $[0,+\infty)$, where $f(v) > 0$ for all v, $F(0) = 0$, and $F(+\infty) = 1$. The firm has private knowledge about $F(v)$ that is acquired through market research. In line with Thaler (1985), we assume that consumers derive both acquisition utility and transaction utility from purchasing the product. Formally, acquisition utility is the valuation net of price, $v - p$. Transaction utility, in turn, reflects the "perceived merits of the deal." We assume that consumers evaluate the merits of the deal by comparing the outcome $x \in \mathbb{R}_+$ to an exogenous reference point $\bar{x} \in \mathbb{R}_+$ in the psychological domain. We introduce the following definition:

Definition 1. *Let $\Delta x(p;c,v,\bar{x}) \equiv x(p;c,v) - \bar{x}$ denote the deviation of the outcome of the transaction $x(p;c,v)$ from the reference point $\bar{x}$ in the psychological domain.*

Definition 1 characterizes the difference between the outcome x and the reference point $\bar{x}$ as a function of price p, unit cost c, and valuation v (we henceforth suppress the arguments of x and Δx for ease of exposition). Note that although the reference point $\bar{x}$ is the same for all consumers, there is consumer heterogeneity in deviations from the reference point if Δx depends on the valuation v.

We assume that consumers suffer from a psychological loss if the outcome of the transaction deviates from the reference point in an unfavourable way. The loss function is given by

$$L(\Delta x, \lambda), \tag{1}$$

where $\lambda \geq 0$ translates deviations from the reference point Δx in the psychological domain into associated monetary losses L. To simplify notation, we introduce the following definition:

Definition 2. *For $y \in \{p,c,v\}$, let $L_y \equiv L_{\Delta x}\frac{\partial \Delta x}{\partial y}$ denote the derivative of the loss function with respect to y.*

With this in mind, we impose the following assumption on the loss function.

Assumption 1. *The loss function satisfies*

(i) $L(\Delta x, \lambda) > 0$ *for* $\Delta x > 0$ *and* $\lambda > 0$,

(ii) $L(\Delta x, \lambda) = 0$ *for* $\Delta x \leq 0$ *and all* λ, *and* $L(\Delta x, 0) = 0$ *for all* Δx,

(iii) $L_{\Delta x}(\Delta x, \lambda) \geq 0$ *and* $L_{\lambda}(\Delta x, \lambda) \geq 0$ *for all* Δx *and* λ, *and*

(iv) $L_p \geq 0$, $L_c \leq 0$, $L_v \leq 0$, *and* $L_p \geq -L_v$ *for all* Δx *and* λ.

Assumption 1 assures that (i) consumers suffer from a loss if there is a costly deviation of the outcome from the reference point, (ii) there is no loss if either $\Delta x \leq 0$ or $\lambda = 0$, (iii) the loss increases in Δx and λ, respectively, and (iv) that the loss increases in p and decreases in c and v. The assumption $L_p \geq -L_v$ means that the loss function is more sensitive to p than it is to v (in absolute value), which implies that a higher price cannot reduce consumer resistance—a natural assumption.[6]

We assume that a consumer's indirect utility function is given by

$$V(p) = \max\{v - p - L(\Delta x, \lambda), 0\},$$

where $v - p - L$ is the total utility when purchasing the product at price p, while the utility of the outside option is normalized to zero. Intuitively, a consumer purchases when the valuation v exceeds the "perceived price" $p + L(\Delta x, \lambda)$, the sum of the price and the monetary loss associated with the purchase.

2.3   Timeline

The firm and consumers play the following game: In the first stage, the firm sets the price p knowing the distribution of consumer types $F(v)$ and the loss function $L(\Delta x, \lambda)$ (from market research). In the second stage, consumers make their purchase decision based on the price p. Note that the timing is similar to standard ultimatum games (Camerer 2003), where the proposer offers a deal that can be rejected by the respondent.

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[6]Note that Assumption 1 implies that consumers exhibit an extreme form of loss aversion (Tversky and Kahneman 1991), where gains from favorable deviations from the reference point are normalized to zero. This ensures that consumers do not purchase when the acquisition utility is negative.

2.4 Demand

Consumers with a valuation v that exceeds the perceived price $p + L(\Delta x, \lambda)$ purchase the product. Assumption 1 implies that the valuation of the consumer who is indifferent between purchasing and choosing the outside option $\bar{v}(p)$ is uniquely defined by the indifference condition

$$\bar{v}(p) = p + L(\Delta x(p; \bar{v}(p)), \lambda). \tag{2}$$

Note that The cutoff $\bar{v}(p)$ can be interpreted as the perceived price at the purchase price p. We introduce the following definition.

Definition 3. *Consumer resistance occurs if and only if the cutoff $\bar{v}(p)$ strictly exceeds the price p, that is, $\bar{v}(p) > p$.*

Definition 3 implies that consumers with valuations $v \in [p, \bar{v}(p)]$ do not purchase at price p—even when they should do so based on acquisition utility alone. Consumer resistance therefore means that some consumers drop out of the market due to the psychological loss that raises the perceived price above the price. Clearly, changes in price affect consumer resistance. Specifically, Assumption 1 implies that a higher price cannot reduce consumer resistance as

$$\bar{v}_p(p) = \frac{1 + L_p}{1 - L_v} \geq 1, \tag{3}$$

where the equality follows from applying the implicit function theorem to the indifference condition (2). Note that a price increase drives more consumers out of the market than in a standard model because of transaction utility.

The demand for the product follows from summing up purchases across consumers at the given price p:

$$D(p) = \int_{\bar{v}(p)}^{\infty} dF(v) = 1 - F(\bar{v}(p)). \tag{4}$$

To put additional structure on demand, we impose the following assumption:

Assumption 2. *The demand function $D(p) = 1 - F(\bar{v}(p))$ is log-concave.*

Assumption 2 is standard and implies that the revenue function is "well-behaved" (the assumption includes a concave revenue function as a special case). We derive the following result (the proof of this and all other results is relegated to the Appendix).

Lemma 1. *Suppose Assumptions 1 and 2 hold. Then, demand is downward sloping and consumer resistance increases the price elasticity of demand $\varepsilon(p) \equiv -\frac{pD'(p)}{D(p)}$ at any given price p.*

To understand the intuition for Lemma 1, observe that an increase in price has two effects. First, consumer resistance increases the perceived price and therefore the price elasticity of demand because of log-concavity (this is the standard effect of increasing the cutoff). Second, a higher price increases consumer resistance, which provides a new channel for price to affect demand. This result thus provides a theoretical foundation for Anderson and Simester (2008), who empirically identify such a channel and find that fairness concerns make demand more elastic.

2.5   Common examples of reference points

So far, we have been agnostic about the consumers' choice of the relevant reference point. We now want to illustrate that the function $L(\Delta x, \lambda)$ nests several commonly used reference points into our analysis. The common feature of these examples is that consumers suffer from a loss if the price is perceived "unfair."[7]

Reference price. If consumers compare the price p to some reference price $\bar{p}$, the deviation from the reference point is given by $\Delta x \equiv p - \bar{p}$, and they suffer from a loss if the price exceeds $\bar{p}$. In line with Thaler (1985), Kahnemann, Knetsch, and Thaler (1986a), and Rabin (1993), the reference price may be viewed as a just or fair price. Various models of reference prices have been studied in marketing (see Mazumdar, Raj and Sinha 2005 for a survey) and economics (Heidhues and Kőszegi 2008; Spiegler 2011; Buehler and Gaertner 2013; Karle and Peitz 2014).

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[7]Of course, there may be other reasons for consumer resistance. For instance, consumers may suffer from a psychological loss if the production process violates ethical norms. We address this issue in Section 5.

Reference margin. If consumers compare the firm's (profit) margin m to some reference margin $\bar{m}$, the deviation from the reference point is given by $\Delta x \equiv m - \bar{m}$, and they suffer from a loss if the margin exceeds $\bar{m}$. This builds on Kahnemann, Knetsch, and Thaler (1986a), who show that consumers dislike paying prices above a fair markup over marginal cost, a robust psychological phenomenon (Eyster, Madarasz and Michaillat 2017). Alternatively, $\bar{m}$ could be interpreted as an "anger threshold" (Rotemberg 2005, 2008) that triggers consumer resistance. Our analysis nests two common measures for the profit margin in the context of cost-plus pricing:

(i) *Absolute margin*. In this case, consumers compare the absolute markup $m \equiv p - c$ to the reference point $\bar{m}$.

(ii) *Percentage margin*: In this case, consumers compare the percentage markup over cost $m \equiv \frac{p-c}{c}$ to the reference point $\bar{m}$. Alternatively, one could assume that consumers compare the percentage markup over price $m \equiv \frac{p-c}{p}$, the so-called "Lerner index," to some reference point. Consumers then judge whether the margin as a fraction of price is fair.

Reference surplus share. If consumers compare the firm's surplus share $s \equiv \frac{p-c}{v-c}$ to some reference share $\bar{s} \in [0,1]$, the deviation from the reference point is given by $\Delta x \equiv s - \bar{s}$, and consumers suffer from a loss if the share exceeds $\bar{s}$.[8] Clearly, this is equivalent to a setting in which consumers feel entitled to a surplus share of at least $1 - \bar{s}$ (cf. Kahnemann, Knetsch, and Thaler 1986a, b). Note that our framework allows for arbitrary reference shares $\bar{s}$ and $1 - \bar{s}$ and thus nests settings with inequality aversion (Fehr and Schmidt 1999; Bolton and Ockenfels 2000; Guo 2015) that focus on an egalitarian reference point.

These common examples illustrate that there are several reasons why consumers may resist purchases that they should accept based on acquisition utility alone: consumer

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[8]There is ample experimental evidence from ultimatum games that individuals reject unfair offers that leave them less than 20-25% of the total surplus (Camerer 2003).

resistance may be triggered by "excessively high prices," by "excessively high margins," or by "excessively high surplus shares" appropriated by the firm. The following result holds:

Lemma 2. *For a given valuation v, the reference points regarding the price $\bar{p}$, the margin $\bar{m}$, and the surplus share $\bar{s}$ may represent the same consumer entitlement to profit.*

Lemma 2 shows that the different reference points may reflect the same entitlement by consumers to value created by the transaction—and thus to firm profit (Kahnemann, Knetsch, and Thaler 1986a, b). However, the three examples differ in an important way: in contrast to the reference price, reference markups and reference surplus shares require consumers to have cost information. This suggests a natural role for cost communication when costs are private information of the firm, an issue that we address in Section 4 below.

3   Pricing under full information

This section studies optimal pricing in the presence of consumer resistance when consumers know the unit cost—our benchmark case. To illustrate, we provide a simple reference-price example.

3.1   Optimal pricing

The firm chooses the price by maximizing profit and therefore solves

$$\max_{p} \quad \pi(p) = \int_{\bar{v}(p)}^{\infty} (p-c)dF(v) = (p-c)\left[1 - F(\bar{v}(p))\right].$$

Assumption 2 implies that $\pi(p)$ is strictly quasi-concave, which ensures the existence of a unique global maximizer of $\pi(p)$ (Caplin and Nalebuff 1990). The necessary and sufficient first-order condition for profit maximization is

$$1 - F(\bar{v}(p^*)) - (p^* - c)f(\bar{v}(p^*))\bar{v}_p(p^*) = 0. \tag{5}$$

This first-order condition has an intuitive interpretation. A marginal increase in price p directly increases profit by $1 - F(\bar{v}(p))$. Due to consumer resistance, the revenue reduction

from the inframarginal units is distorted by the factor $\bar{v}_p(p)$. We derive the following result.

Proposition 1. *Suppose Assumptions 1 and 2 hold. Then, the optimal price p^* satisfies*

$$p^* = c + \frac{1 - F(\bar{v}(p^*))}{f(\bar{v}(p^*))\bar{v}_p(p^*)},$$

and consumer resistance forces the optimal price and profit down compared to standard monopoly.

Proposition 1 shows that consumer resistance reduces the pricing power of the firm. The key difference to standard monopoly pricing is the factor $\bar{v}_p(p) \geq 1$, which makes demand more elastic (Lemma 1). The result also shows that consumer resistance reduces profit: While the price goes down relative to standard monopoly, the perceived price increases, which reduces demand and thus profit. Note that Proposition 1 has an important managerial implication: Ignoring consumer resistance will reduce sales and even cause outright "market failure" if demand at the standard price turns out to be zero. Put differently, ignoring consumer resistance leads managers to price themselves out of the market.

The next result follows from Proposition 1 and shows that consumer resistance may lead to competitive pricing:

Corollary 1. *Consumer resistance may force the firm to price at cost in a monopoly market.*

This result is unexpected: Corollary 1 shows that, even though the monopolist can make take-it-or-leave-it offers to consumers, it lacks market power when deviations from a reference point that leaves zero profit to the firm are extremely costly ($\lambda \to \infty$). Such preferences make demand perfectly elastic ($\bar{v}_p(p^*) \to \infty$) and thus force the firm to sell at cost—a result that is reminiscent of the Coase conjecture (Coase 1972).[9]

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[9]Note that Corollary 1 provides a behavioral explanation for pricing patterns in digital markets, where it is often a good approximation to assume that $c = 0$: Consumer resistance may then drive the price down to zero—the "culture of free."

3.2 Reference-price example

Consider a market in which consumers suffer from a loss if the price p exceeds the reference price $\bar{p}$. The loss function is given by

$$L(\Delta x, \lambda) = \max\left\{0, \lambda(p - \bar{p})\right\},$$

which satisfies Assumption 1.[10] We assume that the valuations v are drawn independently from a uniform distribution over the interval $[0,1]$, so that demand is given by

$$D(p) = 1 - (p + \max\left\{0, \lambda(p - \bar{p})\right\}).$$

To focus on the interesting case where the monopolist serves the market, we assume that $c < 1$. The next result illustrates the impact of the reference price on optimal pricing.

Corollary 2. *Suppose that the reference price is below the monopoly price and satisfies $\bar{p} < \frac{1+c}{2}$. Then, there is consumer resistance, and the optimal price p^* is given by*

$$p^* = \frac{1 + c + \lambda(c + \bar{p})}{2(1 + \lambda)}.$$

When the reference price is $\bar{p} \equiv c$ and consumers suffer from a large loss ($\lambda \to \infty$) if $p > c$, then the firm is forced to price at cost, $p^* = c$. Instead, if $\bar{p} \geq \frac{1+c}{2}$, it is optimal to set the standard monopoly price $p^m = \frac{1+c}{2}$.

To intuitively understand this result, note that the reference price $\bar{p}$ is not binding if it exceeds the standard monopoly price p^m. Specifically, Corollary 2 illustrates three main insights: First, consumer resistance distorts the optimal price p^* downward relative to the standard monopoly price,

$$p^* - p^m = \frac{\lambda(\bar{p} - 1)}{2(1 + \lambda)} \leq 0,$$

where the inequality follows from $\bar{p} \leq 1$. Second, ignoring consumer resistance leads to market failure if $p^m \geq 1 - L^*$, where $1 - L^*$ is the highest net valuation in the market

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[10]This specification has been extensively used in the behavioral industrial organization literature to study loss aversion. See Spiegler (2011) for a comprehensive survey.

given p^*. Put differently, if managers do not take consumer resistance into account, sales may turn out to be zero when the product is sold at p^m instead of p^*. Third, reference price comparisons act as a competitive constraint and force the price down to cost when deviations from the reference point are extremely costly ($\lambda \to \infty$).[11]

4 Dealing with unknown cost

This section considers the setting in which the firm has private information about the cost. With asymmetric information, consumers who care about cost must form a belief about cost to evaluate the transaction utility. We study three scenarios: no communication, cheap communication (that may or may not be truthful), and persuasive communication (that is truthful and verifiable).

4.1 No communication

In the absence of communication about cost, the firm's only decision is about price, which is observed by consumers before making their purchase decisions. Since pricing is contingent on true cost, price may serve as a signal for cost. To study optimal pricing, we use the concept of perfect Bayesian equilibrium (Fudenberg and Tirole 1993). Specifically, a perfect Bayesian of the game between the firm and consumers consists of the following:

1. Firm strategy: Profit-maximizing choice of the price p conditional on the true cost level c.

2. Consumers' strategy: Utility-maximizing purchase decision conditional on the price p.

3. Consumers' belief: The posterior belief $\mu(c|p) = \int_0^p cz(c|p)dc$ is derived from the prior $\mu(c) = \int_0^\infty cz(c)dc$ and the price p using Bayes' rule (when applicable).

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[11]This example illustrates that fairness considerations put a constraint on profit seeking (Kahneman, Knetsch and Tversky 1986a): If $m = p - c$ and $L(\Delta x, \lambda) = \max\{0, \lambda(m - \bar{m})\}$, the optimal price is forced down to cost if $\bar{m} = 0$, that is, if consumers feel entitled to the total surplus created by the transaction. Note that the implicit "reference price" is in this case given by $\bar{p} = c + \bar{m}$.

Note that the posterior belief $\mu(c|p)$ is a conditional expectation of c that sums up (density-weighted) cost levels after having observed the price p.[12] Importantly, $\mu(c|p)$ rules out cost levels that exceed the observed price, because such beliefs would be inconsistent with profit maximization by the firm. Given the posterior belief $\mu(c|p)$, the valuation of the consumer who is indifferent between purchasing and choosing the outside option $\hat{v}(p)$ is uniquely defined by the indifference condition

$$\hat{v}(p) = p + L(\Delta x(p; \mu(c|p), \hat{v}(p)), \lambda). \tag{6}$$

Compared to the benchmark case, the indifference condition now depends on the belief about cost $\mu(c|p)$ rather than the true cost c. In equilibrium, only consumers with a valuation $v \geq \hat{v}(p)$ purchase.

The firm chooses the price to maximize profit and therefore solves

$$\max_p \quad \pi(p) = \int_{\hat{v}(p)}^{\infty} (p-c) dF(v) = (p-c)[1 - F(\hat{v}(p))].$$

We derive the following result.

Proposition 2. *Suppose Assumptions 1 and 2 hold. Then, in perfect Bayesian equilibrium, (i) the optimal price p° satisfies*

$$p^\circ = c + \frac{1 - F(\hat{v}(p^\circ))}{f(\hat{v}(p^\circ))\hat{v}_p(p^\circ)},$$

which coincides with the optimal price p^* under full information if consumers have correct point beliefs about cost; and (ii) if consumers underestimate (overestimate) cost, profit is lower (higher) than in the benchmark case with full information.

Proposition 2 shows that the structure of the pricing rule carries over the case where consumers do not know cost. The difference is that the posterior belief $\mu(c|p)$ depends on p and generally differs from the true cost level, which affects $\hat{v}(p^\circ)$ and $\hat{v}_p(p^\circ)$. Therefore,

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[12]Throughout, we focus on interesting cases where Bayes' rule allows us to pin down posterior beliefs.

if consumers have correct point beliefs about c, the optimal price p° must coincide with p^* in the benchmark case.[13]

Proposition 2 also shows that profit is lower than in the benchmark case if consumers underestimate cost. Intuitively, consumers overestimate the loss and therefore purchase too little, which reduces profit. This result has an important managerial implication: When consumers care about and underestimate cost, the firm has an incentive to inform consumers about the true cost level. In contrast, if consumers overestimate cost, the firm can benefit from the distorted beliefs.

4.2 Cheap communication

With cheap communication, the firm not only sets the price p, but also sends a message $\tilde{c}$ to convey information about the unit cost c to consumers. Communication is cheap because the cost message is costless, non-verifiable, and possibly non-truthful. A perfect Bayesian equilibrium consists of the following:

1. Firm strategy: Profit-maximizing choice of the price p and the message $\tilde{c}$ conditional on the true cost level c.

2. Consumers' strategy: Utility-maximizing purchase decision conditional on the price p and the message $\tilde{c}$.

3. Consumers' belief: The posterior belief $\mu(c|p,\tilde{c}) = \int_0^p cz(c|p,\tilde{c})dc$ is derived from the prior $\mu(c) = \int_0^\infty cz(c)dc$, the price p, and the message $\tilde{c}$ using Bayes rule (when applicable).

We derive the following result.

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[13]This is perhaps best illustrated if consumers know the true distribution $F(v)$, in which case they can infer c from observing p by solving the firm's optimization problem. In this case, the conditional probability density function $z(c|p)$ is degenerate and has point measure at c. Instead, if consumers do not know the true distribution $F(v)$, they must attach a probability weight to each possible $F(v)$, infer the corresponding cost, and form the conditional expectation $\mu(c|p)$ across the inferred cost levels.

Proposition 3. *Suppose Assumptions 1 and 2 hold. Then, there exists a unique babbling equilibrium in which the cost message $\tilde{c}$ is ignored by consumers and the optimal price is set at p°, as in the case absent communication.*

Proposition 3 is intuitive: If a change in the message $\tilde{c}$ were able to change the belief about cost and thereby demand at a given price, the firm would always want to overstate cost, as profit is increasing in demand (conditional on p and c). Consequently, in equilibrium consumers must ignore cheap cost messages and make purchase decisions based solely on the posterior belief $\mu(c|p)$, as in the case absent communication. The managerial insight of this result is that cost communication does not benefit the firm when cost messages are not verifiable—even if communication costless.

4.3   Persuasive communication

With persuasive communication, the firm not only sets the price p, but may also send a truthful and verifiable message $\hat{c}$ about the unit cost c to consumers (Milgrom 2008). Whenever the firm sends a message, it thus discloses the true cost level. The assumption that cost messages are truthful seems plausible: costs are verifiable and therefore the firm cannot make manifestly false public statements about its cost. Alternatively, the firm can choose not to disclose cost. In contrast to the setting with cheap communication, the firm's decision not to disclose cost contains information and triggers consumer skepticism. A perfect Bayesian equilibrium consists of the following:

1. Firm strategy: Profit-maximizing choice of the price p and the message $\hat{c} \in \{c, \emptyset\}$ conditional on the true cost level c.

2. Consumers' strategy: Utility-maximizing purchase decision conditional on the price p and the message $\hat{c}$.

3. Consumers' belief: The posterior belief $\mu(c|p, \hat{c}) = \int_0^p c z(c|p, \hat{c}) dc$ is derived from the prior $\mu(c) = \int_0^\infty c z(c) dc$, the price p, and the message $\hat{c}$ using Bayes rule (when applicable).

We derive the following result.

Proposition 4. *Suppose Assumptions 1 and 2 hold. Then, there exists an unraveling equilibrium in which the firm benefits (suffers) from cost disclosure when consumers underestimate (overestimate) cost.*

Proposition 4 shows that the firm always discloses cost in equilibrium when persuasive communication is costless. While a firm that benefits from disclosure voluntarily engages in communication, a firm that suffers from disclosure is forced to reveal its cost because of consumer resistance. Intuitively, when consumers overestimate cost, the firm is forced to disclose its cost even though it reduces profit: if it were silent, skepticism would induce consumers to revise their belief downward until it becomes profitable for the firm to disclose its cost and distinguish itself from firms with even lower cost. The managerial insight of this result is that a firm should strive for cost transparency when cost messages are verifiable.

5   Operational transparency

So far, we have focused on settings in which the firm sends a message about the unit cost of production. However, in practice firms sometimes prefer to disclose prominent features of the production process (Mohan, Buell, and John 2016; Buell, Kim and Tsay 2017) rather than informing consumers about unit cost. Such features may often be interpreted as proxies for cost: For instance, labels such as "Made in the USA" indicate that the product is made at high labor cost and in accordance with local regulations (regarding workplace safety, environmental standards, etc.) that increase cost. Similarly, communicating that a product exhibits "CO_2 neutrality" suggests that the unit cost of production is higher than it would otherwise have been.

To capture the idea that a firm may want to engage in operational transparency and disclose prominent features of the production process rather than cost, we introduce the

index $\xi \geq 0$ that reflects the quality of the production process.[14] If quality encompasses multiple relevant features, ξ should be interpreted as a real-valued index summarizing the various aspects of quality. We assume that unit cost is strictly monotone increasing in the quality of the production process, $c(\xi)$, with $c'(\xi) > 0$, which is known by consumers. Then, if a firm can send a truthful and verifiable message $\tilde{\xi}$ about the quality of the production process, the following result holds.

Corollary 3. *Suppose Assumptions 1 and 2 hold, and in addition that unit cost is strictly monotone increasing in the quality of the production process. Then, there is an unraveling equilibrium in which the firm engages in operational transparency about the quality of the production process.*

The result is an interesting implication of Proposition 4 and shows that consumer resistance may provide an incentive for firms to engage in operational transparency. Intuitively, the result follows from the fact that if unit cost c is a strictly monotone transformation of the quality of the production process ξ, the relevant information on c can be conveyed by cost transparency or operational transparency. The managerial implication of this result is that high cost can be disclosed by verifiable claims about the quality of the production process.

6 Competitive markets

We now study how consumer resistance affects optimal pricing and profit when consumers can choose among competing offerings. For simplicity, we abstract from the possibility of communication and assume that two firms $i = 1, 2$ produce vertically differentiated products. The unit cost of firm i is $c_i \geq 0$ and exogenous product quality is $q_i \geq 0$. Without loss of generality, we assume that product 2 is the high-quality product ($q_2 > q_1$), which is sold at a higher perceived price ($p_2 + L_2 > p_1 + L_1$), where $L_i \geq 0$ is the loss associated

---

[14]A prominent quality feature in digital markets is how firms handle and protect consumer data. Violations of privacy can lead to "consumer backlash" (Acquisti, Taylor and Wagman 2016) or consumer resistance.

with the purchase of product i. There is a unit measure of consumers who have private valuation θ for product quality, which distributed according to $G(\theta)$ with density $g(\theta)$.

The firms choose prices to maximize their respective profits

$$
\begin{aligned}
\max_{p_1} \quad \pi_1(p_1, p_2) &= (p_1 - c_1) \left[G(\bar{\theta}) - G(\underline{\theta}) \right] \\
\max_{p_2} \quad \pi_2(p_1, p_2) &= (p_2 - c_2) \left[1 - G(\bar{\theta}) \right],
\end{aligned}
$$

where $\underline{\theta} < \bar{\theta}$ in order to guarantee that both products have a positive market share. The key difference to a standard vertical differentiation duopoly model is that the consumer types $\underline{\theta} = \frac{p_1 + L_1}{q_1}$ and $\bar{\theta} = \frac{p_2 + L_2 - p_1 - L_1}{q_2 - q_1}$ that segment the market depend not only on prices, but also on the losses associated with the respective products. We derive the following result.

Proposition 5. *Suppose Assumption 1 holds, and in addition that $g'(\theta) \geq 0$. Then, consumer resistance forces the equilibrium prices and profits down compared to standard duopoly.*

Proposition 5 shows that the key insight that consumer resistance forces the price and profit down generalizes naturally to a setting with multiple firms if $g'(\theta) \geq 0$. The latter assumption is a standard regularity condition on the distribution of consumer types. In our setting, this assumption imposes that the price for the low-quality product decreases. Intuitively, it requires that the number of consumers increases in the valuation of product quality θ.

7 Conclusion

We have shown that reference-dependent preferences give rise to consumer resistance, which means that some consumers decide not to purchase even though their valuation exceeds the price of the product. The reason is that consumers do not care for price alone, but also evaluate the loss (if any) from the comparison to the reference point. Next, we

have analyzed how consumer resistance affects optimal pricing and cost communication by the firm.

The paper offers three key results. First, consumer resistance forces the firm's optimal price and profit down when consumers know the unit cost. The managerial implication is that ignoring consumer resistance reduces sales and may even lead to market failure. Second, the firm may benefit from cost disclosure in the presence of consumer resistance. The managerial insight is that using price *and* cost allows the firm to deal more effectively with consumer resistance than using price alone. Finally, a firm may benefit from engaging in operational transparency when claims about the quality of the production process mirror cost.

Our analysis suggests several avenues for future research. First, it would be interesting to study how a firm can shape consumer resistance by influencing the reference point or the cost of a deviation from the reference point. Anecdotal evidence suggests that firms have strong economic incentives to engage in such activities.[15] Second, one could extend the setting to allow for cost communication by competing firms and explore the relations to the analysis of information sharing among competitors (Raith 1996). Third, it would be interesting to further explore the extent to which the logic of consumer resistance applies to instances of consumer backlash in digital markets. We hope to address these issues in future research.

Appendix

Proof of Lemma 1. First we show that demand is downward-sloping. Differentiating (4) with respect to p yields

$$D'(p) = -f(\bar{v}(p))\bar{v}_p(p), \tag{A.1}$$

where $\bar{v}_p(p) \geq 1$ by (3). Since $f(v) > 0$ on the support of v, this implies that $D'(p) < 0$.

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[15] For instance, Exxon Mobil has been accused of misleading consumers about the risks of climate change (Schwartz 2017).

Next, using (A.1), the price elasticity of demand can be written as

$$\varepsilon(p) = -\frac{pD'(p)}{D(p)} = \frac{pf(\bar{v}(p))\bar{v}_p(p)}{1 - F(\bar{v}(p))}.$$

Assumption 2 implies that the Mills ratio $\frac{1-F(v)}{f(v)}$ is non-increasing in v. This and the fact that $\bar{v}_p(p) \geq 1$ imply that consumer resistance makes demand more elastic. $\square$

Proof of Lemma 2. Fix the valuation v and suppose that a consumer feels entitled to a share $1 - \bar{s}$ of the surplus created by the transaction. Equivalently, this means that the consumer views the share $\bar{s}$ as an upper limit of the surplus share that accrues to the firm. Thus, the consumer suffers from a loss if

$$\frac{p-c}{v-c} \geq \bar{s}.$$

Expressed in terms of the absolute margin, the consumer suffers from a loss if

$$p - c \geq \bar{s}(v - c) \equiv \bar{m}_a,$$

or, equivalently, if the percentage margin satisfies

$$\frac{p-c}{c} \geq \frac{\bar{s}(v-c)}{c} \equiv \bar{m}_p.$$

In terms of price, the consumer suffers from a loss if

$$p \geq c + \bar{s}(v - c) \equiv \bar{p}.$$

Consequently, the reference points regarding the price $\bar{p}$, the margin $\bar{m}$, and the surplus share $\bar{s}$ may express the same underlying entitlement to firm profit. $\square$

Proof of Proposition 1. The optimal price p^* follows from rearranging the first-order condition (5). Now suppose, contrary to the assumption, that $L > 0$ and $p^* \geq p^m$, where p^m is the standard monopoly price satisfying

$$p^m = c + \frac{1 - F(p^m)}{f(p^m)}$$

(note that this corresponds to the case where $\bar{v}_p = 1$). In the presence of consumer resistance, it follows that $\bar{v}(p^*) > p^*$, and therefore that $\bar{v}(p^*) > p^m$ (as $p^* \geq p^m$). Next, Assumption 2 implies that the Mills ratio $\frac{1-F(v)}{f(v)}$ is non-increasing in v. Taken together, this yields

$$p^* = c + \frac{1 - F(\bar{v}(p^*))}{f(\bar{v}(p^*))\bar{v}_p(p^*)} < c + \frac{1 - F(p^m)}{f(p^m)} = p^m,$$

a contradiction. Finally, profit decreases as both price and demand decreases. $\square$

Proof of Corollary 1. The result immediately follows from Proposition 1 if $\bar{v}_p(p^*) \to \infty$, which makes demand perfectly elastic and thus forces the firm to sell at cost. $\qquad\square$

Proof of Corollary 2. When v is drawn from a uniform distribution, we have that $F(\bar{v}(p)) = \bar{v}(p)$. The perceived price follows from the indifference condition in (2) and is given by $\bar{v}(p) = p + \max\{0, \lambda(p - \bar{p})\}$. Hence the profit function is

$$\max_p \quad \pi(p) = (p - c)[1 - (p + \max\{0, \lambda(p - \bar{p})\})].$$

There are two cases. First, note that the reference price does not bind when it exceeds the standard monopoly price p^m, which solves $\max_p \pi(p) = (p - c)(1 - p)$ and is given by $p^m = \frac{1+c}{2}$. Second, there is consumer resistance if $\bar{p} < p^m$. In this case, the optimal price is characterized by the first-order condition (5):

$$1 - \bar{v}(p^*) - (p^* - c)\bar{v}_p(p^*) = 0.$$

Substituting for $\bar{v}(p^*)$ and $\bar{v}_p(p^*) = 1 + \lambda$, and solving immediately yields

$$p^* = \frac{1 + c + \lambda(c + \bar{p})}{2(1 + \lambda)}.$$

The comparative statics properties are straightforward and therefore omitted. Note that the loss evaluated at the optimal price p^* is given by

$$L^* = \lambda(p^* - \bar{p}) = \frac{\lambda^2(\bar{p} - 1)}{2(1 + \lambda)}.$$

The highest net valuation in the market is therefore $1 - L^*$. Clearly, there are zero sales for prices above this level. $\qquad\square$

Proof of Proposition 2. Let $L_\mu \equiv L_{\Delta x}\frac{\partial \Delta x}{\partial \mu}$ denote the derivative of the loss function with respect to the belief μ. (i) The optimal price p° satisfies the first-order condition

$$1 - F(\hat{v}(p^\circ)) - (p^\circ - c)f(\hat{v}(p^\circ))\hat{v}_p(p^\circ) = 0, \qquad\qquad (A.2)$$

Applying the implicit function theorem to the indifference condition (6) results in

$$\hat{v}_p(p) = \frac{1 + L_p + \mu_p L_\mu}{1 - L_v}.$$

With correct point beliefs, we have that $\mu(c|p) = c$ (for any p) and thus that $\mu_p = 0$, which implies that the first-order condition (A.2) is equivalent to (5). Consequently, the optimal price p° coincides with p^*, the optimal price under full information. (ii) In equilibrium, consumers underestimate cost if $\mu(c|p^\circ) < c$. Since $L_\mu \leq 0$ by assumption, this implies that $L(\Delta x(p^\circ; \mu)) \geq L(\Delta x(p^\circ; c))$, and therefore that $p^\circ + L(\Delta x(p^\circ; \mu)) \geq p^\circ + L(\Delta x(p^\circ; c))$. Consequently, we have that $\hat{v}(p^\circ) \geq \bar{v}(p^\circ)$, which means that incorrect beliefs reduce sales at p°. Thus,

$$
\begin{aligned}
\pi(p^\circ) &\equiv (p^\circ - c)[1 - F(\hat{v}(p^\circ))] \\
&\leq (p^\circ - c)[1 - F(\bar{v}(p^\circ))] \\
&\leq (p^* - c)[1 - F(\bar{v}(p^*))] \\
&\equiv \pi(p^*)
\end{aligned}
$$

by optimality of p^*. Instead, consumers overestimate cost if $\mu(c|p^\circ) > c$. Using that $L_\mu \leq 0$, we know that $p + L(\Delta x(p; \mu)) \leq p + L(\Delta x(p; c))$ for any p, and in particular for $p = p^*$. Consequently, we have that $\hat{v}(p^*) \leq \bar{v}(p^*)$, which means that incorrect beliefs increase sales at p^*. A fortiori, since the firm can choose the price in equilibrium, $\pi(p^\circ) \geq \pi(p^*)$. $\qquad \square$

Proof of Proposition 3. Let $L_\mu \equiv L_{\Delta x} \frac{\partial \Delta x}{\partial \mu}$ denote the derivative of the loss function with respect to the belief μ. If consumers do not know cost and receive the cost message $\tilde{c}$, the consumer who is indifferent between purchasing and choosing the outside option $\hat{v}(p)$ is uniquely defined by the indifference condition

$$
\hat{v}(p) = p + L(\Delta x(p; \mu(c|p, \tilde{c}), \hat{v}(p)), \lambda). \tag{A.3}
$$

Applying the implicit function theorem to the indifference condition (A.3) yields

$$
\hat{v}_{\tilde{c}}(p) = \frac{\mu_{\tilde{c}} L_\mu}{1 - L_v}.
$$

Equilibrium requires that changes in $\tilde{c}$ do not affect sales, and hence that $\hat{v}_{\tilde{c}}(p) = 0$. Consequently, we must have $\mu_{\tilde{c}} = 0$, which means that in equilibrium the consumer belief is not allowed do depend on the message sent by the firm. The optimal price is therefore characterized by Proposition 2. $\qquad \square$

Proof of Proposition 4. Let $L_\mu \equiv L_{\Delta x} \frac{\partial \Delta x}{\partial \mu}$ denote the derivative of the loss function with respect to the belief μ. The firm has two options: to disclose cost or to remain silent. First, consider the case

where the firm discloses c. Hence, consumers form correct point beliefs $\mu(c|p,c) = c$. It is then immediate that only consumers with $v \geq \bar{v}(p)$ purchase, where the cutoff $\bar{v}(p)$ satisfies equation (2), the threshold under full information. The optimal price (and profit) is therefore characterized by Proposition 1.

Second, consider the case where the firm remains silent and does not disclose its cost. Then, if $c \geq \mu(c|p,\emptyset)$, consumers overestimate the loss and therefore purchase too little. As a result, firms with a type $c \geq \mu(c|p,\emptyset)$ reveal their type. Instead, if $c < \mu(c|p,\emptyset)$, consumers infer that they underestimate the loss and therefore would consume too much. This leads consumers to adjust their belief downward to some strictly lower level $\mu^*(p,\emptyset) < \mu(p,\emptyset)$. As a result, firms with a type $c \geq \mu^*(c|p,\emptyset)$ also reveal their type. This process continues until $\mu^*(p,\emptyset)$ approaches zero. In this limiting case, the firm's profit is $\pi(p^*(0))$, where $p^*(0)$ denotes the optimal price for a firm with known type $c = 0$.

Finally, we need to compare among the two options. Since $\pi(p^*(c)) \geq \pi(p^*(0))$ for $c \geq 0$, it is always optimal for the firm to disclose its cost. $\qquad\square$

Proof of Corollary 3. The result follows from Proposition 4 because unit cost c is a strictly monotone transformation of ξ. $\qquad\square$

Proof of Proposition 5. Consumers purchase the high-quality product if their valuation exceeds $\bar{\theta}$ defined by the indifference condition

$$\bar{\theta}q_1 - p_1 - L_1 = \bar{\theta}q_2 - p_2 - L_2, \tag{A.4}$$

and they purchase the low-quality product if their valuation θ is less than $\bar{\theta}$ and exceeds $\underline{\theta}$ defined by

$$\underline{\theta}q_1 - p_1 - L_1 = 0. \tag{A.5}$$

The indifference condition (A.4) implies that

$$\bar{\theta} = \frac{p_2 + L_2 - p_1 - L_1}{q_2 - q_1} > 0,$$

while the indifference condition (A.5) implies that

$$\underline{\theta} = \frac{p_1 + L_1}{q_1}.$$

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Demand for the low-quality product is positive if $\underline{\theta} < \bar{\theta}$, that is,

$$\frac{q_2}{p_2 + L_2} < \frac{q_1}{p_1 + L_1}.$$

To determine the optimal price, each firm solves its respective profit-maximization problem:

$$\begin{aligned}\max_{p_1} \quad \pi_1(p_1, p_2) &= (p_1 - c_1)\left[G(\bar{\theta}) - G(\underline{\theta})\right] \\ \max_{p_2} \quad \pi_2(p_1, p_2) &= (p_2 - c_2)\left[1 - G(\bar{\theta})\right]\end{aligned}$$

The first-order condition for p_1 is given by

$$\frac{\partial \pi_1}{\partial p_1} = \left[G(\bar{\theta}) - G(\underline{\theta})\right] + (p_1 - c_1)\left[-g(\bar{\theta})\frac{1 + \partial L_1/\partial p_1}{q_2 - q_1} - g(\underline{\theta})\frac{1 + \partial L_1/\partial p_1}{q_1}\right] = 0,$$

which can be rearranged as

$$p_1^* = c_1 + \frac{G(\bar{\theta}) - G(\underline{\theta})}{g(\bar{\theta})\frac{1 + \partial L_1/\partial p_1}{q_2 - q_1} + g(\underline{\theta})\frac{1 + \partial L_1/\partial p_1}{q_1}}.$$

Similarly, the first-order condition for p_2 is given by

$$\frac{\partial \pi_2}{\partial p_2} = \left[1 - G(\bar{\theta})\right] + (p_2 - c_2)\left[-g(\bar{\theta})\frac{1 + \partial L_2/\partial p_2}{q_2 - q_1}\right] = 0,$$

which yields

$$p_2^* = c_2 + \frac{1 - G(\bar{\theta})}{g(\bar{\theta})\frac{1 + \partial L_2/\partial p_2}{q_2 - q_1}}.$$

Solving simultaneously yields the optimal prices

$$p_1^* = c_1 + \frac{G(\bar{\theta}) - G(\underline{\theta})}{g(\bar{\theta})\frac{1 + \partial L_1/\partial p_1}{q_2 - q_1} + g(\underline{\theta})\frac{1 + \partial L_1/\partial p_1}{q_1}}$$

and

$$p_2^* = c_2 + \frac{1 - G(\bar{\theta})}{g(\bar{\theta})\frac{1 + \partial L_2/\partial p_2}{q_2 - q_1}}.$$

To see that p_2^* is lower than the price absent consumer resistance, note that $g'(\theta) \geq 0$ is sufficient for $(1 - G)/g$ to be non-increasing. In addition, recall that $\partial L_2/\partial p_2 \geq 0$ by Assumption 1. Taken together, this yields that consumer resistance forces the price of the high-quality firm down. The argument for the price of the low-quality firm p_1^* is more involved: Defining

$$Z(L_1) = \frac{G(\bar{\theta}) - G(\underline{\theta})}{g(\bar{\theta})\frac{1 + \partial L_1/\partial p_1}{q_2 - q_1} + g(\underline{\theta})\frac{1 + \partial L_1/\partial p_1}{q_1}}$$

and differentiating it with respect to L_1 shows that $Z'(L_1) < 0$ if $g'(\theta) \geq 0$ (the analysis is tedious but straightforward).

$\square$

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