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When firms can hide charges and consumers are prone to salient or relative thinking, this may have severe welfare consequences. The ensuring greater competition on headline prices, far from protecting consumers, may distort their choice and induce firms to offer inefficiently low product quality. As more intense competition leads to a larger pass-through of shrouded charges into lower headline prices, which aggravates these problems, competition policy alone cannot correct market outcomes. When competition is however complemented by effective consumer protection, high-quality firms have sufficient incentives to unshroud hidden charges, disciplining firms' choice of quality and restoring efficiency.

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Excessive Competition on Headline Prices

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Abstract

When firms can hide charges and consumers are prone to salient or relative thinking, this may have severe welfare consequences. The ensuing greater competition on headline prices, far from protecting consumers, may distort their choice and induce firms to offer inefficiently low product quality. As more intense competition leads to a larger pass-through of shrouded charges into lower headline prices, which aggravates these problems, competition policy alone cannot correct market outcomes. When competition is however complemented by effective consumer protection, high-quality firms have sufficient incentives to unshroud hidden charges, disciplining firms' choice of quality and restoring efficiency.

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1 Introduction

The recent survey on Behavioral Industrial Organization by Heidhues and Kőszegi (2018) dedicates its first part to the "economics of hidden prices",[1] which testifies to the positive and normative importance of this phenomenon. When hidden, unavoidable price components[2] lead firms to compete intensively on the remaining headline price, it is widely perceived that this waterbed effect protects consumers, which Heidhues and Kőszegi (2018) refer to as "safety-in-markets".[3] We however show that this conclusion does not necessarily arise when consumers exhibit salient or relative thinking. Then, artificially low headline prices may inefficiently bias consumers' product choice towards low-quality variants. In the longer term, this may also negatively affect the provision of higher-quality products in the market.

In our model, without effective consumer policy, intense competition alone is thus unable to protect consumers. When hidden charges are however sufficiently constrained, competition plays an important role as it motivates otherwise disadvantaged high-quality firms to unshroud hidden charges. This, in turn, prevents firms from choosing inefficiently low quality (and subsequently engaging in fiercer headline price competition). For high-quality firms' incentive to unshroud, consumers' salient or relative thinking is crucial, as this is the channel trough which otherwise, i.e., with shrouded charges and lower headline prices, low-quality firms would have a competitive advantage.[4] This also

[1]Next to providing various examples, they also point out that such hiding or shrouding may also occur through an increased complexity of offers (cf. Carlin (2009)).

[2]Instead, in Gabaix and Laibson (2006), shrouding relates to one component of a bundle which more attentive consumers may avoid to purchase. The welfare implications there derive precisely from attentive consumers' inefficient actions to circumvent the consumption of the overpriced component. This is also the inefficiency on which Armstrong and Vickers (2012) focus, while otherwise they point out that welfare implications hinge mainly on distributional priorities (notably between more or less sophisticated consumers).

[3]Clearly, this does not work when consumers underestimate all price components (Johnson (2017); Chetty et al. (2009)) or when there is a "price floor" for the transparent component. A similar mechanism also appears in different contexts, e.g., in the theory of switching costs (cf. Farrell and Klemperer (2007)).

[4]Inderst and Ottaviani (2013) also stress differences between consumer protection and competition policy, but there more competition is unambiguously positive as it constrains firms' ability to extract (inflated) consumer rent.

contrasts with earlier contributions, which seem to be more pessimistic about the potential for unshrouding in the market (cf. Gabaix and Laibson (2006) or, more recently, Heidhues et al. (2017)).[5]

Analyzing imperfect competition between firms that are potentially vertically differentiated, we need to rely on a simple model of consumer choice. For this, we follow our approach in Inderst and Obradovits (2020a), which modifies Varian's seminal model of sales (Varian (1980)) to allow for product heterogeneity and salient or relative thinking. Borrowing from Varian (1980), we posit that only a share of consumers "shop" among offers, which is also our key indicator of the degree of competition. The remaining fraction of consumers have a smaller consideration set (namely, of only one firm's offer). Only the first fraction is indeed prone to salient or relative thinking, as this requires the formation of a reference point across different offers in the market.[6]

Our main analysis further adopts a simplified choice rule in stipulating that when consumers compare different offers, they only consider a single, salient attribute. In our setting, this proves to be equivalent to choosing the product which delivers the highest "quality-per-dollar", which we term relative thinking. With this simplification, the characterization of the full equilibrium, including the different stages of product choice, possible unshrouding, and pricing, remains highly tractable.[7]

Our paper is related to other recent applications of context-dependent or reference-point-dependent preferences to Industrial Organization, such as Bordalo et al. (2016), Dertwinkel-Kalt and Köster (2017), Helfrich and Herweg (2020) and Apffelstaedt and Mechtenberg (forthcoming). We see our contribu-

[5]We note that when quality is endogenous in our model, unshrouding does not arise on equilibrium, but it becomes an effective threat when a rival would choose a lower quality. Hence, the prevalence of unshrouding in the market may not be fully informative about its actual role.

[6]Using a model of sales links our contribution to Heidhues et al. (forthcoming), who analyze the trade-off when consumers either analyze fewer products in detail, thereby detecting all charges, or "browse" more products. Such an allocation of attention could be an interesting research avenue also in our model of salient or relative thinking.

[7]Still, in an extension, we follow Bordalo et al. (2013, 2016) and also analyze a setting where the non-salient attribute is only partially discounted. This gives rise to various additional implications, such as how the degree of salient thinking affects efficiency, although this comes at the cost of substantial added complexity.

tion as applied, rather than conceptual (in contrast to, notably, Bordalo et al. (2013), Kőszegi and Szeidl (2013), or Bushong et al. (forthcoming)). As mentioned earlier, through the interaction with consumer preferences, in our model consumers are not (fully) protected from hidden charges by the waterbed effect that leads to lower headline prices. Both the resulting short-term and longer-term inefficiencies are, to the best of our knowledge, novel. Longer-term inefficiencies are also the focus of Heidhues et al. (2016, 2017), where firms rather invest in their potential to increase hidden prices, which they term "exploitative" innovation. Importantly, in their model such inefficiency arises in particular when the waterbed effect is relatively ineffective, as then firms can earn higher profits from hidden charges.[8] We dedicate a separate discussion to the waterbed effect as, interestingly, it is also dampened by consumers' salient or relative thinking.

Next to our normative implications, which stress the limitations of competition policy but also the role of market forces through the threat of unshrouding, we emphasize various positive implications that arise from such a tractable model. Amongst others, we point out how the different behavior of consumers with larger or smaller consideration sets may be informative about the relevance of salient or relative thinking.

We certainly do not claim that our analysis applies to every market. In fact, our modelling assumptions may be of particular relevance in markets where frequent promotions require consumers to constantly reassess the relative positioning of firms' offers. Perception biases should also be more relevant when the experience of quality does not immediately derive from (physical) interaction with the product. On the other hand, while our model focuses on hidden charges, the described mechanism of excessively low headline prices becomes effective also when firms can clandestinely shift costs towards consumers, such as those arising from the malfunctioning of a product. Consumer protection policy is thus not narrowly confined to making charges more transparent, but extends, for instance, to the allocation of liability. This should broaden the general applicability of our model and its implications.

[8] Michel (2018) points yet to another inefficiency that may arise from firms screening between more or less wary consumers.

The rest of this paper is organized as follows. Section 2 introduces the model. Firms' price competition with exogenous product qualities is analyzed in Section 3. In Section 4, we add, as initial step, firms' endogenous quality choice. Section 5 introduces the possibility of unshrouding. In Section 6, we finally derive policy implications from our results and provide an additional analysis of (consumer) welfare. Section 7 concludes. All proofs are contained in the Appendix. In an extensive Online Appendix[9], we derive results for a generalized version of salience, for an arbitrary number of firms, and for a modified model where only a share of consumers is subject to the salience bias.

2 The Model

The market. In our baseline model, we consider $I = 2$ firms that compete for a mass one of consumers.[10] We stipulate that a fixed fraction $\lambda \in (0, 1)$ of consumers is aware of all offers, while the remaining fraction $1-\lambda$ only considers (randomly) the offer of a single firm. The former consumers are thus akin to "shoppers" in Varian's model of sales (Varian (1980)). The key difference between consumers lies thus in the larger consideration or choice set of the former group of consumers. In what follows, we refer to these consumers as "market savvy".[11]

Each consumer demands at most one product. Firms' offers may differ in qualities and prices, where we index quality by some positive real number q. A firm's price involves a headline price p as well as a hidden or shrouded charge h. The price component h is hidden to all consumers, irrespective of whether they are market savvy or not. The (maximum) size of h depends on consumer protection policy, as well as possible unshrouding by firms, as we discuss below. The total true price paid by a consumer is thus $p + h$. Firms' offers are indexed by i and we suppose that they have constant marginal costs $c_i \in (0, q_i)$. We simplify the exposition by supposing that there is a single

[9] URL: https://drive.google.com/file/d/1KIvpxHYXuL6eRww3F8HlEb3RjxcIN0tZ

[10] In the Online Appendix, we extend our results to more than two firms ($I > 2$).

[11] While a consumer's type is exogenous in our model, we briefly discuss below the possibility that consumers' consideration sets are determined endogenously.

low-quality and a single high-quality variant, $q_i \in \{q_L, q_H\}$, with $q_L < q_H$ and associated marginal costs $c_L < c_H$ (where $c_L < q_L$ and $c_H < q_H$). For each consumer we normalize the (reservation) value from any alternative outside the considered market to zero. With standard preferences, as they will always apply to non-savvy consumers observing a single offer, a consumer would thus strictly prefer an offer, compared to the outside option of no purchase, if $q_i - p_i > 0$.

Our baseline game consists of the following sequence of moves. In $t = 1$, firms with potentially different qualities q_i choose their headline price p_i and their hidden charge h_i. In $t = 2$, non-savvy consumers only have the choice whether to take up the observed single offer or whether not to purchase at all; market-savvy consumers consider both firms' offers instead. Their respective choice criterion is formalized below. In $t = 3$, all payoffs are realized.

After solving this simple game, we introduce two extensions, both of which are crucial for our positive and normative implications. First, we let firms choose their quality q_i endogenously. Second, we allow firms to potentially unshroud the hidden price component. More precisely, for the first modification we introduce an initial stage $t = 0$ where firms simultaneously choose which product variety to offer: $q_i \in \{q_L, q_H\}$. For the second modification, after product choice we allow firms to educate consumers. Such possible unshrouding takes place in $t = 0.5$. For instance, this may be achieved by the design of (pricing) labels, which induce consumers to also consider the respective, previously ignored information for other offers in the market. Educating consumers could also occur through a longer-term advertising campaign, emphasizing again the potential of hidden costs to consumers. We thus consider both product choice and unshrouding as longer-term strategies, compared to pricing.

Hidden or shrouded charges. The extent to which firms are able to shroud part of their charges should depend crucially on consumer protection and its enforcement. In this paper, we employ a reduced-form parametrization of the respective policies and the effectiveness of their enforcement. This is captured by an upper boundary up to which firms can shroud their charges, which for simplicity is denoted by $h \geq 0$, such that $h_i \leq h$. We further suppose that there is always some minimum level of consumer protection, so that $h \leq c_H$.

Preferences of market-savvy consumers. The key feature of the subsequently introduced choice criterion is that those consumers who observe more than one offer compare offers not in absolute terms, but relative to some reference point, which in turn depends on their choice set. Thereby, a given price or quality difference between offers will weigh more or less, depending on comparable offers in a consumer's consideration set. The subsequent specification follows that in Inderst and Obradovits (2020a). We outline below how this borrows from the literature.

Salient or relative thinking affects market-savvy consumers' ordering of options that can be compared along the described attributes, price and quality, i.e., in our case the offers (q_1, p_1) and (q_2, p_2). With a slight abuse of notation and supposing that no offer dominates the other along both attributes, so that $p_H > p_L$, the respective reference point is given by the average price $P = \frac{p_L+p_H}{2}$ and the average quality $Q = \frac{q_L+q_H}{2}$ of the two offers.[12] Below we specify how a market-savvy consumer puts more weight on a (salient) attribute. For the low-quality product, whether its low price or low quality is salient depends on a comparison of the specific values p_L and q_L *relative* to those of the reference points P and Q: its (low) price is salient when

$$\frac{p_L}{P} < \frac{q_L}{Q}, \tag{1}$$

while its (low) quality is salient when the converse of (1) holds strictly. For the high-quality product, its (high) quality is salient when $\frac{q_H}{Q} > \frac{p_H}{P}$, while its (high) price is salient when the converse of this holds strictly. Given this, we note that the same attribute is salient for both offers: When (1) (the strict converse of (1)) holds such that the low-quality offer's low price (low quality) is salient, this

[12] We thus do not include the outside option into the reference point, albeit stipulating an outside option of $(0, 0)$ would presently not change results. This follows the hierarchical approach as described in Inderst and Obradovits (2020a); cf. however the additional analysis under a generalized version of salience in the Online Appendix. We also acknowledge that there could still be other notions of reference-point formation, e.g., when offers are evaluated (also) relative to expected prices and qualities (with expectations formed over retailers' mixed pricing strategies; cf. below).

implies that $\frac{p_H}{P} > \frac{q_H}{Q}$ ($\frac{p_H}{P} < \frac{q_H}{Q}$), i.e., that also the high-quality offer's high price (high quality) is salient.[13]

Bordalo et al. (2013) motivate this specific criterion of salience with evidence from psychology, which supports an underlying notion of a diminishing sensitivity. In our main analysis, we make the stark assumption that consumers compare offers only on the salient attribute, so that when (1) holds (and price is salient), consumers strictly prefer the low-quality product, while otherwise, they prefer the high-quality product. In the Online Appendix, we show, however, that the main features of the equilibrium characterization fully survive when the non-salient attribute is only partially discounted by some factor $\delta \in (0,1)$.[14] While the presently analyzed case is thus particularly tractable, it is not knife-edge.

Before we complete the specification of the consumer choice criterion, we outline the following alternative interpretations. Observe first that, substituting for P and Q, (1) transforms to

$$\frac{q_L}{p_L} > \frac{q_H}{p_H}. \tag{2}$$

The criterion that a market-savvy consumer compares offers only according to the salient attribute is thus equivalent to a comparison in terms of the "quality-per-dollar" ratio, choosing low quality when condition (2) holds.[15] Alternatively, we obtain the same criterion when consumers compare relative differences in qualities and prices. For instance, the price increment is relatively larger than the quality increment for the high-quality product when

$$\frac{p_H - p_L}{p_L} > \frac{q_H - q_L}{q_L}, \tag{3}$$

which again transforms to condition (2). While this provides alternative interpretations for the chosen choice criterion, we stress again that ours is not a conceptual contribution. Instead, starting from (1) (and its converse), we show

[13] This can be seen immediately after substituting for P and Q.

[14] There, we also conduct a comparative analysis of the equilibrium characterization in δ.

[15] Indeed, some contributions in the literature, such as Azar (2014), start right with similar choice rules.

that this gives rise to a tractable model of imperfect competition, in which various applied questions can be answered.

Note finally that to what extent salient or relative thinking affects the market outcome crucially depends on the composition of consumers in the market. While in our model, consumers are not distinct by some inherent propensity to salient or relative thinking, they differ in their smaller or larger consideration set. From an empirical perspective, this could be proxied by observed (purchasing) behavior, e.g., from homescan panel data.[16]

3 Equilibrium of the Baseline Model: "Shrouding Meets Salience"

In this section, we solve the pricing subgame in $t = 1$. Since (without unshrouding) any hidden charges are unobservable to consumers, it is immediate that both firms set h_i as high as possible, $h_i = h$, so that it remains to characterize their choice of the headline price p_i. The unique pricing equilibrium is in mixed strategies, such that firm i's price choice will be a random variable $\tilde{p}_i$. The technical steps of our characterization follow from the seminal works of Varian (1980) and Narasimhan (1988).

We denote firm i's price strategy by the cumulative distribution function (CDF) $F_i(p_i) = \Pr(\tilde{p}_i \leq p_i)$ with lower and upper support bounds $\underline{p}_i$ and $\overline{p}_i$, respectively. Over the respective support for firm i, the rival's CDF $F_j(p_j)$ must be such that firm i is indifferent: When π_i describes the respective profit, we thus have the requirement

$$\begin{aligned} \pi_i &= (p_i - c_i + h)\left[\frac{1-\lambda}{2} + \lambda \Pr\left(\frac{p_i}{q_i} < \frac{\tilde{p}_j}{q_j}\right)\right] \\ &= (p_i - c_i + h)\left[\frac{1-\lambda}{2} + \lambda\left(1 - F_j\left(\frac{q_j}{q_i} p_i\right)\right)\right]. \end{aligned} \tag{4}$$

[16] Still, in the Online Appendix, we provide a discussion of a model variant where, instead of having more or less savvy consumers who all share the same proclivity to salient thinking, all consumers sample both offers, but only a fraction θ are salient thinkers. This model however proves far less tractable and, in particular, does not allow us to analyze the interaction of competition (policy) and consumer protection.

Expression (4) contains the following terms: the respective margin, $p_i - c_i + h$, the mass of non-savvy consumers who are always attracted, $\frac{1-\lambda}{2}$, and the expected mass of attracted savvy consumers who compare both offers, $\lambda\Big(1 - F_j\big(\frac{q_j}{q_i}p_i\big)\Big)$. When firms have symmetric qualities q_i, we are back to the standard case, where it is well known that supports are convex with upper boundary $\overline{p}_i = q_i$, there are no mass points, and firms realize profits

$$\pi_i = \frac{1-\lambda}{2}\left(q_i - c_i + h\right), \tag{5}$$

i.e., exactly the profits that they would make when charging the highest price q_i and only selling to non-savvy consumers. To characterize the outcome with heterogeneous qualities, denote the threshold

$$\widetilde{h} = \frac{q_H c_L - q_L c_H}{q_H - q_L}, \tag{6}$$

which is smaller than c_L and strictly positive if and only if $\frac{q_H}{c_H} > \frac{q_L}{c_L}$.[17] We now have the following formal result.

Lemma 1 *There is a unique pricing equilibrium in mixed strategies, where supports are convex and the CDFs have at most a mass point at $\overline{p}_i = q_i$. When firms have the same quality, the equilibrium is symmetric and without a mass point, while firms realize profits (5). When firms have different qualities, then we have the following case distinction: i) when the maximum feasible shrouded charges are sufficiently small, $h < \widetilde{h}$, only F_L has a mass point,*

$$\pi_H = \frac{1-\lambda}{2}(q_H - c_H + h) + \lambda\left[\frac{q_H}{q_L}(c_L - h) - (c_H - h)\right], \tag{7}$$

and π_L is given by (5); ii) when $h > \widetilde{h}$, only F_H has a mass point,

$$\pi_L = \frac{1-\lambda}{2}(q_L - c_L + h) + \lambda\left[\frac{q_L}{q_H}(c_H - h) - (c_L - h)\right], \tag{8}$$

[17] In fact, $\widetilde{h}$ is derived from the requirement that $\frac{q_H}{c_H - \widetilde{h}} = \frac{q_L}{c_L - \widetilde{h}}$.

and π_H is given by (5); when $h = \widetilde{h}$, there are no mass points and π_i is given by (5) for both firms.

We relegate a full explicit characterization of the CDFs (and the mass points) to the proof of the lemma. The fact that the equilibrium is always in mixed strategies should lend our model additional support in the following sense. When prices are in mixed strategies, this essentially implies that, compared to the expected price $E[\tilde{p}_i]$, on the equilibrium path consumers are always "surprised" by the respective deviation $p_i - E[\tilde{p}_i]$.[18] Compared to a model with deterministic equilibrium prices, in our model consumers are therefore "forced" to (re-)assess their optimal choice between different products after the actual realization of prices. Depending on the particular application, this could take place under considerable time pressure. Especially in such situations, salient or relative thinking may be of particular relevance.

Turning to Lemma 1, below we will use the characterization of profits for the endogenization of product qualities. Here, we first focus on the the pricing distributions. When $h < \widetilde{h}$, the low-quality firm's distribution has a mass point at the upper boundary, while otherwise this holds for the high-quality firm's distribution. When pricing at the upper boundary, the respective firm only attracts its share of non-savvy consumers, but not consumers who compares offers. This already suggests that that when firms can more easily shroud charges, $h > \widetilde{h}$, the low-quality firm will become more competitive in the marketplace and will attract a larger expected number of consumers. To make this precise, denote for given price distributions the likelihood that a savvy consumer buys product i by

$$\sigma_i = \Pr\left(\frac{q_i}{\tilde{p}_i} > \frac{q_j}{\tilde{p}_j}\right),$$

where we have used the re-formulation of the choice criterion in (2). An explicit characterization of σ_L for the low-quality product and of $\sigma_H = 1 - \sigma_L$ for the high-quality product is provided in the subsequent proof. Proposition 1 is one of our main results.

[18]Strictly speaking, this holds when $F_i(p_i)$ has no mass point at $E[\tilde{p}_i]$, which is always the case.

Proposition 1 *Suppose that firms have different qualities in $t = 1$. Then, if the maximum feasible shrouded charges are sufficiently large with $h > \widetilde{h}$, the low-quality firm has a larger expected market share ($\sigma_L > \sigma_H$). When instead $h < \widetilde{h}$ holds, the picture is reversed as then $\sigma_H > \sigma_L$. Generally, across both cases, when the maximum feasible shrouded charges h increase, σ_H decreases strictly and σ_L increases strictly, so that consumers who observe both firms' offers become more likely to buy low instead of high quality.*

In the proof of this proposition, we are able to derive the comparative analysis of σ_i in h after a transformation of the random variable (prices). There, we also observe that indeed for both firms the expected price $E[\tilde{p}_i]$ strictly decreases in h: When firms' can hide more charges, this intensifies competition on the headline price. Below we will explore in more detail the extent of this waterbed effect.

The observation that headlines prices decrease when hidden charges are higher is key to understand the resulting shift in market share to the low-quality firm. Before we elaborate on this, we note that this is shared with Inderst and Obradovits (2020a), though the characterization of the pricing equilibrium is different, as there firms choose qualities and prices simultaneously, which, amongst others, implies that in case of different qualities, the low-quality product is always bought by the contested share of the market.[19]

With the chosen preferences, the low-quality firm wins the savvy consumers if it provides a *relatively* better deal. Formally, making use of the formulation in condition (3),[20] to win the savvy consumers, for a given price p_H of its rival the low-quality firm's discount $\Delta_p = p_H - p_L$ must satisfy $\Delta_p > \Delta_q \frac{p_H}{q_H}$. Hence, a lower *absolute* price difference is required when p_H is lower. When hidden charges h are higher and, by the waterbed effect, headline prices are lower, it thus becomes less expensive for the low-quality firm to win the savvy customers, which increases σ_L and decreases σ_H.

[19] The subsequent analysis, including that of unshrouding, is different as well. Also Inderst and Obradovits (2020b) do not analyze these issues. There, with sequential timing of product and price choices, the focus is both on a comparison between absolute and relative thinking and on empirical implications that result when firms have different loyal customer bases.

[20] In our model, recall that conditions (1), (2), and (3) can be used interchangeably.

4 Endogenous Product Choice

Continuing with our backward induction, we now consider firms' choice of products in $t = 0$. We denote the respective likelihood with which either firm chooses high quality by γ_i.

We first deal with a particularly clear-cut case. When $q_H - c_H < q_L - c_L$, only low quality will be provided in equilibrium. This is intuitive as in this case low quality both affords firms a strictly larger margin with non-savvy consumers (for any given utility $u_i = q_i - p_i$ offered) and it generates a higher quality-per-dollar when priced at costs, $\frac{q_L}{c_L} > \frac{q_H}{c_H}$.[21] Formally, the result is obtained from a comparison of the respective profits in Lemma 1 and after noting that $q_H - c_H < q_L - c_L$ implies $h > \widetilde{h}$ so that case ii) applies. This observation is the reason for why in what follows we restrict consideration to the case where

$$q_H - c_H > q_L - c_L. \tag{9}$$

It is only in this case that both qualities may arise endogenously.[22] In the remainder, we will thus always invoke this restriction. For ease of exposition, denote the profit of a firm that chooses high quality H, while its rival chooses low quality L, by $\pi_{H,L}$. Profits for all other permutations are denoted accordingly. In the following part, we derive step-by-step the product-choice equilibrium.

As obviously $\gamma_i = 0$ for both firms is not an equilibrium since $\pi_{L,L} < \pi_{H,L}$ given (9), we turn first to the candidate equilibrium with $\gamma_i = 1$ for both firms, which can be supported when $\pi_{H,H} \geq \pi_{L,H}$. Intuitively, from Lemma 1 this holds for sure when $h \leq \widetilde{h}$, as when hidden charges are sufficiently small, the (deviating) low-quality firm is still at a disadvantage in the market.[23] There

[21] This follows as $q_H - c_H < q_L - c_L$ can be rewritten as $q_H\left(1 - \frac{c_H}{q_H}\right) < q_L\left(1 - \frac{c_L}{q_L}\right)$, which implies that $1 - \frac{c_H}{q_H} < 1 - \frac{c_L}{q_L}$ and therefore $\frac{q_L}{c_L} > \frac{q_H}{c_H}$.

[22] Strictly speaking, both qualities may also arise as part of an asymmetric pure-strategy equilibrium when (9) holds with equality, though in what follows we ignore this knife-edge case. Moreover, in this case, it would be irrelevant from a social point of view which product is offered and bought.

[23] Formally, the (deviating) low-quality firm's profit would then be equal to that obtained just with its share of non-savvy consumers, $\pi_{L,H} = (q_L - c_L + h)\frac{1-\lambda}{2}$, which from (9) is clearly strictly smaller than $\pi_{H,H} = (q_H - c_H + h)\frac{1-\lambda}{2}$.

exists however a strictly higher cutoff $h^* > \widetilde{h}$ so that for all $h > h^*$, such a deviation becomes profitable and $\gamma_i = 1$ can no longer be an equilibrium. Making use of the analytical tractability of our model, we can directly compare the candidate equilibrium payoff with high quality to that from deviating to low quality in case of $h > \widetilde{h}$, so that, using expression (8), $\pi_{H,H} \geq \pi_{L,H}$ becomes

$$\frac{1-\lambda}{2}\left[(q_H - q_L) - (c_H - c_L)\right] \geq \lambda \left[\frac{q_L}{q_H}(c_H - h) - (c_L - h)\right]. \tag{10}$$

Condition (10) captures a firm's trade-off for the case where $h > \widetilde{h}$: The left-hand side captures the additional margin (for any given utility offered) when selling only to non-savvy consumers, while the right-hand side captures the advantage vis-à-vis savvy consumers when a firm offers low quality while the rival offers high quality. At $h = \widetilde{h}$, price is equally likely to be salient as quality and the right-hand side of (10) is zero, such that the condition is always satisfied. But as h increases, the right-hand side increases, and we denote the level at which (10) is satisfied just with equality by h^*. The monotonicity in h reflects the comparative analysis in Proposition 1, from which the low-quality firm's market share increases with h.

When there is no longer an equilibrium where firms choose high quality for sure, there exist multiple equilibria: one where both firms choose a symmetric mixed strategy and one where firms choose asymmetric but deterministic strategies.

Proposition 2 *Suppose still that unshrouding (in $t = 0.5$) is not a possibility. Then the size of firms' maximally feasible shrouded charges h determines the provision of qualities in equilibrium as follows: When $h \leq h^*$, with*

$$h^* = \widetilde{h} + \frac{1-\lambda}{2\lambda}\frac{q_H}{q_H - q_L}\left[(q_H - c_H) - (q_L - c_L)\right], \tag{11}$$

only high quality is provided ($\gamma_i = 1$ for $i = 1, 2$). When $h > h^*$, there exist multiple equilibria as follows: In the unique equilibrium in deterministic strategies, one firm chooses high and the other firm low quality ($\gamma_i = 1$ and $\gamma_j = 0$ for $i \in \{1, 2\}$, $j \neq i$). The unique equilibrium in mixed strategies is symmetric,

$\gamma_1 = \gamma_2 = \gamma \in (0,1)$*, so that both qualities are offered with strictly positive probability, where*

$$\gamma = \frac{1-\lambda}{2\lambda}\left[\frac{(q_H - c_H) - (q_L - c_L)}{\frac{q_L}{q_H}(c_H - h) - (c_L - h)}\right], \tag{12}$$

which is strictly decreasing in h*.*

While we already know that the level of h determines whether low quality will be provided, we also learn from Proposition 2 that in the mixed-strategy equilibrium, where both firms randomize which quality to offer, the provision of low quality becomes more likely as (the maximum) hidden charges are higher and thus headline prices lower. The following comparative analysis summarizes Propositions 1 and 2.

Proposition 3 *Suppose still that unshrouding (in* $t = 0.5$*) is not a possibility. As the maximum hidden charges* h *increase, it becomes more likely that low quality is provided and purchased: When* $h > h^*$*, high quality is no longer offered with probability one, and in the symmetric mixed-strategy equilibrium, an increase in* h *further strictly increases the likelihood with which either firm chooses to offer low quality,* $1-\gamma$*. In case of different qualities, an increase in* h *also increases the likelihood with which savvy consumers purchase low instead of high quality,* σ_L*.*

Note that we are so far silent regarding an interpretation in terms of efficiency and welfare, to which we turn only after fully solving the model, including firms' potential unshrouding. There, we also comment on the interaction of competition and consumer protection policy.

5 The Potential for Unshrouding

We have used so far that both firms fully exploit any leeway that results from a slack in consumer protection legislation or its enforcement and thus choose

$h_i = h$. We analyze now how the outcome changes when firms can educate consumers in $t = 0.5$. When this is the case, consumers become wary of any supposedly hidden charges, which effectively eliminates firms' scope for shrouding, setting $h = 0$. For simplicity and following the literature (cf., e.g., Gabaix and Laibson (2006)), we abstract from any costs that would be associated with such unshrouding (arising either directly for the respective firm or for consumers, who may have to devote more time to understand the respective offers). As discussed above, such unshrouding may be achieved by the design of (pricing) labels, which induce consumers to look for such information also when contemplating other offers. Educating consumers could also occur through respective information as part of an advertising campaign.

Consider now first the case where firms have the same quality. It is immediate that in this case each firm would strictly lose from unshrouding, as this would reduce profits by $\frac{1-\lambda}{2}h$. This is different when firms are vertically differentiated. Now the high-quality firm faces the following trade-off. On the one hand, through unshrouding it loses its own ability to exploit consumers. This loss is obviously particularly high when firms can shroud charges to a large extent (high h). On the other hand, unshrouding dampens competition on headline prices. The resulting higher price level favors the high-quality firm, as then its higher quality becomes relatively more important. The latter advantage should matter more when there is a large fraction of savvy consumers in the market (high λ). Taken together, we obtain the following result:[24]

Proposition 4 *Consider the extended game where each firm can unshroud all hidden charges in $t = 0.5$. Then only a firm with high quality may ever unshroud, and only so when the rival offers low quality. Such unshrouding in case of different qualities occurs if and only if $\widetilde{h} > 0$, the fraction of savvy consumers λ is sufficiently high,*

$$\lambda \geq \underline{\lambda} = \frac{q_L}{2q_H - q_L} \in (0, 1), \tag{13}$$

[24]For the subsequent proposition, we assume that if a firm is indifferent between shrouding and unshrouding it unshrouds, though this only makes a difference at the parameter boundaries.

and the maximum feasible shrouded charges are not too high,

$$h \leq \overline{h} = \frac{2\lambda(q_H c_L - q_L c_H)}{q_L(1-\lambda)}. \tag{14}$$

Proposition 4 thus delineates the conditions for when unshrouding will occur in case of different qualities. If there is unshrouding, it is immediate that the pricing equilibrium will be different, but we can still completely rely on the characterization in Lemma 1, setting $h = 0$. As we know from Proposition 1, this will tilt purchases towards the high-quality product.

The preceding observations however do not yet describe the equilibrium outcome, but only whether, for given parameters and given qualities, unshrouding would occur in the respective subgame. As we show next, when product choice is endogenous, unshrouding will in fact never occur in equilibrium! This is the case because when, along the equilibrium path, different qualities are chosen, the parameter constellations are such that, according to Proposition 4, also the high-quality firm has no incentive to unshroud. Nevertheless, unshrouding is still effective, as the threat of subsequent unshrouding by the rival may prevent firms from choosing low quality.

Proposition 5 *Consider the extended game where firms can unshroud all hidden charges in* $t = 0.5$*. While in the equilibrium of the full game, where qualities are chosen in* $t = 0$*, unshrouding never occurs, the possibility of unshrouding may affect the choice of qualities when* $\widetilde{h} > 0$*. This is the case when the share of market-savvy consumers is sufficiently large,* $\lambda > \hat{\lambda}$ *for some* $\hat{\lambda} \in (\underline{\lambda}, 1)$*, and the maximum feasible shrouded charges are in an intermediate range,* $h \in (h^*, \overline{h}]$*. Then, when unshrouding is possible, both firms choose high quality for sure, while otherwise low quality would be chosen with strictly positive probability.*

Thus, the possibility that a high-quality firm may unshroud charges ensures that, provided that the conditions of Proposition 5 hold, only high quality is chosen. The threat of unshrouding disciplines both firms in that it makes a deviation to low quality unprofitable, while this would be profitable without such a threat. That unshrouding is not observed in equilibrium may then provide a misleading picture, as firms' ability to educate consumers is still an effective

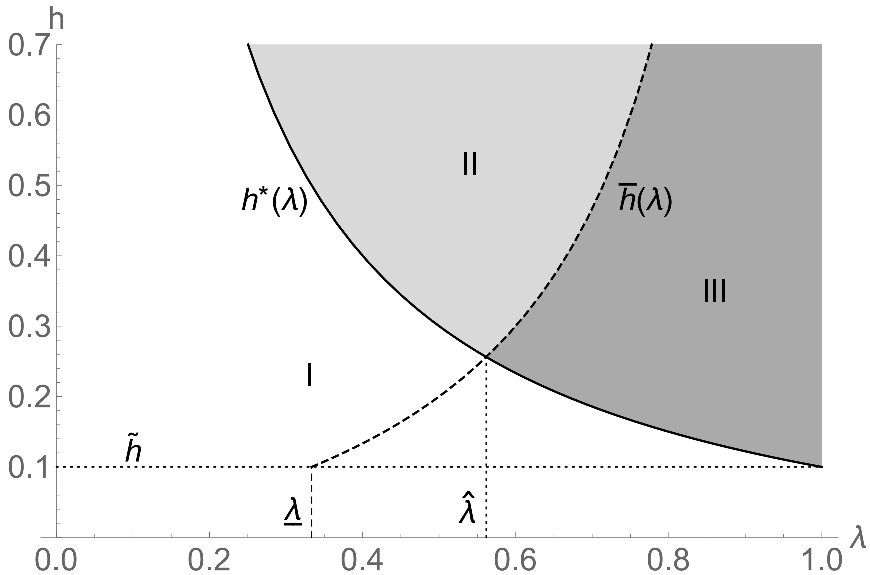

Figure 1: Equilibrium product-choice regions in (λ, h)-space when unshrouding is possible. The parameters used are $q_H = 1$, $c_H = 0.7$, $q_L = 0.5$, $c_L = 0.4$.

threat against rivals and renders the equilibrium outcome efficient. This requires, however, that consumer protection policy already sufficiently constrains hidden charges ($h \leq \overline{h}$). We keep this interaction of unshrouding and consumer protection in mind when we return below to a full discussion of policy implications.

Figure 1 visualizes the equilibrium outcomes when accounting for firms' option to unshroud. Region I arises if the maximum feasible hidden charges are small, $h \leq h^*$ (or alternatively, if the fraction of market-savvy consumers is not too high for given $h > \widetilde{h}$). We know that in this case both firms choose high quality even without the ability to unshroud hidden charges. Obviously, the potential to unshroud thus has no effect on the equilibrium outcome in this region. This also holds for region II, though there in equilibrium low quality is (still) chosen with positive probability as there is no effective threat of unshrouding. This is because the per-customer benefits from shrouding are high compared to the number of market-savvy consumers, $h > \overline{h}(\lambda)$, so that the gains for a high-quality firm from competing more effectively for these consumers by unshrouding are insufficient. Finally, in region III, the threat of unshrouding changes the equilibrium outcome. There, the maximum feasible hidden charges are both not too low, $h > h^*(\lambda)$, as otherwise only high quality would be provided even without the threat of unshrouding, and not too high, $h \leq \overline{h}(\lambda)$, as otherwise unshrouding would not be profitable even for a disadvantaged high-quality firm. Importantly, the threat of unshrouding becomes only effective when the share of market-savvy consumers is sufficiently high, $\lambda > \hat{\lambda}$.

6 Welfare Analysis and Policy Implications

Turning now to potential policy implications, we have to take a stance on how we define (consumer) welfare. Our measure of consumer welfare is the difference $q_i - (p_i + h_i)$, irrespective of which decision rule a consumer followed when choosing between competing offers.[25]

We first discuss total welfare, the sum of firm profits and consumer welfare. When the same quality is offered by both firms, given that the (true) price paid is just a transfer, total welfare is either $w_{LL} = q_L - c_L$ or $w_{HH} = q_H - c_H$. When firms offer different qualities, total welfare is given by

$$w_{HL} = \frac{1-\lambda}{2}(q_L - c_L) + \frac{1-\lambda}{2}(q_H - c_H) + \lambda \left[\sigma_L(q_L - c_L) + \sigma_H(q_H - c_H)\right],$$

where the first two terms capture the welfare created by the sale to non-savvy consumers and the last term the expected welfare created by the sale to market-savvy consumers. From an ex-ante perspective, the expected total welfare equals

$$W = \gamma_1\gamma_2 w_{HH} + (1-\gamma_1)(1-\gamma_2)w_{LL} + \left[\gamma_1(1-\gamma_2) + \gamma_2(1-\gamma_1)\right] w_{HL}.$$

Recall that we focus on the case where (9) holds. Otherwise, only low quality would be offered in equilibrium, regardless of the choice of all other parameters. When (9) holds, total welfare would be highest when $\gamma_1 = \gamma_2 = 1$ or when, provided that $\gamma_i < 1$ for at least one firm i, $\sigma_L = 0$ and $\sigma_H = 1$. When there is no unshrouding, we can infer from Proposition 3 that welfare gradually increases

[25] For instance, when we interpret consumer choice in terms of salience, the same measure of consumer welfare applies irrespective of whether at the time of purchase price or quality was salient.

when stricter consumer protection policy and its enforcement reduce h. There is however an additional, potentially larger effect of consumer protection policy, given firms' potential to unshroud (cf. Proposition 5).

Corollary 1 *When consumer protection policy becomes sufficiently strict, so that h falls below $\overline{h}$, and when competition is sufficiently intense ($\lambda > \hat{\lambda}$), this leads to a discrete increase in welfare. This is because, due to high-quality firms' treat of unshrouding, only high quality will be offered in equilibrium. When $h > \max\{h^*, \overline{h}\}$, a marginal reduction of h through consumer protection policy has a marginal positive effect on welfare through two channels: It decreases the likelihood with which either firm inefficiently choose low quality in a symmetric mixed-strategy equilibrium, $1-\gamma$, and, in case different qualities are offered (as always applies in the pure-strategy equilibrium), it reduces the expected market share of low quality, σ_L.*

When we consider total welfare, its distribution between consumers and firms remains irrelevant. Naturally, consumer protection focuses instead on consumer welfare. As we noted in the Introduction, it is widely believed that the waterbed effect protects consumers when there is sufficient competition. This is however different in our model. Fiercer competition on headline prices may lead to inefficiencies that are, as we show, fully borne by consumers. Interestingly, we also find that with salient or relative thinking, the waterbed effect remains incomplete.

Consumer Welfare. We start with a benchmark and consider the case where (exogenously) both firms choose the same quality. Then, we know from (5) that their joint expected profits are $\Pi = (1-\lambda)\,(q-c+h)$; total welfare is $W = q-c$; and consequently consumer surplus is $S = \lambda(q-c) - (1-\lambda)h$. The derivative $\frac{dS}{dh} = -(1-\lambda)$ exposes the incompleteness of the waterbed effect, as long as not all consumers are market-savvy ($\lambda < 1$). Only when $\lambda \to 1$, with symmetric qualities, consumers are fully protected.

In what follows we focus on parameters for which heterogeneous qualities will arise in the market with positive probability (which, depending on whether unshrouding is possible, requires at least that $h > h^*$, where $h^* > \widetilde{h}$). Recall that in this case, there exists a symmetric mixed-strategy equilibrium in product choice and two asymmetric pure-strategy equilibria. As the mixed-strategy equilibrium is both composed of a subgame with symmetric qualities, to which the discussion of the (symmetric) benchmark applies, and one with heterogeneous qualities, to streamline the discussion we focus on the pure-strategy equilibrium with heterogeneous qualities. Expressing consumer welfare again as the difference between total welfare and firm profits, $S = w_{HL} - \pi_{HL} - \pi_{LH}$, using the respective profits in Lemma 1 it now holds that

$$\frac{dS}{dh} = \frac{dw_{HL}}{dh} - (1-\lambda) - \lambda\left(1 - \frac{q_L}{q_H}\right). \tag{15}$$

The right-hand side of expression (15) can be interpreted as follows. The first term captures the, as we know, negative effect of higher shrouded charges on efficiency (via an increase of σ_L, cf. Proposition 1), which is fully borne by consumers. This is also the effect on total welfare. The second and the third terms additionally capture the welfare transfer from consumers to firms as h increases: the limits to the waterbed effect. Here, the term $-(1-\lambda)$ arises analogously to the (benchmark) case with symmetric qualities. But now, the waterbed effect is further subdued by the final term. In particular, in the limit as $\lambda \to 1$, the waterbed effect is no longer equal to one, but converges to $\frac{q_L}{q_H} < 1$, so that in the limit a one dollar increase in shrouded charges is only passed through into a $\frac{q_L}{q_H} < 1$ dollar reduction in headline prices. The intuition follows immediately from consumers' choice criterion as follows. For this, suppose that the high-quality firm would choose a headline price of $c_H - h$, so that its margin becomes zero. Given consumers' choice criterion, to attract market-savvy consumers the low-quality firm needs to ensure that the ratio $\frac{p_L}{p_H}$ lies (just) below $\frac{q_L}{q_H}$ and thus that p_L lies (just) below $\frac{q_L}{q_H}(c_H - h)$. If now the high-quality firm reduced its headline price by one dollar, following the same increase in shrouded charges, to still capture the whole market when $\lambda \to 1$, the low-quality firm would thus need to lower its headline price by only $\frac{q_L}{q_H} < 1$.

We summarize our discussion of consumer welfare as follows.

Corollary 2 *Suppose that firms choose different qualities (requiring $h > h^*$). When now shrouded charges (further) increase, consumers bear the full burden of the reduced efficiency resulting from a shift towards low-quality products. In addition, the waterbed effect, which limits the direct transfer to firms, is strictly smaller than with symmetric qualities, and it remains incomplete even as $\lambda \to 1$.*

Imposing a limit on hidden charges thus protects consumers in two ways, both by shielding them from a direct price effect, as in our model the waterbed effect is never complete when there are heterogeneous qualities in the market, and by limiting the provision and purchase of inferior low-quality products, as the resulting inefficiency is fully borne by consumers. Relying on market forces alone is instead not sufficient, and, as already noted, without constraining hidden charges, the resulting excessive competition on headline prices can actually hurt consumers. This is particularly true for those who actively compare offers. In fact, while with standard preferences market-savvy consumers with a larger consideration set are always (weakly) better off, even from an ex-ante perspective they may be worse off under salient or relative thinking. To show this through an example, we consider the case where $\lambda \to 1$, as then expressions become more tractable. Around this limit, the parameter region where savvy consumers are worse off (than the average non-savvy consumer) is non-empty. In the proof of Observation 1 in the Appendix, we also derive explicitly the expected welfare for both types of consumers.

Observation 1 *With different qualities in the market, there is a parameter range of strictly positive measure so that market-savvy consumers are strictly worse off also from an ex-ante perspective than consumers with a smaller consideration set.*

When not anticipating their potentially erroneous decisions, market-savvy consumers will overestimate their expected surplus. For future work, it would seem interesting to explore this insight further when endogenizing consumers' decision to become informed about more offers in the market. We conjecture, for instance, that this may frequently lead to overinvestment into the associated activities such as shopping, paying attention to offers, or memorizing different offers. Policies that encourage such activities to "make the market work", e.g., by providing or sponsoring comparison websites, could then backfire.

7 Conclusion

Consumer protection policy and its enforcement aim at protecting consumers from unfair trading practices and thereby, notably, also from the imposition of hidden charges. This topic features prominently in the recent survey of Behavioral Industrial Organization in Heidhues and Kőszegi (2018). It is there rightly observed that the market provides a first layer of protection, as when competition is intense, this will result in lower headline prices through a waterbed effect. A core insight of the present analysis is however that such competition can be excessive and reduce both total and consumer welfare when consumers are prone to salient or relative thinking. As perceived (headline) prices thereby become artificially low, this makes quality differences relatively less important, distorting both the provision and competitive position of higher-quality products. Competition is thus not a substitute to consumer protection policy, but without adequate consumer protection, it can even exacerbate consumer detriment.

On the other hand, we show how competition can work when it generates sufficient incentives for high-quality firms to unshroud theirs as well as rivals' hidden charges so as to eliminate a competitive disadvantage. This effect is not direct, but it works through an increase in headline prices following a reduction of hidden charges (to zero), which renders quality differences relatively more important in the eyes of consumers. While in equilibrium such unshrouding would not be observed in our model, it disciplines firms' choice of qualities, but only when the extent to which charges can be maximally shrouded is sufficiently restricted by consumer protection policy. In this case, consumer protection policy and competition can jointly ensure that the market works efficiently.

The relevance of our model and its implications hinge crucially on the importance of the specific consumer decision bias that we harnessed for our analysis, i.e., that of salient or relative thinking. There is some empirical and experimental evidence that the relative importance of attributes changes with consumers' reference point, as derived from all observed offers in the market (cf. Hastings and Shapiro (2013); Dertwinkel-Kalt et al. (2017)). In the Introduction, we already noted that such a bias should also be more important when the experience of quality does not immediately derive from (physical) interaction with the product and when, e.g., through frequent promotions, consumers constantly need to reassess the relative positioning of offers. A similar reassessment may also be triggered when consumer protection policy or unshrouding lead to drastic changes in headline prices. Such a drastic increase in headline prices may also arise when firms can no longer secretly shift some costs towards consumers, such as those arising from the malfunctioning of a product. This all speaks in favor of a wider applicability of our model.

While some of the invoked assumptions are admittedly stark, one of our model's key benefits is its tractability, despite the endogenization of product and pricing choices as well as potential unshrouding. As we mentioned earlier, future work may also endogenize the size of consumers' consideration sets and thereby both the competitiveness of the market and the extent to which salient or relative thinking becomes effective. This would allow to assess policies that intend to encourage such shopping so as to "make the market work", which may however backfire in light of a biased consumer choice.

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Appendix: Proofs

Proof of Lemma 1. We first state more explicitly the characterization of the pricing equilibrium, as we will refer to this also in subsequent proofs:

Claim: *For $h \leq \widetilde{h}$: Firm H randomizes over $[\underline{p}_H, \overline{p}_H)$, where $\underline{p}_H = \frac{q_H}{q_L}[c_L - h + \frac{1-\lambda}{1+\lambda}(q_L - c_L + h)]$ and $\overline{p}_H = q_H$, according to the CDF*

$$F_H(p_H) = \frac{1+\lambda}{2\lambda} - \frac{1-\lambda}{2\lambda}\left(\frac{q_L - c_L + h}{p_H \frac{q_L}{q_H} - c_L + h}\right).$$

Firm L randomizes over $[\underline{p}_L, \overline{p}_L]$, where $\underline{p}_L = c_L - h + \frac{1-\lambda}{1+\lambda}(q_L - c_L + h)$ and $\overline{p}_L = q_L$, according to the CDF

$$F_L(p_L) = \frac{1+\lambda}{2\lambda} - \frac{\frac{1-\lambda}{2\lambda}(q_H - c_H + h) + [\frac{q_H}{q_L}(c_L - h) - (c_H - h)]}{p_L \frac{q_H}{q_L} - c_H + h} \text{ for } p_L < \overline{p}_L,$$

and with a mass point at $\overline{p}_L$ of size $m_L = \frac{\frac{q_H}{q_L}(c_L - h) - (c_H - h)}{q_H - c_H + h}$ (which is zero if $h = \widetilde{h}$).

For $h > \widetilde{h}$: Firm L randomizes over $[\underline{p}_L, \overline{p}_L)$, where $\underline{p}_L = \frac{q_L}{q_H}[c_H - h + \frac{1-\lambda}{1+\lambda}(q_H - c_H + h)]$ and $\overline{p}_L = q_L$, according to the CDF

$$F_L(p_L) = \frac{1+\lambda}{2\lambda} - \frac{1-\lambda}{2\lambda}\left(\frac{q_H - c_H + h}{p_L \frac{q_H}{q_L} - c_H + h}\right).$$

Firm H randomizes over $[\underline{p}_H, \overline{p}_H)$, where $\underline{p}_H = c_H - h + \frac{1-\lambda}{1+\lambda}(q_H - c_H + h)$ and $\overline{p}_H = q_H$, according to the CDF

$$F_H(p_H) = \frac{1+\lambda}{2\lambda} - \frac{\frac{1-\lambda}{2\lambda}(q_L - c_L + h) + [\frac{q_L}{q_H}(c_H - h) - (c_L - h)]}{p_H \frac{q_L}{q_H} - c_L + h} \text{ for } p_H < \overline{p}_H,$$

and with a mass point at $\overline{p}_H$ of size $m_H = \frac{\frac{q_L}{q_H}(c_H - h) - (c_L - h)}{q_L - c_L + h}$.

We prove this claim together with the respective expressions for profits. For this we treat separately the cases $h \leq \widetilde{h}$ (Case A) and $h > \widetilde{h}$ (Case B) in a series of assertions.

Case A: $h \leq \widetilde{h}$.
Assertion (i): Supports are convex and cannot contain mass points in the interior or at the lower boundary, while upper boundaries are given by q_i.
Proof of Assertion (i): This follows from standard arguments, see e.g. Varian (1980). **Q.E.D.**

Assertion (ii): $\pi_L = (q_L - c_L + h)\frac{1-\lambda}{2}$.
Proof of Assertion (ii): As this is what the firm can realize by choosing $p_L = q_L$, we only need to show that this is also an upper boundary. We argue to a contradiction and suppose that π_L was higher. Then, denoting L's upper support bound by $\overline{p}_L \leq q_L$, it must hold that L then attracts more consumers than $\frac{1-\lambda}{2}$, so that H must have positive probability mass at or above $\overline{p}_L \frac{q_H}{q_L} \leq q_H$, which further implies that $\pi_H \leq (q_H - c_H + h)\frac{1-\lambda}{2}$ (this is true in particular since it cannot be the case that both L has a mass point at $\overline{p}_L$ and H has a mass point at $\overline{p}_L \frac{q_H}{q_L}$). We now obtain a contradiction as H can realize strictly higher profits by choosing a price constructed as follows: Since $\pi_L > (q_L - c_L + h)\frac{1-\lambda}{2}$ by assumption, L's pricing is bounded below by p'_L that solves $(p_L - c_L + h)\frac{1+\lambda}{2} = \pi_L$, so that when H chooses $p'_L \frac{q_H}{q_L}$, from $h \leq \widetilde{h}$ profits indeed exceed $(q_H - c_H + h)\frac{1-\lambda}{2}$.
Q.E.D.

Assertion (iii): $\pi_H = \frac{1-\lambda}{2}(q_H - c_H + h) + \lambda \left[\frac{q_H}{q_L}(c_L - h) - (c_H - h)\right]$.
Proof of Assertion (iii): H can ensure at least this profit by pricing at L's lower boundary $\underline{p}_L$, which solves $(p_L - c_L + h)\frac{1+\lambda}{2} = \pi_L$ (using Assertion (ii)). Suppose next to the contrary that H's profits strictly exceeded π_H, from which (for the respective equilibrium) it must hold that $\underline{p}_H > \underline{p}_L \frac{q_H}{q_L}$. But then, by pricing at $\underline{p}_H \frac{q_L}{q_H}$, L could realize strictly more than π_L, as given in Assertion (ii). **Q.E.D.**

With Assertions (i)-(iii) at hands, the respective characterizations of F_i are now immediate from the indifference condition (4). Note finally that these CDFs are indeed well-behaved with $F_H(\underline{p}_H) = 0$ and $\lim_{p_H \to q_H} F_H(p_H) = 1$, whereas

$F_L(\underline{p}_L) = 0$ and $F_L(q_L) = \frac{q_L - c_L + h}{q_L - \frac{q_L}{q_H}(c_H - h)} \in (0, 1]$ due to $h \leq \widetilde{h}$.

Case B: $h > \widetilde{h}$.
Assertion (i): Supports are convex and cannot contain mass points in the interior or at the lower boundary, while upper boundaries are given by q_i.
Proof of Assertion (i): Again, this follows from standard arguments, see e.g. Varian (1980). **Q.E.D.**

Assertion (ii) and (iii): $\pi_H = (q_H - c_H + h)\frac{1-\lambda}{2}$ and $\pi_L = \frac{1-\lambda}{2}(q_L - c_L + h) + \lambda\left[\frac{q_L}{q_H}(c_H - h) - (c_L - h)\right]$.
Proof of Assertions (ii) and (iii): This is analogous to the proof of Assertions (ii) and (iii) in Case A above when swapping firm indices. **Q.E.D.**

With Assertions (i)-(iii) at hands, the respective characterizations of F_i are now immediate from the indifference condition (4). Note finally that these CDFs are indeed well behaved with $F_L(\underline{p}_L) = 0$ and $\lim_{p_L \to q_L} F_L(p_L) = 1$, whereas $F_H(\underline{p}_H) = 0$ and $F_H(q_H) = \frac{q_H - c_H + h}{q_H - \frac{q_H}{q_L}(c_L - h)} \in (0, 1)$ due to $h > \widetilde{h}$.

Having analyzed both Case A and B, this concludes the proof of Lemma 1. **Q.E.D.**

Proof of Proposition 1. There are again two cases, as in Lemma 1.

Case A: $h \leq \widetilde{h}$.
Assertion (i): Savvy consumers' probability of purchasing at L is given by

$$\sigma_L = \int_0^1 \frac{k}{1 + \frac{1+\lambda-2\lambda k}{1-\lambda}\left[\frac{c_L - h - \frac{q_L}{q_H}(c_H - h)}{q_L - c_L + h}\right]} dk.$$

Proof of Assertion (i): We first integrate over firms' price realizations in order to express firm L's probability of attracting savvy consumers, which yields

$$\sigma_L = \int_{\underline{p}_H}^{\overline{p}_H} F_L\Big(p_H \frac{q_L}{q_H}\Big) dF_H(p_H),$$

noting that $F_L\Big(p_H\frac{q_L}{q_H}\Big)$ is defined over the same support as $F_H(p_H)$. We now introduce the following substitution of variables: $k = F_H(p_H)$, so that

$$p_H(k) = F_H^{-1}(k) = \frac{q_H}{q_L}\left[\frac{q_L(1-\lambda)+2\lambda(1-k)(c_L-h)}{1+\lambda-2\lambda k}\right],$$

and suppressing the dependency $p_H(k)$, we can rewrite σ_L as

$$\sigma_L = \int_0^1 F_L\Big(p_H\frac{q_L}{q_H}\Big)dk. \tag{16}$$

Comparing $F_L\Big(p_H\frac{q_L}{q_H}\Big)$ with $F_H(p_H)$, we can furthermore rewrite $F_L\Big(p_H\frac{q_L}{q_H}\Big)$ as

$$F_L\Big(p_H\frac{q_L}{q_H}\Big) = F_H(p_H)\frac{\frac{q_L}{q_H}p_H - c_L + h}{\frac{q_L}{q_H}p_H - \frac{q_L}{q_H}(c_H-h)}.$$

Substituting now $p_H(k)$ yields, after various transformations,

$$F_L\Big(p_H\frac{q_L}{q_H}\Big) = \frac{k}{1+\frac{1+\lambda-2\lambda k}{1-\lambda}\left[\frac{c_L-h-\frac{q_L}{q_H}(c_H-h)}{q_L-c_L+h}\right]}.$$

Inserting this back into (16) yields σ_L as stated in the assertion. **Q.E.D.**

Assertion (ii): σ_L is strictly increasing in h.

Proof of Assertion (ii): Since $\frac{c_L-h-\frac{q_L}{q_H}(c_H-h)}{q_L-c_L+h}$ is strictly decreasing in h, as is easy to show, it follows that σ_L is strictly increasing in h. **Q.E.D.**

Assertion (iii): $\lim_{h\uparrow\widetilde{h}}\sigma_L = 1/2$.
Proof of Assertion (iii): This is obvious when noting that σ_L collapses to $\int_0^1 kdk$ for $h = \widetilde{h}$. **Q.E.D.**

Case B: $h > \widetilde{h}$.

Assertion (i): Savvy consumers' probability of purchasing at L is given by

$$\sigma_L = 1 - \int_0^1 \frac{k}{1 + \frac{1+\lambda-2\lambda k}{1-\lambda}\left[\frac{c_H - h - \frac{q_H}{q_L}(c_L - h)}{q_H - c_H + h}\right]} dk.$$

Proof of Assertion (i): We first integrate over firms' price realizations in order to express firm L's probability of attracting savvy consumers, which yields

$$\sigma_L = \int_{\underline{p}_L}^{\overline{p}_L} \left[1 - F_H\left(p_L \frac{q_H}{q_L}\right)\right] dF_L(p_L) = 1 - \int_{\underline{p}_L}^{\overline{p}_L} F_H\left(p_L \frac{q_H}{q_L}\right) dF_L(p_L),$$

noting that $F_H\left(p_L \frac{q_H}{q_L}\right)$ is defined over the same support as $F_L(p_L)$. We now introduce the following substitution of variables: $k = F_L(p_L)$, so that

$$p_L(k) = F_L^{-1}(k) = \frac{q_L}{q_H}\left[\frac{q_H(1-\lambda) + 2\lambda(1-k)(c_H - h)}{1 + \lambda - 2\lambda k}\right],$$

and, suppressing the dependency $p_L(k)$, we can rewrite σ_L as

$$\sigma_L = 1 - \int_0^1 F_H\left(p_L \frac{q_H}{q_L}\right) dk. \tag{17}$$

Comparing $F_H\left(p_L \frac{q_H}{q_L}\right)$ with $F_L(p_L)$, we can furthermore rewrite $F_H\left(p_L \frac{q_H}{q_L}\right)$ as

$$F_H\left(p_L \frac{q_H}{q_L}\right) = F_L(p_L) \frac{\frac{q_H}{q_L} p_L - c_H + h}{\frac{q_H}{q_L} p_L - \frac{q_H}{q_L}(c_L - h)}.$$

Substituting now $p_L(k)$ yields, after various transformations,

$$F_H\left(p_L \frac{q_H}{q_L}\right) = \frac{k}{1 + \frac{1+\lambda-2\lambda k}{1-\lambda}\left[\frac{c_H - h - \frac{q_H}{q_L}(c_L - h)}{q_H - c_H + h}\right]}.$$

Inserting this back into (17) yields σ_L as stated in the assertion. **Q.E.D.**

Assertion (ii): σ_L is strictly increasing in h.

Proof of Assertion (ii): Since $\frac{c_H - h - \frac{q_H}{q_L}(c_L - h)}{q_H - c_H + h}$ is strictly increasing in h, as is easy to show, it follows that σ_L is strictly increasing in h. **Q.E.D.**

Assertion (iii): $\lim_{h \downarrow \widetilde{h}} \sigma_L = 1/2$.
Proof of Assertion (iii): This is obvious when noting that σ_L collapses to $1 - \int_0^1 kdk$ for $h = \widetilde{h}$. **Q.E.D.**

Having analyzed both Case A and B, this concludes the proof of Proposition 1. **Q.E.D.**

Proof of Proposition 2. We consider various cases, depending on whether (9) holds as well as on the size of h.

(i) If $q_L - c_L \geq q_H - c_H$ (the converse of (9) holds), this implies $\frac{q_L}{c_L} > \frac{q_H}{c_H}$ and thus $\widetilde{h} < 0 \leq h$, so that from Lemma 1 $\pi_{H,L} = \pi_{H,H} = (q_H - c_H + h)\frac{1-\lambda}{2}$, $\pi_{L,H} = (q_L - c_L + h)\frac{1-\lambda}{2} + \lambda\left[\frac{q_L}{q_H}(c_H - h) - (c_L - h)\right]$, and $\pi_{L,L} = (q_L - c_L + h)\frac{1-\lambda}{2}$. Direct comparison reveals that (q_L, q_L) constitutes an equilibrium in product choice, as $\pi_{L,L} \geq \pi_{H,L}$, and that, unless $q_L - c_L = q_H - c_H$, no other equilibrium exists, as a firm with q_H would strictly prefer to deviate, regardless of its rival's choice. When $q_L - c_L = q_H - c_H$, also an asymmetric equilibrium exists where one firm chooses q_L and the other q_H.

(ii) If (9) holds and $h \leq \widetilde{h}$, we have from Lemma 1 that $\pi_{L,H} = (q_L - c_L + h)\frac{1-\lambda}{2}$, $\pi_{H,L} = (q_H - c_H + h)\frac{1-\lambda}{2} + \lambda\left[\frac{q_H}{q_L}(c_L - h) - (c_H - h)\right] \geq (q_H - c_H + h)\frac{1-\lambda}{2} > \pi_{L,H}$, $\pi_{L,L} = (q_L - c_L + h)\frac{1-\lambda}{2}$, and $\pi_{H,H} = (q_H - c_H + h)\frac{1-\lambda}{2} > \pi_{L,L}$. Direct comparison reveals that (q_H, q_H) constitutes an equilibrium in product choice, as deviating to q_L is strictly inferior, and that no other equilibrium exists, as a firm with q_L would strictly prefer to deviate, regardless of its rival's choice.

(iii) If (9) holds and $h > \widetilde{h}$, we have from Lemma 1 that $\pi_{L,H} = (q_L - c_L + h)\frac{1-\lambda}{2} + \lambda\left[\frac{q_L}{q_H}(c_H - h) - (c_L - h)\right]$, $\pi_{H,L} = (q_H - c_H + h)\frac{1-\lambda}{2}$, $\pi_{H,H} = (q_H - c_H + h)\frac{1-\lambda}{2}$, and $\pi_{L,L} = (q_L - c_L + h)\frac{1-\lambda}{2}$. We have that $\pi_{H,H} \geq \pi_{L,H}$ holds if and only if $h \leq h^*$, where $h^* > \widetilde{h}$, so that for $h \leq h^*$, (q_H, q_H) constitutes an equilibrium.

It is also the unique equilibrium for $h < h^*$, as it holds that $\pi_{L,L} < \pi_{H,L}$, and $\pi_{L,H} < \pi_{H,H}$ for $h < h^*$. Next, for $h > h^*$, no high-quality equilibrium exists and also no low-quality equilibrium, since $\pi_{L,L} < \pi_{H,L}$. A symmetric equilibrium must therefore be in mixed strategies. The characterization of $\gamma \in (0,1)$ then follows from the equal-expected-profit condition $\gamma\pi_{H,H} + (1-\gamma)\pi_{H,L} = \gamma\pi_{L,H} + (1-\gamma)\pi_{L,L}$, which gives $\gamma = \frac{\pi_{H,H}-\pi_{L,L}}{\pi_{L,H}-\pi_{L,L}}$ and thereby (12) after substitution. The asymmetric equilibria exist for $h \geq h^*$ since then $\pi_{L,H} \geq \pi_{H,H}$, and $\pi_{H,L} < \pi_{L,L}$. **Q.E.D.**

Proof of Proposition 4. We now solve for stage $t = 0.5$, given firms' choices of qualities. Since the statement for homogeneous qualities is obvious, we turn directly to heterogeneous qualities. We distinguish between the following cases:

(i) Condition (9) does not hold. As then from $\widetilde{h} < 0$ it holds that $h > \widetilde{h}$ for all $h \geq 0$, firm H's profit under shrouding is always given by $\pi_H^S = \frac{1-\lambda}{2}(q_H - c_H + h)$, while after unshrouding it is always given by $\pi_H^U = \frac{1-\lambda}{2}(q_H - c_H) < \pi_H^S$. Firm L's profit under shrouding is always given by $\pi_L^S = \frac{1-\lambda}{2}(q_L - c_L + h) + \lambda\left[\frac{q_L}{q_H}(c_H - h) - (c_L - h)\right]$, while under unshrouding it is always given by $\pi_L^U = \frac{1-\lambda}{2}(q_L - c_L) + \lambda\left[\frac{q_L}{q_H}c_H - c_H\right] < \pi_L^S$. Hence, no firm unshrouds.

(ii) Condition (9) holds and $\widetilde{h} \leq 0$. Again this implies $h \geq \widetilde{h}$ for all $h \geq 0$, so that the results from (i) apply as well.

(iii) Condition (9) holds, $\widetilde{h} > 0$ (i.e., $\frac{q_H}{c_H} > \frac{q_L}{c_L}$), and $h \leq \widetilde{h}$. While it is again immediate that firm L does not unshroud, now firm H's profit with shrouding is $\pi_H^S = \frac{1-\lambda}{2}(q_H - c_H + h) + \lambda\left[\frac{q_H}{q_L}(c_L - h) - (c_H - h)\right]$, while after unshrouding it is $\pi_H^U = \frac{1-\lambda}{2}(q_H - c_H) + \lambda\left[\frac{q_H}{q_L}c_L - c_H\right]$. Comparison reveals that H finds it optimal to unshroud if $\frac{1-\lambda}{2\lambda} \leq \frac{q_H - q_L}{q_L}$, which holds if and only if $\lambda \geq \frac{q_L}{2q_H - q_L} = \underline{\lambda}$.

(iv) Condition (9) holds, $\widetilde{h} > 0$, and $h > \widetilde{h}$. Focusing again on firm H, we have $\pi_H^S = \frac{1-\lambda}{2}(q_H - c_H + h)$ and $\pi_H^U = \frac{1-\lambda}{2}(q_H - c_H) + \lambda\left[\frac{q_H}{q_L}c_L - c_H\right]$, so that firm H finds it optimal to unshroud if and only if $h \leq \frac{2\lambda}{1-\lambda}\left(\frac{q_H c_L - c_H q_L}{q_L}\right) = \overline{h}$.

We now sum up the different cases. We have that only H has an incentive to unshroud and that this is the case only in (iii) and (iv). What is then required, next to $\widetilde{h} > 0$, is that either $h \leq \widetilde{h}$ and $\lambda \geq \underline{\lambda}$, or $h \in (\widetilde{h}, \overline{h}]$, where the latter is only possible (as then $\overline{h} > \widetilde{h}$) if $\lambda > \underline{\lambda}$. **Q.E.D.**

Proof of Proposition 5. Proposition 4 shows that unshrouding occurs (by firm H) only with heterogeneous qualities and when, next to $\widetilde{h} > 0$, $\lambda \geq \underline{\lambda}$ and $h \leq \overline{h}(\lambda)$. When it occurs in this case, the low-quality firm is strictly worse off than if it had chosen high quality instead, so that then q_H is chosen by both firms. This represents a change in the equilibrium outcome, compared to when shrouding is not feasible, only when $h \in (h^*(\lambda), \overline{h}(\lambda)]$ (where instead of an asymmetric or mixed-strategy equilibrium in product choice the possibility of shrouding leads to the deterministic choice of q_H). Since $h^*(\lambda)$ is continuous and strictly decreasing, $\overline{h}(\lambda)$ is continuous and strictly increasing (given $\widetilde{h} > 0$, as assumed) and $\overline{h}(\underline{\lambda}) = h^*(1) = \widetilde{h}$, it follows that there must be a unique $\hat{\lambda} \in (\underline{\lambda}, 1)$ satisfying $h^*(\hat{\lambda}) = \overline{h}(\hat{\lambda})$, such that $\overline{h}(\lambda) > h^*(\lambda)$ if and only if $\lambda > \hat{\lambda}$. Hence, unshrouding may only affect the equilibrium outcome if $\lambda > \hat{\lambda} \in (\underline{\lambda}, 1)$. **Q.E.D.**

Proof of Corollary 2. It remains to derive that, when the expected price paid by consumers is $E[p]$, $\lim_{\lambda \to 1} \frac{dE[p]}{dh} = -\frac{q_L}{q_H}$ in the subgame with different qualities. It is first straightforward to check that firm L prices at $\frac{q_L}{q_H}(c_H - h)$ deterministically in the limit as $\lambda \to 1$, so that from continuity it follows that $\lim_{\lambda \to 1} E[p_L] = \frac{q_L}{q_H}(c_H - h)$. Note finally that we can focus on firm L as in the limit savvy consumers purchase at firm L with probability one and as then there are only savvy consumers. **Q.E.D.**

Proof of Observation 1. In what follows, denote an individual savvy (non-savvy) consumer's expected surplus by ω_S (ω_{NS}). Recall that we consider first the limit $\lambda \to 1$ in a subgame where firms offer different qualities. Since savvy consumers purchase at firm L with probability 1 and in the limit firm L deterministically charges $p_L = \frac{q_L}{q_H}(c_H - h)$, it follows that $\omega_S = q_L - \frac{q_L}{q_H}(c_H - h) - h$.

On the other hand, using that

$$\omega_{NS} = \frac{1}{2}\left[\int_{\underline{p}_L}^{q_L} F_L(p_L)dp_L + \int_{\underline{p}_H}^{q_H} F_H(p_H)dp_H\right] - h,$$

it is easily confirmed in the limit that

$$\begin{aligned}\omega_{NS} = &\frac{1}{2}\left\{q_L - \frac{q_L}{q_H}(c_H - h)\right\} + \\ &\frac{1}{2}\left\{\left(q_H - c_H + h\right) - \left[c_H - h - \frac{q_H}{q_L}(c_L - h)\right]\log\left(\frac{q_H - \frac{q_H}{q_L}(c_L - h)}{c_H - h - \frac{q_H}{q_L}(c_L - h)}\right)\right\} - h\end{aligned}$$

and that $\omega_{NS} > \omega_S$ holds if

$$(q_H - c_H + h) - \frac{q_L}{q_H}[q_H - c_H + h] > \left[c_H - h - \frac{q_H}{q_L}(c_L - h)\right]\log\left(\frac{q_H - \frac{q_H}{q_L}(c_L - h)}{c_H - h - \frac{q_H}{q_L}(c_L - h)}\right).$$

Note that the LHS of the above inequality is strictly positive and independent of c_L. At the same time, one can check that the limit of the RHS as c_L tends to $h + \frac{q_L}{q_H}(c_H - h)$ (the highest value of c_L that is compatible with $h > \widetilde{h}$) is zero. Hence, by continuity, if both λ is sufficiently close to 1 and c_L is sufficiently large, it follows that $\omega_{NS} > \omega_S$. **Q.E.D.**