B Web Appendix: No Price Advertising

We next consider a setup in which the monopolist is not required to advertise price information. We focus on the most critical case for equilibrium existence—the case in which the monopolist discloses full match value but no price information—and show that, due to consumer loss aversion, the monopolist always has an incentive to deviate from consumers' expected price. To formalize this argument, the next lemma shows that, in this case, firm's demand is not price sensitive around consumer's expected price p'.

Lemma 5. *Suppose consumers observe their match value ex ante but observe prices only ex post. If consumers expect $p' \geq 0$ to be the equilibrium price, then, $\forall p, p \geq 0$, firm's demand function is equal to*

$$D(p|p') = \begin{cases} 1 - F(\max\{\min\{\frac{\lambda+1}{2}p, b\}, a\}), & \text{if } p < \frac{2}{\lambda+1}p'; \\ 1 - F(\max\{\min\{p', b\}, a\}), & \text{if } p \in [\frac{2}{\lambda+1}p', \frac{2\lambda}{\lambda+1}p']; \\ 1 - F(\max\{\min\{p - \frac{\lambda-1}{\lambda+1}p', b\}, a\}), & \text{if } p > \frac{2\lambda}{\lambda+1}p'. \end{cases}$$

The proof of the lemma is provided below. Note that firm's demand has slope zero for $p \in [2/(\lambda+1)p', 2\lambda/(\lambda+1)p']$ which means that deviating from consumers' expected price p' to a higher price p up to $2\lambda/(\lambda+1)p'$ is profitable for the firm if $1-F(\max\{\min\{p', b\}, a\})$ is positive, since such a deviation increases firm's markup without reducing its demand. On the other hand, if consumers expect a very high price such that $1 - F(\max\{\min\{p', b\}, a\})$ is zero, then the firm always prefers to set a low price level (below $2/(\lambda + 1)b$) which yields positive demand (and markup). Thus, there cannot exist an equilibrium in which the firm advertises only full match value information but no price information. This result suggests that, although consumers are willing to buy the good at a higher price ex post, the firm cannot exploit this in equilibrium. This means that our equilibrium concept selects equilibria in which producers do not engage in short–term deception. Hence, the game we consider in this paper can be interpreted as a static reduced form of a dynamic game with brand reputation (compare Heidhues and Kőszegi (2010) who use a similar interpretation). In Section 5.1, we present assumptions which ensure existence even if the monopolist is not required to disclose price information.

Proof of Lemma 5. Let p' be the price expected by consumers. So all consumers with $r \geq p'$ anticipate that they will buy the product ($H(p'|p') = 1$, $G(r|r \geq p', p') = 1$), while other consumers with $r < p'$ will not.

1. Suppose the firm deviates to $p > p'$. Consider first a consumer with $r \geq p'$. If she chooses to buy, her indirect utility will be

$$u(r, p, 1) = r - p - \lambda(p - p'),$$

whereas her indirect utility of not buying ex post equals

$$u(r, p, 0) = 0 + p' - \lambda r.$$

Then,

$$u(r, p, 1) - u(r, p, 0) \geq 0 \Leftrightarrow r \geq p - \frac{\lambda - 1}{\lambda + 1} p'.$$

If p is close to p' such that $p - \frac{\lambda-1}{\lambda+1} p' \Leftrightarrow p < \frac{2\lambda}{\lambda+1} p'$, then all such consumers will buy; while if p is relatively high such that the opposite condition holds, then some consumers will be induced to leave the market without buying the product and only those with $r \geq p - \frac{\lambda-1}{\lambda+1} p'$ will buy.

Next consider a consumer with $r < p'$. If she chooses to buy, her indirect utility will be

$$u(r, p, 1) = r - p - \lambda p - r,$$

while her indirect utility of not buying ex post equals

$$u(r, p, 0) = 0.$$

As $u(r, p, 1) < 0$ no such consumer will buy.

2. Suppose now the firm deviates to a price $p < p'$. Consider first a consumer with $r \geq p'$. If she chooses to buy, her indirect utility will be

$$u(r, p, 1) = r - p + (p' - p) > 0,$$

whereas her indirect utility of not buying ex post equals

$$u(r, p, 0) = p' - \lambda r < 0.$$

Thus, all such consumers will buy.

Consider now a consumer with $r < p'$. If she chooses to buy, her utility will be

$$u(r, p, 1) = r - p - \lambda p + r > 0,$$

while her indirect utility of not buying ex post is equal to

$$u(r, p, 0) = 0.$$

Then,

$$u(r, p, 1) - u(r, p, 0) \geq 0 \Leftrightarrow r \geq \frac{\lambda + 1}{2} p.$$

So, if p is close to p' such that $\frac{\lambda+1}{2} p \geq p'$, then no such consumers will buy; while if p is low enough such that the opposite condition holds, then those consumers with $r \in [\frac{\lambda+1}{2} p, p')$ will be induced to reverse their initial decisions and buy. the good.

Combining the demand of part one and two leads to the demand in the lemma. □

Advertising Content when Consumers are Loss Averse*

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Abstract

In a theoretical model with non–standard preferences, we show that informative advertising can have a persuasive effect, in line with empirical evidence. We examine the product match advertising strategies of a single–product monopolist when consumers are expectation–based loss averse à la Kőszegi and Rabin (2006). Consumers are initially uncertain about their individual match value from the product but observe the price set by the monopolist. They receive the monopolist's advertising signal before forming their reference point about the outcome of their purchase decision. The advertising signal reveals hard information about consumers' match value or no information at all. Before making their purchase decision, consumers become fully informed (independently of the content of the advertising signal). With standard consumers, the advertising signal is redundant, while, with loss–averse consumers, it shifts consumers' reference point. We show that the monopolist can increase loss–averse consumers' willingness to pay above their intrinsic valuation (attachment effect) by either engaging in partial (but not full) match value disclosure or by setting a low price without match value disclosure.

Keywords: Advertising, Loss Aversion, Information Disclosure

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1 Introduction

The empirical literature on advertising provides strong evidence for the existence of the persuasive effect of advertising.[1] Bagwell (2007) refers to the persuasive effect of advertising as “altering consumers’ tastes and creating spurious product differentiation and brand loyalty”. Anand and Shachar (2011) find empirically that informative advertising (about consumers’ match with a product) has a persuasive effect as well. Our paper explains this fact by a theoretical model based on purely informative advertising and non–standard preferences with fixed, intrinsic product valuation.

With loss–averse consumers, partial information disclosure increases consumers’ willingness to pay. Advertising content which is directly informative thus plays a novel role when consumers face non–standard preferences: it has an indirect, persuasive effect. To the best of our knowledge, this is the first advertising paper which examines this point.[2] Our framework also suggests that the persuasive effect is non–monotonic (inversely U–shaped) in the information content of advertising. A direct implication of this result is that advertising firms have an incentive to maintain some residual uncertainty about their new products. This prediction is supported by the content analysis in the marketing literature (following Resnik and Stern, 1977), which provides empirical evidence that—for many product categories such as cars, furniture, and electronics—the informative content of advertisements is positive but partial.[3]

Following recent experimental evidence by Ericson and Fuster (forthcoming), we assume that the endowment effect of possessing a good[4] is expectation based and reference dependent. In our setup, this implies that loss–averse consumers face an anticipated endowment effect when thinking about the purchase of a new product. Referring to the loss aversion theory of Kőszegi and Rabin (2006) we denote this effect the *attachment effect*: the more likely the purchase of a product appears to a consumer ex ante, the more attached to buying it she will be ex post. This implies that an attached consumer might accept buying at

[1] For instance, see Erdem and Keane (1996), Ackerberg (2001), Ackerberg (2003) and Anand and Shachar (2011).

[2] Analyzing duopolistic competition when consumers are loss averse, Karle and Peitz (2011) discover the link between consumer information and loss aversion. In their setup, firms can either disclose full information or no information at all. The authors show that disclosing full information makes loss–averse consumers behave like standard consumers which can be optimal if price competition with loss-averse consumers is fiercer than with standard consumers (e.g., in strongly asymmetric markets).

[3] For a more detailed discussion, see Abernethy and Franke (1996) in the literature review in Section 6.3.

[4] The endowment effect describes that people place a higher value on objects they own than on objects that they do not own. E.g., see Knetsch (1989).

a purchase price which exceeds her intrinsic valuation.[5] In this paper, we argue that, by increasing the probability of buying a good for some consumers, informative advertising creates consumer attachment.

In the marketing literature, Ariely (2009) introduced the concept of *virtual ownership* which suggests that disclosing certain product attributes to consumers induces a perception of ownership for a good even before purchase takes place. This in turn increases the product valuation of potential buyers similar to an endowment effect of possessing a good. As examples, Ariely mentions TV advertisements for cars or furniture catalogues. In our model, we explain this concept by the *attachment effect* and, in addition, suggest that keeping some residual uncertainty about consumers' product valuation increases high–type consumers' willingness to pay by the largest amount (this can be referred to as "keeping consumers excited").

Our setup builds on the monopoly advertising model of Anderson and Renault (2006) but focusses on consumers who are expectation-based loss averse in the product valuation and the price dimension based on Kőszegi and Rabin (2006, 2007) and Heidhues and Kőszegi (2008, 2010). Consumers are initially uncertain about their individual match value (horizontal valuation of the good) but observe the price set by the monopolist. Consumers receive an advertising signal from the monopolist before forming their reference point distributions with respect to their purchase decision. By potentially disclosing product characteristics, the advertising signal reveals full or partial match value information or no information at all. Before making their purchase decision, consumers become fully informed in any case (inspection good; see Hirshleifer, 1973).[6] Advertising signals are then redundant for consumers not exhibiting loss aversion, while, for loss–averse consumers, they matter because they influence consumers' reference point. We show that, with loss–averse consumers, the monopolist wants to disclose partial match value information to consumers ex ante even when costs of advertising would be positive. If transmitting partial information is not feasible, then the monopolist prefers no information disclosure to full information disclosure but wants to set a particularly low price. This leads to a

[5]In a simple exchange experiment, Ericson and Fuster (forthcoming) find that participants are willing to pay 20 – 30 percent more for an object if they had expected to be able to get it with 80 – 90% probability rather than 10 – 20% probability. In a similar experiment, however, Smith (2008) does not find the same effect.

[6]To make our main point as clear as possible, we implicitly abstract from consumers' search costs here. This is equivalent to considering a setup with purchase under residual uncertainty but with free return policy (e.g. consider experience goods with respect to a horizontal component). We will relax this assumption later in the paper and show that our results are robust to positive search costs if those do not exceed certain limits. Beyond those limits, the monopolist would also have an informative motive to disclose product information (attracting consumers to visit) but the persuasive motive would still have an impact.

positive level of consumer attachment which overcompensates the monopolist for setting a low price. However, the maximum level of consumer attachment is only reached by partial information disclosure.

Advertising signals in our setup provide hard information about consumers' valuation (see, e.g., Taylor (2011) and Chakraborty and Harbaugh (2010) for work on informative advertising and consumer persuasion based on cheap talk messages). We assume that the monopolist cannot discriminate advertising signals or prices between consumers. Furthermore, it is not required that the monopolist holds any information about consumers' valuation except for their prior distribution—i.e, the advertising signal reveals information about consumers' valuation anonymously (cf. Anderson and Renault (2006) who use the same approach).

In our model, we find that, if products are sufficiently complex,[7] it is optimal for the monopolist to disclose to consumers solely whether their intrinsic valuation lies above or below a certain threshold level which is lower than the purchase price.[8] We show that this form of partial match value advertising attaches consumers to a maximum level. This means that, for a given price, the set of buyers is maximized and any buyer expects to buy the product with probability one. The optimal advertising strategy leads to maximal prices set by the monopolist and to maximal overpay of the marginal consumer. The intuition for the effectiveness of threshold advertising is as follows: loss aversion in the price dimension decreases consumer attachment, while loss aversion in the match value dimension increases it. So the firm wants to achieve maximum match value uncertainty above some threshold but minimum uncertainty in payment. The monopolist implements threshold match advertising by disclosing an intermediate amount of product features to consumers such that high–valuation consumers learn that their valuation is at least as high as the threshold but without fully observing their true valuation. At the same time, consumers with lower valuation learn that they won't buy the product ex post. For instance, consider TV spots for cars or product introduction campaigns for electronic devices like the iPad of Apple.

[7] We denote products as being complex when threshold information can be transmitted.

[8] Threshold match value advertising was introduced by Anderson and Renault (2006). Threshold information can be released by the monopolist by disclosing a certain number of product attributes when not any potential product contains any attribute and not any consumer type values any attribute. A requirement for this to be feasible is a sufficiently high total number of product attributes (i.e., products have to be complex enough). An alternative, sufficient condition for undertaking threshold match advertising is perfect sequencing of product attributes by consumers which requires that each consumer orders all product attributes from "most preferred" to "least preferred" in the same way. Then, releasing product attributes starting with the "most preferred" ones leads to threshold information above the threshold and full information below it. It can be shown that this is sufficient to attain the main results of this paper.

If partial information disclosure is not feasible—due to low product complexity—the monopolist finds it optimal to disclose no match value information at all but to set low prices. Since prices are observable to consumers, we refer to this strategy as "low price advertising". Here, ex–ante uninformed consumers become partially attached by a low price offer, since low prices increase their initial probability of buying the product ex post (e.g. see last–minute travel offers). Full match value advertising is the least preferred mode of advertising with loss–averse consumers (at zero production cost), since it creates zero consumer attachment at the initial stage when consumers form expectations.

Due to consumer attachment, loss–averse consumers might accept higher prices or buy more often under partial or no match value advertising with low prices than under full match advertising (in which case they act like standard consumers). So, under partial or no match value advertising with low prices, loss–averse consumers are in expectation worse off than under full match advertising and the monopolist receives a higher profit. Optimal consumer protection policy should therefore highlight the importance of full information disclosure (transparency policies) in advertising or of self—contained information acquisition by consumers after having had exposure to advertisements but in advance of actual purchase decisions which could reduce the level of consumer attachment.

In a different application, Heidhues and Kőszegi (2010) examine a monopolist's optimal pricing strategy when loss–averse consumers decide upon buying one unit of a product with known, common valuation (e.g. consider groceries) or not. The authors show that the monopolist who is able to commit ex ante to a price distribution can create consumer attachment by infrequently offering variable sales prices for which "not buying the good" is not credible for consumers. By doing so, consumers' reference point is shifted in favor of "buying the good" such that buying at the higher regular price also becomes more attractive. This can be exploited by the monopolist by setting a regular price above consumers' intrinsic valuation. In our setup, prices are uniform but the monopolist uses informative advertising which (partially) reveals consumers' heterogeneous product valuation to shift consumers' reference points in the most profitable way; in particular, the monopolist aims at optimally shifting consumers' implied cutoff match value between buying and not buying which reflects consumers' willingness to pay for a given price.

A large part of the economic literature on advertising focusses on the role of advertising in shifting the (inverse) demand curve outward: such as directly persuasive advertising, advertising as a signalling device for product quality, or advertising as a means to inform consumers about product existence (see Bagwell (2007), for a survey on the economics of advertising). In this paper, we draw attention to the informative content of advertising which reveals horizontal product information to consumers who are already aware of the product's existence. This form of advertising rotates the inverse demand curve clockwise instead of shifting it (see (Johnson and Myatt, 2006)). Due to revelation of product information, consumers learn about their intrinsic valuation (match value) of one unit of the product. Johnson and Myatt (2006) (in line with (Lewis and Sappington, 1994)) find that a monopolist undertaking informative advertising prefers one of two extremes: either no information disclosure if consumers' taste heterogeneity and marginal costs are small (as in the case of mass products) or perfect information disclosure if consumers' taste heterogeneity and marginal costs are sufficiently large (as in the case of niche products). In contrast to their result, in this paper we argue that, with loss–averse consumers, the optimal level of information disclosure is always partial (even when information disclosure is costless). This resembles a simultaneous outward shift and clockwise rotation of the inverse demand curve up to the optimal level of information content and a move backward thereafter. If the degree of loss aversion becomes negligible, the demand function will be independent of the information content of advertising since we consider inspection goods. The monopolist therefore will be indifferent between full, partial and no information disclosure.

The paper closest to ours is that of Anderson and Renault (2006). In an advertising model with standard consumers, they also find that partial information disclosure can be optimal if consumers are discouraged from learning their intrinsic product valuation for an inspection good, for instance through high search or transportation costs. In contrast to their result, we find that disclosing partial information about products is optimal even if search costs do not affect consumers' purchase decision. The reason for this result is that our model incorporates the additional, persuasive effect of informative advertising. Therefore, we can also explain the empirical evidence that the informative and the persuasive effect of advertising coexist which their model cannot. Our policy implications also differ from theirs: while, in our model, transparency policies reduce prices and increase consumer surplus, those policies reduce sales volume and hurt firms and consumers in their model.

Next we present a simple example that illustrates how informative advertising attaches loss–averse consumers. In Section 3, we introduce our baseline advertising model which we apply to analyze the monopolist's optimal advertising strategies in Section 4. In Section 5, we analyze extensions of our baseline model to the case when the monopolist can choose whether to advertise the price or not and to the case of positive search costs. We discuss the use of more general marketing tools and consumer unawareness of their non–standard preferences in Section 6. We also compare our results to those of the classical advertising literature and the literature on consumer loss aversion. Finally, we indicate welfare implications and conclude in Section 7.

2 Illustrative Example

In this section we present a short example with simplified consumer behavior which illustrates the impact of different modes of informative advertising when consumers are expectation–based loss averse. It is shown that increasing the ex–ante probability of buying (but leaving some residual uncertainty) leads to consumer attachment when consumers are loss averse. Both, no match value disclosure with a low price offer and threshold match advertising can increase the ex–ante probability of buying and lead to attachment but the latter seems to dominate the former.

Suppose that a monopolist sells one unit of a single product to a loss–averse consumer. The consumer is initially uncertain about her horizontal valuation (match value) of the product. Her prior distribution of her match value is uniformly distributed on $\{0, 1, ..., 8, 9\}$. At stage 0, the monopolist sets a uniform price p which is observed by the consumer and sends an advertising signal to the consumer which might contain full, partial or no match value information. After receiving the monopolist's advertising signal, the consumer updates her beliefs about her expected match value and forms her reference point distribution in the price and the match value dimension with respect to her purchase decision ex post. The consumer will make her purchase decision after she inspected the product and became fully informed about her match value. For her purchase decision, the consumer compares her realized match value r and price p with all alternative outcomes under her reference point distribution. We assume that the consumer will learn ex post that her match value is equal to $r = 3$.[9] Consumer's degree of loss aversion is $\lambda = 3.5$. In the following, we will consider full, partial and no match value disclosure.

1.) If the monopolist reveals full match value information and sets a price of $p = 4.01$,[10] then the consumer becomes fully informed at the reference–point–formation stage. She simply buys the product if $r \geq p$ (standard purchase decision). This means that the consumer does not buy since $r = 3 < 4.01 = p$.

2.) If the monopolist discloses no match value information and sets a price of $p = 3.5$, the loss–averse consumer expects a cutoff match value between buying and not buying of

[9] The monopolist does not observe consumer's match value.

[10] A price of $p > 4$ but $p \leq 5$ ensures that the ex–ante probability of buying with no match value disclosure is equal to $1/2$.

$\hat{r}(p) = 4$.[11] She plans to buy with a probability of 60% and not to buy with a probability of 40%.[12] The probability of buying reflects also the probability of paying the price p and the probability of not buying the probability of paying zero. With respect to her match value level ex post, she expects zero with the probability of not buying and an integer value of 4 up to 9 with a probability of 10% respectively. After the consumer learnt her intrinsic match value ex post, her indirect utility function from buying can be expressed as

$$u(r, p, 1|\hat{r}(p)) = \underbrace{(r-p)}_{\text{intrinsic u.}} - \underbrace{\lambda(p-0)\cdot 2/5}_{\text{loss in price}} - \underbrace{\lambda \cdot \sum_{s=4}^{9}(s-r)\cdot 1/10}_{\text{loss in match value}} + \underbrace{(r-0)\cdot 2/5}_{\text{gain in match value}},$$

where $p = 3.5$ and $r = 3$. The consumer derives intrinsic utility from buying the good as well as gain–loss utility in the price and in the match value dimension. In the price dimension, she faces a loss when buying the good since, alternatively, she could have paid zero with a probability of 40%. In the match value dimension, she experiences a loss when buying the good because she does not receive a match value equal to or higher than $\hat{r} = 4$ and a gain since she receives no match value of zero. Her indirect utility function from not buying equals

$$u(r, p, 0|\hat{r}(p)) = \underbrace{0}_{\text{intrinsic u.}} + \underbrace{(p-0)\cdot 3/5}_{\text{gain in price}} - \underbrace{\lambda \cdot \sum_{s=4}^{9}(s-0)\cdot 1/10}_{\text{loss in match value}}.$$

The consumer faces a gain in the price dimension when not buying because ex ante she expected to pay p with a probability of 60% and a loss in the match value dimension because she receives no match value no lower than $\hat{r} = 4$. Her net utility from buying relatively to not buying ($\Delta u = u_1 - u_0$) can be simplified to

$$\Delta u = r \cdot \Big(2 + (\lambda - 1)\cdot 3/5\Big) - p \cdot \Big(2 + (\lambda - 1)\cdot 2/5\Big),$$

which, with $r = 3$ and $p = 3.5$, is positive for $\lambda \geq 3.5$. This means that, in our example, the consumer at $r = 3$ will be attached to buying the good at a price of $p = 3.5$ by no match value disclosure but a low price offer by the monopolist. This is due to the fact

[11] In this example, we assume that consumers form rational expectations but do not anticipate their future attachment. This means that consumers are naive with respect to their positive degree of loss aversion and do not anticipate potential shifts of their cutoff match value due to attachment. We do not solve for consumers' personal equilibrium in this setting. So, in this example, we underestimate the attachment effect of loss aversion.

[12] For a price of $p = 4.01$, she expected to buy with a probability of 50%.

that a low price offer increases consumer's ex–ante probability of buying from 1/2 to 3/5 which increases consumer's net loss in the match value dimension and simultaneously decreases her net loss in the price dimension. Both of these effects are in favor of buying the good. Her actual cutoff match value $\hat{r}$ is equal to 3 (instead of being equal to 4).[13] Note that, at a price of 4.01, the consumer would prefer not to buy the product when no match value is disclosed.

3.) If the monopolist reveals threshold match information with threshold $t = 3$ and sets a price of $p = 4.01$, the "naively" loss–averse consumer expects a cutoff match value of $\hat{r}(p) = 5$. After receiving a positive signal ($r \geq t = 3$), she expects to buy with a probability of 5/7 and not to buy with a probability of 2/7. Due to the positive signal, the probability of facing a match value level of 5 up to 9 equals 1/7 respectively. Consumer's indirect utility function from buying is equal to

$$u(r, p, 1|\hat{r}(p)) = \underbrace{(r-p)}_{\text{intrinsic u.}} - \underbrace{\lambda(p-0)\cdot 2/7}_{\text{loss in price}} - \underbrace{\lambda \cdot \sum_{s=5}^{9}(s-r)\cdot 1/7}_{\text{loss in match value}} + \underbrace{(r-0)\cdot 2/7}_{\text{gain in match value}},$$

Her indirect utility function from not buying equals

$$u(r, p, 0|\hat{r}(p)) = \underbrace{0}_{\text{intrinsic u.}} + \underbrace{(p-0)\cdot 5/7}_{\text{gain in price}} - \underbrace{\lambda \cdot \sum_{s=5}^{9}(s-0)\cdot 1/7}_{\text{loss in match value}}.$$

Her net utility from buying relatively to not buying can be simplified to

$$\Delta u = r \cdot \Big(2 + (\lambda - 1)\cdot 5/7\Big) - p \cdot \Big(2 + (\lambda - 1)\cdot 2/7\Big),$$

which, with $r = 3$ and $p = 4.01$, is positive for $\lambda > 3.03$. This means that for $\lambda = 3.5$, the consumer at $r = 3$ will be attached to buying the good at a price $p = 4.01$ by threshold advertising with threshold $t = 3$ which increases her ex–ante probability of buying from 1/2 to 5/7. Her actual cutoff match value $\hat{r}$ is lower than 3 (instead of being equal to 5). Thus, threshold match advertising can increase the ex–ante probability of buying of consumers with a sufficiently high product valuation which leads to consumer attachment when consumers are loss–averse. In this example, the persuasive effect of threshold match advertising is larger than that of no match value disclosure with a low price offer.

[13] A consumer who is sophisticated about her loss aversion would anticipate a shift in her cutoff and by doing so further increase her attachment. See the concept of personal equilibrium.

3 The Model

3.1 Setup

We build on the monopoly model of informative advertising à la Anderson and Renault (2006) but depart from their setup by assuming that consumers face expectation-based loss aversion in the match value and the price dimension (Kőszegi and Rabin 2006 and Heidhues and Kőszegi 2010) and that consumers face no search costs:[14] a monopolistic firm produces a single product at constant marginal costs normalized to zero. The monopolist sets a uniform, deterministic price p ex ante which is observed by consumers.[15]

There is a continuum of consumers of mass one. Initially, consumers are uncertain about their match value (reservation utility) of one unit of the product, r, but observe the price of the product, p. Let r be iid with cumulative distribution function $F(r)$ and support $[a, b] \subseteq \mathbf{R}_0^+$.[16] Consumers receive an advertising signal by the monopolist containing full, partial, or no match value information before forming their reference point distributions in the two dimensions. Before making their purchase decision, consumers observe their intrinsic match value r of the good (inspection good).[17] Consumers buy one unit of the good at price p ($\sigma = 1$) or do not buy at all ($\sigma = 0$). In the price and in the match value dimension, consumers compare their realized outcome if buying (resp. if not buying) with any alternative outcome under their probabilistic reference point. The reference comparisons with more likely alternatives receive higher probability weights than those with less likely ones. Overall, a consumer's decision to buy relatively to not to buy depends on the sum of three components: the standard (intrinsic) utility, the gain–loss utility in the price dimension and that in the match value dimension.

Consumers form their reference point distributions after having received the monopolist's advertising signal. At this stage, all remaining uncertainty stems from undisclosed match value information. In the price dimension there are only two possible outcomes: pay the

[14]We extend the baseline model to the case with positive search costs in Section 5.2 and show that our main results are robust to this modification.

[15]In contrary to this assumption, Heidhues and Kőszegi (2010) consider a model in which the monopolist can commit to a price distribution ex ante. In our setup, the fact that prices are initially observable by consumers can be interpreted as price advertising. We discuss the relaxation of this assumption in Section 5.1.

[16]We assume that common product components as quality are known by consumers from the outset. For instance, think about third–party quality certification. Those components solely shift the support of match values in this model.

[17]Note that this setup can also be interpreted as a reduced–form representation of a model with purchase under uncertainty but free return policy (experience goods with respect to the horizontal component).

price p if buying ex post or pay zero if not buying ex post. Thus, the reference point distribution in the price dimension is discrete and assigns the probability of buying to the former and the complementary probability to the latter outcome. The probability of buying is determined by an optimal cutoff match value $\hat{r}$ for which a consumer will be indifferent between buying and not buying ex post (if $\hat{r}$ is interior).[18] This cutoff match value reflects loss–averse consumers' optimal behavior given rational expectations. We refer to the reference point distribution in the price dimension as $H(p|\hat{r})$. The reference point distribution in the match value dimension depends also on the cutoff match value $\hat{r}$ but it is continuous except for the case when full information was released by the monopolist. In the following, the reference point distribution in the match value dimension is denoted by $G(r|\hat{r})$.

Consumers' indirect utility function ex post (for buying $\sigma = 1$ and for not buying $\sigma = 0$) consists of a standard (intrinsic) part and a non–standard (gain–loss) part. It can be expressed as follows,

$$u(r,p,\sigma|H(p|\hat{r}),G(r|\hat{r})) = \underbrace{(r-p)\sigma}_{\text{intrinsic u.}} + \eta\Big(\underbrace{\int_q \mu(p\sigma - q)dH(q|\hat{r})}_{\text{gain–loss u. in price}} + \underbrace{\int_s \mu(r\sigma - s)dG(s|\hat{r})}_{\text{gain–loss u. in match value}}\Big)$$

with μ being the gain–loss utility function. Following Kőszegi and Rabin (2006), we assume that μ is piecewise linear with slope one on gains and slope $\lambda > 1$ on losses; where gains and losses are defined as the distance of a realized value $p\sigma$ (resp. $r\sigma$) to the alternative values under the corresponding reference point distribution.[19] $\eta > 0$ reflects the weight of the gain–loss utility compared to the intrinsic utility. In order to keep the presentation of our analysis as simple as possible, we will normalize η to one in the following. The first term on the RHS of the previous equation shows consumer's intrinsic utility, while the second and third term show her gain–loss utility in the price and the match value dimension. The differences under the integrals reflect the reference comparison in the two dimensions.

Based on Kőszegi and Rabin (2006), we next define a consumer's personal equilibrium (PE) and her preferred personal equilibrium (PPE) in our setup. PE requires that consumer's induced purchase strategy is optimal given her ex ante formed, rational expectations. This means that only purchase plans which are credible to be followed through

[18] We show below that a unique cutoff is optimal in our setup.

[19] We assume in the baseline model that the degree of loss aversion λ is the same across dimensions. We will relax this assumption in Section 6. Like Kőszegi and Rabin (2006), we do not consider *diminishing sensitivity* and *probability weighting* (the two remaining features of prospect theory; see Kahneman and Tversky 1979 and Tversky and Kahneman 1992).

can state a PE. In our setup, any PE shows a cutoff structure—i.e., buying is optimal for a consumer for a given price p if and only if her intrinsic match value ex post lies weakly above a cutoff $\hat{r}(p)$; otherwise not buying is her optimal strategy. This is due to fact is that the net utility of buying is strictly increasing in the level of match value ex post for all expectations ex ante.[20]

Definition 1. *A cutoff match value $\hat{r}(p)$, together with the plan to buy the good at price p if $r \in [\hat{r}(p), b]$ and not to buy otherwise, constitutes a consumer's* ***personal equilibrium (PE)*** *given consumers' information of r after advertising, if for the induced expectations $H(p|\hat{r})$ and $G(r|\hat{r})$, it is true that*

$$u(\hat{r}, p, 1|H(p|\hat{r}), G(r|\hat{r})) \geq u(\hat{r}, p, 0|H(p|\hat{r}), G(r|\hat{r})),$$

with strict inequality only if r is non–interior.

Her PPE is consumer's PE that maximizes her initial utility.

Definition 2. *A cutoff match value $\hat{r}(p)$, together with the plan to buy the good at price p if $r \in [\hat{r}(p), b]$ and not to buy otherwise, constitutes a consumer's* ***preferred personal equilibrium (PPE)*** *given consumers' information of r after advertising, if it is a PE and for any PE cutoff match value $\hat{r}'(p)$,*

$$E_r[u(r, p, \sigma(r|\hat{r})|H(p|\hat{r}), G(r|\hat{r}))] \geq E_r[u(r, p, \sigma(r|\hat{r}')|H(p|\hat{r}'), G(r|\hat{r}'))],$$

where $\sigma(r|\hat{r})$ describes consumer's initial plan to buy or not to buy given realized match value r and cutoff $\hat{r}$.

Moreover, we will break any remaining indifference of consumers in favor of buying the product.

The monopolist can undertake full match value advertising ex ante ($i = A$) or advertise partial or no match value information ($i = N$).[21] His demand equals $D(p)$ with price p.

[20] In fact, for all expectations ex ante, the intrinsic utility from buying and the gain–loss utility in the match value dimension from buying are strictly increasing in the level of match value ex post, while the gain–loss utility in the price dimension from buying and the total utility from not buying are constant in the level of match value ex post. So, the total utility difference in favor of buying is strictly increasing the level of match value ex post for all expectations ex ante and thus there cannot exist a non-convex set for which buying is optimal.

[21] Note that it is sufficient that match value advertising makes consumers who watch an ad informed about their match value without the monopolist knowing individual match values. See also Anderson and Renault (2006).

Monopolist's profit is described by

$$\pi_i(p_i) = p_i D_i(p_i) \quad \forall i \in \{A, N\} \text{ and } p_i \geq 0.$$

With $\hat{r}_i(p_i)$ being the cutoff match value between buying and not buying for given price p_i, it holds that

$$D_i(p_i) = \int_{\hat{r}_i(p_i)}^{b} dF(r) = 1 - F(\hat{r}_i(p_i)). \tag{1}$$

We make the assumption that the cdf $F(r)$ is convex which yields concavity of $(1-F(r))$.[22] Moreover, F is twice continuously differentiable.

Timing:

1. **Nature draws match values** r according to $F(r)$.
2. **Advertising and price setting:** Firm decides whether

   a) to fully disclose match value information to consumers ex ante (complete, informative advertising, $i = A$)

   b) or not to fully disclose (partial or no, informative advertising, $i = N$)

   and sets price p_i conditional on the advertising decision, $i \in \{A, N\}$.

3. **Reference point formation:** Consumer observes price p_i and updates her belief about her match value r:

   a) all uncertainty is resolved and she forms a degenerate reference point distribution (buy with certainty if $p_A \leq r$ or do not buy otherwise).

   b) she forms a probabilistic reference point distribution in the price dimension (pay price p_N or pay zero) and in the match value dimension (receive a match value r above the cutoff between buying and not buying $\hat{r}(p_N)$ or receive zero match value).

[22] It is easy to check that, for instance, the uniform distribution satisfies this condition as a borderline case. Note that concavity of $1-F$ is a stricter assumption than log–concavity of $1-F$ and F, an assumption often made in this literature to yield quasi–concavity of the profit function (e.g., see Anderson and Renault 2006). In our setup, however, $\hat{r}(p)$ is a non–linear function of p such that log–concavity of $1-F$ and F does not automatically ensure existence. Yet, it can be shown on a case–by–case basis that our results except for that in Proposition 1 directly carry over to the class of log–concave cdf's when the loss aversion parameter λ is restricted to lower levels than in the current version of this paper and when f' is not too negative. With log–concave cdf's, disclosing full match information can become preferable to disclosing no match information when f' is sufficiently negative (compare Proposition 1).

4. **Inspection and purchase:** Consumer inspects the product and observes her match value r (if she has not done so in stage 3):

   a) she then undertakes a standard purchase decision; that is she buys the product if $p_A \leq r$ or does not buy otherwise.

   b) she then undertakes a non–standard purchase decision, based on her utility that includes realized gains and losses relative to her reference–point distribution.

The equilibrium concept is subgame perfect Nash with consumers playing a personal equilibrium. We assume that if a transparency policy is required for a certain product, the firm cannot use a no–match–value–disclosure strategy. This could be made explicit by assuming that the firm has to make an initial product–existence announcement to consumers which is always profitable but underlies any transparency policy requirement.

3.2 Full Match Value Advertising

First, we examine the case in which the monopolist advertises full match value information to consumers ex ante. When price and match value are perfectly known after advertising, consumers do not face uncertainty at the reference–point–formation stage (riskless choice). Kőszegi and Rabin (2006) (Proposition 3) show that, in this case, consumers will undertake a standard purchase decision—i.e., that they will maximize their intrinsic utility in PPE. Consumer's intrinsic utility of buying the good is equal to $r - p$, while that of not buying is 0. Thus, consumer's cutoff match value between buying and not buying $\hat{r}$ is equal to p. This means that a consumer whose product valuation is lower than the price does not buy the product. Therefore, $\forall p \in [a, b]$, firm's demand equals

$$D(p) = 1 - F(p). \tag{2}$$

By assumption the monopolist's profit function is twice continuous and globally quasi-concave (due to concavity of $1 - F(p)$). Maximizing profits over p leads to the following first–order condition,

$$p = \frac{(1 - F(p))}{f(p)}. \tag{3}$$

Example 1 (Uniform distribution)**.** *If r is uniformly distributed on* $[0, 1]$*, the optimal price equals*

$$p_A^* = \frac{1}{2}, \tag{4}$$

which describes the Nash equilibrium of this subgame.

Attachment ex post and the maximum level of attachment: we show next that an outcome which differs from consumers' expectations, as e.g. an unexpected price increase, can create consumer attachment ex post. Note that, without price commitment, this might indeed give an incentive to the monopolist to increase the price ex post.[23] We also derive the maximum level of consumer attachment which is reached when consumers expect to buy with probability one.

Consider a consumer located at r, when $r \in [a, b]$ and r is known. If the consumer initially expects to buy the good with probability one given the observable price p, her indirect utility of buying ex post is equal to

$$u(r, p, 1) = r - p,$$

while her indirect utility of not buying ex post equals

$$u(r, p, 0) = 0 + \underbrace{p}_{\text{gain}} - \underbrace{\lambda r}_{\text{loss}}.$$

So given expectations, if not buying ex post, the consumer faces a gain in the price dimension and a loss in the match value dimension. The consumer will buy the product ex post if $\Delta u = u(r, p, 1) - u(r, p, 0) \geq 0$ which is equivalent to

$$p \leq \frac{\lambda + 1}{2} r \equiv \overline{p}(r).$$

This means that, in a deterministic environment, initially expecting to buy the product with probability one attaches the consumer at r to buy the product up to a price of $\overline{p}(r)$. Note that this price exceeds consumer's intrinsic valuation r as $\lambda > 1$.[24] E.g., for $\lambda = 2$, $\overline{p}(r)$ exceeds r by 50%. This confirms the importance of consumers' expectations for the prediction of their purchase behavior. The next lemma summarizes this finding.

Lemma 1. *The maximum level of consumer attachment is reached if a consumer expects to buy with probability one. Given price p, such a consumer will buy the good if and only*

[23] We discuss this case in more detail in Section 5.1.

[24] Equivalently, we can derive a lower bound $\underline{r}$ on consumer's valuation for which she will purchase the good ex post given p,

$$r \geq \frac{2}{\lambda + 1} p \equiv \underline{r}(p).$$

if her valuation r is not lower than $2/(\lambda + 1) \cdot p$*.*

The proof of this lemma is relegated to Appendix A.

Expecting to buy with probability one maximizes the loss in the match value dimension if not buying (λr) and minimizes the loss in the price dimension if buying (0). Since match value (resp. price) enters the utility function with a positive (resp. negative) sign, both effects are in favor of buying the good. In fact, they maximize the distance between price and the cutoff match value between buying and not buying—i.e., they maximize consumer attachment. Note that expecting to buy with probability one might not be the PPE for consumers located between $2/(\lambda + 1) \cdot p$ and p. In a deterministic environment, we therefore do not observe consumer attachment on the equilibrium path.

Now, consider the case in which the consumer expects ex ante not to buy the good with probability one. Her indirect utility of buying ex post is equal to

$$u(r, p, 1) = r - p - \underbrace{\lambda p}_{\text{loss}} + \underbrace{r}_{\text{gain}},$$

while her indirect utility of not buying ex post equals

$$u(r, p, 0) = 0.$$

The consumer faces a loss in the price dimension and a gain in the match value dimension if she will buy ex post. Not buying ex post is credible if the price is sufficiently high[25]

$$p > \frac{2}{\lambda + 1} r \equiv \underline{p}(r).$$

It follows that for $p \in [\underline{p}(r), \overline{p}(r)]$ (resp. $r \in [\underline{r}(p), \overline{r}(p)]$), there exist multiple PE depending on initial expectations, while for $p < \underline{p}(r)$ buying is the unique PE (hence PPE) and for $p > \overline{p}(r)$ not buying is the unique PE. Kőszegi and Rabin (2006) find that, for $p \in [\underline{p}(r), \overline{p}(r)]$, "buy if $r \geq p$" is consumer's PPE. This is due to the fact that her gain-loss utility is zero on the equilibrium path. Therefore, consumer's PPE is equal to the PE that maximizes her intrinsic utility.

[25]Equivalently, not buying ex post is credible if the match value is sufficiently low,

$$r < \frac{\lambda + 1}{2} p \equiv \overline{r}(p).$$

3.3 No Match Value Advertising

Suppose next that the monopolist does not disclose match value information ex ante (so only price p is observed) and that consumers form expectations about their purchase expenditure (p or 0) and their corresponding match value ($r \in [\hat{r}(p), b]$ or $r = 0$). $\hat{r}(p)$ depicts the cutoff level in the match value dimension at which the corresponding consumer will be indifferent between buying and not buying ex post for given price p. Let $\Gamma(p) = (H(p'|\hat{r}(p)), G(r|\hat{r}(p)))$ describe the joint reference point distribution in the price and the match value dimension given the price p advertised by the firm.

$H(p'|\hat{r}(p))$ is defined as the probability of the purchase price being lower than a certain price level p' conditional on the anticipated cutoff match value $\hat{r}(p)$. For price levels lower than p, the purchase price will be zero and H is equal to the probability of not buying, $F(\hat{r}(p))$, while H is equal to 1 for price levels equal or larger than p.

$$H(p'|\hat{r}(p)) = \begin{cases} F(\hat{r}(p)), & \text{if } p' \in [0, p); \\ 1, & \text{if } p' \in [p, b]. \end{cases} \tag{5}$$

The corresponding pdf can be expressed as

$$h(p'|\hat{r}(p)) = \begin{cases} F(\hat{r}(p)), & \text{if } p' = 0; \\ 1 - F(\hat{r}(p)), & \text{if } p' = p. \end{cases} \tag{6}$$

$G(r|\hat{r}(p))$ is defined as the probability of the match value being lower than a certain match value level r conditional on the anticipated cutoff match value $\hat{r}(p)$. $G(r|\hat{r}(p))$ is a truncated cdf of $F(r)$ with a truncation at $\hat{r}(p)$, since the expected match value is zero for r lower than $\hat{r}(p)$.

$$G(r|\hat{r}(p)) = \begin{cases} F(\hat{r}(p)), & \text{if } r \in [0, \hat{r}(p)); \\ F(r), & \text{if } r \in [\hat{r}(p), b]. \end{cases} \tag{7}$$

The corresponding pdf, $g(r|\hat{r}(p))$, is equal to

$$g(r|\hat{r}(p)) = \begin{cases} F(\hat{r}(p)), & \text{if } r = 0; \\ 0, & \text{if } r \in (a, \hat{r}(p)); \\ f(r), & \text{if } r \in [\hat{r}(p)), b]. \end{cases} \tag{8}$$

The valuation of the indifferent consumer at $\hat{r}(p)$ can be derived as follows: first consider any consumer r who learnt via inspection that her match value is sufficiently high for buying, i.e., $r \in [\hat{r}(p), b]$. Such a consumer's indirect utility function when buying ($\sigma = 1$) can be expressed as follows

$$
\begin{aligned}
u(r, p, 1|\Gamma(p)) =& (r - p) - \lambda \cdot \int_0^p (p - q) dH(q|\hat{r}(p)) + \int_p^b (q - p) dH(q|\hat{r}(p)) \\
& - \lambda \cdot \int_r^b (s - r) dG(s|\hat{r}(p)) + \int_0^r (r - s) dG(s|\hat{r}(p)) \\
=& \underbrace{(r - p)}_{\text{intrinsic u.}} - \underbrace{\lambda \cdot (p - 0) F(\hat{r}(p))}_{\text{loss in price}} \qquad (9) \\
& \underbrace{- \lambda \cdot \int_r^b (s - r) dF(s)}_{\text{loss in match value}} + \underbrace{\int_{\hat{r}(p)}^r (r - s) dF(s) + (r - 0) F(\hat{r}(p))}_{\text{gain in match value}}.
\end{aligned}
$$

Focussing on the second part of the previous equation, the first term shows consumer's intrinsic utility, while the remaining terms express her gain–loss utility in the price and the match value dimension. The second term reveals that the consumer faces a loss in the price dimension from buying if p is larger than 0. This reflects that ex ante the consumer was expecting to pay the price p only with probability $1 - F(\hat{r}(p))$, while she was expecting to pay 0 with probability $F(\hat{r}(p))$. She experiences no gain in the price dimension. The consumer experiences a loss in the match value dimension if r is smaller than b (third term), a corresponding gain if r is larger than $\hat{r}(p)$ (fourth term) and an additional gain of buying for all r above the cutoff (fifth term). Note that the gain–loss utility in the match value dimension is twofold: first, it matters whether the consumer buys or doesn't buy the product and, second, it matters how much the consumer likes the product if she buys.

Next consider any consumer r who learnt that her match value lies somewhere on the interval $[a, b]$. Her indirect utility function when not buying ($\sigma = 0$) equals

$$
\begin{aligned}
u(r, p, 0|\Gamma(p)) =& 0 + \int_0^b (q - 0) dH(q|\hat{r}(p)) - \lambda \cdot \int_0^b (s - 0) dG(s|\hat{r}(p)) \\
=& \underbrace{(p - 0)(1 - F(\hat{r}(p)))}_{\text{gain in price}} - \underbrace{\lambda \cdot \left(\int_{\hat{r}(p)}^b s dF(s) \right)}_{\text{loss in match value}}. \qquad (10)
\end{aligned}
$$

Consumer's intrinsic utility is zero and she faces a gain in the price dimension if p is larger than zero (first term in the second line). She also experiences a loss in the match value dimension from not buying (second term in the second line).

The indirect utility functions of the indifferent consumer at $r = \hat{r}$ are given by

$$u(\hat{r}, p, 1|\Gamma(p)) =(\hat{r} - p) - \lambda \cdot pF(\hat{r}) - \lambda \cdot \int_{\hat{r}}^{b} (s - \hat{r})dF(s) + \hat{r}F(\hat{r}).$$
$$u(\hat{r}, p, 0|\Gamma(p)) =p(1 - F(\hat{r})) - \lambda \cdot \int_{\hat{r}}^{b} sdF(s)$$

and her net utility from buying relatively to not buying simplifies to

$$\Delta u =2 \underbrace{(\hat{r} - p)}_{\text{net intrinsic u.}} + \underbrace{(\lambda - 1)(1 - F(\hat{r}))\hat{r}}_{\text{net loss in match value}} - \underbrace{(\lambda - 1)F(\hat{r})p}_{\text{net loss in price}}. \tag{11}$$

Note that $\hat{r}$ influences the net loss in the match value dimension as well as the net loss in the price dimension, where the latter is influenced indirectly via the probability of not buying. E.g. the higher $\hat{r}$, the higher the probability of not buying and the higher the net loss in the price dimension as paying the price was less likely ex ante.[26] From a technical perspective, it is also worthwhile mentioning that, although the indirect utility functions include a reference comparison based on truncated distribution functions of $F(r)$, the indirect utility difference only depends on the prior distribution of match values $F(r)$. This strongly simplifies the complexity of the underlying fixed point problem and allows for the application of a wide range of distribution functions.

$\Delta u = 0$ is equivalent to

$$p(\hat{r}) = \frac{2 + (\lambda - 1)(1 - F(\hat{r}))}{2 + (\lambda - 1)F(\hat{r})} \cdot \hat{r}. \tag{12}$$

Equation (12) implicitly determines the location of the indifferent consumer $\hat{r}(p)$ which describes the cutoff between buying and not buying given price. Note that, for $\lambda \to 1$, $p = \hat{r}$ which is the cutoff with standard consumers.

The next lemma specifies conditions under which a unique cutoff $\hat{r}(p)$ exists which additionally satisfies the law of demand for $p \in [p(a), p(b)]$. Note that the law of demand is equivalent to strict monotonicity of $\hat{r}(p)$ in p which ensures the existence of the inverse cutoff function $\hat{r}^{-1}(p) = p(\hat{r})$. The existence of the cutoff follows directly from continuity of the F. The law of demand is satisfied for at least some price range if $p(a) < p(b)$. It follows from (12) that $p(a) = (\lambda + 1)/2 \cdot a$ and $p(b) = 2/(\lambda + 1) \cdot b$. Thus, the law of demand is satisfied for at least some prices if $(\lambda + 1)^2/4 \cdot a < b$. It is satisfied for all prices if $p'(\hat{r}) > 0$ for all $\hat{r} \in [a, b]$. The latter property also yields uniqueness of $\hat{r}(p)$.

[26] For $\lambda \to 1$, $\Delta u = 2(r-p)$ which is equal to the utility difference of consumers with standard preferences (up to a positively monotonic transformation of factor two).

Intuitively, it is required that, for a given cdf F with support on $[a, b]$, the degree of loss aversion is sufficiently low.

Lemma 2. *Suppose consumers observe prices ex ante and no match value information is released. Then, for all $p \geq 0$ there exists a unique cutoff $\hat{r}(p)$ which satisfies $\hat{r}'(p) > 0$ for $p \in [p(a), p(b)]$ if and only if*

$$\lambda \leq \lambda^c \equiv \frac{1 + \sqrt{1 + 4b^2 f^2(b)}}{b f(b)} - 1. \tag{13}$$

For $p < p(a))$, $\hat{r}(p)$ is equal to a, while, for all $p > p(b)$, $\hat{r}(p)$ is equal to b.

The proof of this lemma is relegated to the Appendix.

Given that condition (13) holds, the unique pure–strategy PE (PPE) of consumer r is described by[27]

$$\sigma(r, p|\hat{r}(p)) = \begin{cases} 0 & \text{if } r \in [a, \hat{r}(p)) \\ 1 & \text{if } r \in [\hat{r}(p), b]. \end{cases} \tag{14}$$

Therefore, the firm faces the following demand function when only prices are advertised ex ante,

$$D(p) = 1 - F(\hat{r}(p)), \tag{15}$$

with $\hat{r}(p)$ being implicitly determined by (12).

Example 1 (cont'd) (Uniform distribution). *Consider $[a, b] = [0, 1]$ and F being the uniform cdf. Then, $F(\hat{r}) = \hat{r}$ and the inverse cutoff match value function $\hat{r}^{-1} = p$ equals*

$$p(\hat{r}) = \frac{(\lambda + 1) \cdot \hat{r} - (\lambda - 1) \cdot \hat{r}^2}{2 + (\lambda - 1) \cdot \hat{r}}. \tag{16}$$

Furthermore, (16) *is equivalent to*

$$(\lambda - 1) \cdot \hat{r}^2 - \Big((\lambda + 1) - (\lambda - 1)p\Big) \cdot \hat{r} + 2p = 0 \tag{17}$$

[27] Note that $p'(\hat{r}) > 0$ implies that $p(a) < p(b)$ which is equivalent to $\overline{p}(a) < \underline{p}(b)$. The latter condition rules out "always buying" or "never buying" being a PE. This is due to the fact that for $p > \overline{p}(a)$ "always buying" is not credible; neither is "never buying" for $p < \underline{p}(b)$. Compare the discussion of the attachment effect in Subsection 3.2.

Solving (17) *for* $\hat{r}$ *yields the cutoff match value function*

$$\hat{r}(p) = \frac{(\lambda+1)}{2(\lambda-1)} - \frac{p}{2} - \sqrt{\frac{p^2}{4} - \frac{(\lambda+5)p}{2(\lambda-1)} + \frac{(\lambda+1)^2}{4(\lambda-1)^2}} \tag{18}$$

subject to $\lambda > 1$ *and* p *being sufficiently small such that* $\hat{r} \in [0,1]$. *The second solution to* (17) *can ruled out since it does not satisfy the law of demand. The square root is defined for* $p \leq \tilde{p}(\lambda)$ *with*

$$\tilde{p}(\lambda) = \frac{\lambda + 5 - 2\sqrt{2}\sqrt{\lambda+3}}{\lambda - 1}. \tag{19}$$

Hence, $p(b) \leq \tilde{p}(\lambda)$ *determines the upper bound on* λ*,*

$$\lambda^c \equiv \sqrt{5} \approx 2.24. \tag{20}$$

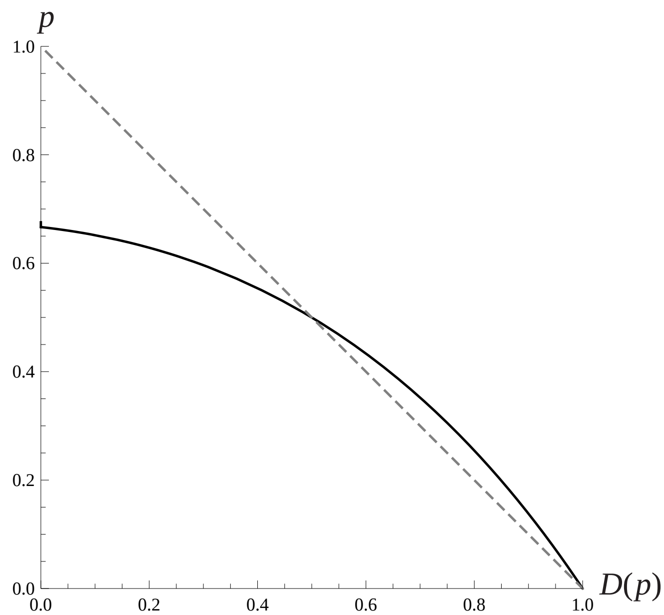
Analogously, λ^c *can be derived from* (13).

Figure 1 illustrates that the demand in the case of no match value disclosure is more concave than that of full match value disclosure.[28] Moreover, for $p <$ Median(r) demand with ex–ante uninformed consumers is higher than demand with fully informed consumers (standard demand). This means that a low price attracts more initially uninformed consumers than fully informed consumers (or consumers with standard preferences). This is due to the fact that a low price increases the initial probability of buying the good which leads to a higher net loss in the match value dimension when the product is not bought ex post. Thus, low prices can be used to attach uninformed consumers: the marginal consumer accepts prices which are above her intrinsic valuation $\hat{r}$—i.e., $\hat{r} < p(\hat{r})$ which follows from (12) for $\hat{r} \in [a, \text{Median}(r))$.

Remark 1. *Advertising a relatively low price to consumers who are initially uninformed about match value induces the marginal consumer to accept prices above her intrinsic valuation.*

In fact, when buying the product, loss-averse consumers face a net loss in the price dimension whose magnitude is reduced by a price decrease (first–order effect). In addition, (via a reduction of $\hat{r}$) a price decrease increases the probability of buying the good. This has two additional purchase–enhancing effects: a further reduction of the net loss in the price dimension since buying (paying the price) becomes more likely ex ante and an increase

[28] As in Johnson and Myatt (2006), p.762, 766, informative advertising leads to a counter–clockwise rotation of the demand function.



Inverse demand functions for $\lambda = 2$, solid: *no match value advertising* and dashed: *full match value advertising*; match values are uniformly distributed on $[a, b] = [0, 1]$.

Figure 1: Inverse Demand Functions: Non–Complex Goods

of the net gain in the match value dimension since receiving the product of match value r becomes more likely ex ante. This can be observed by considering the marginal gain–loss utility difference of a consumer r (compare (11)):

$$\begin{aligned} \Delta u(r, p|\Gamma(p)) =& 2(r - p) \\ & - p\Big((\lambda - 1)F(\hat{r}(p))\Big) \\ & + r\Big((\lambda - 1)(1 - F(\hat{r}(p)))\Big), \end{aligned} \tag{21}$$

$$\begin{aligned} \frac{\partial(\Delta u(r, p|\Gamma(p)) - 2(r - p))}{\partial p} =& -(\lambda - 1)F(\hat{r}(p)) - p(\lambda - 1)f(\hat{r}(p))\hat{r}'(p) \\ & - r(\lambda - 1)f(\hat{r}(p))\hat{r}'(p). \end{aligned} \tag{22}$$

All three effects are negative for a price increase and hence positive for a price decrease. This explains the excess demand with initially uninformed consumers in the low–valuation interval $r \in [0, \text{Median}(r))$.

The monopolist's profit function is continuous and globally quasi–concave if $(1 - F(\hat{r}(p)))$

is log–concave.[29] It equals $\pi(p) = p[1 - F(\hat{r}(p))]$. Maximizing over p leads to

$$p = \frac{1 - F(\hat{r}(p))}{f(\hat{r}(p))\hat{r}'(p)}. \tag{23}$$

As $\hat{r}(p)$ is strictly increasing, the profit function can also be expressed as a function of $\hat{r}$—$\pi(\hat{r}) = p(\hat{r})[1 - F(\hat{r})]$—and be maximized over $\hat{r}$. This yields

$$\frac{p(\hat{r})}{p'(\hat{r})} = \frac{1 - F(\hat{r})}{f(\hat{r})}. \tag{24}$$

Solving for $\hat{r}$ and plugging $\hat{r}$ into $p(\hat{r})$ delivers the equilibrium price in the subgame of no match value advertising p_N^*.

4 Optimal Advertising

4.1 Constrained Information Disclosure

In this subsection we consider the case in which match value is either fully revealed via advertising or not revealed at all. This refers to markets with less complex products (e.g. weekend trips). We combine our results from the previous section.

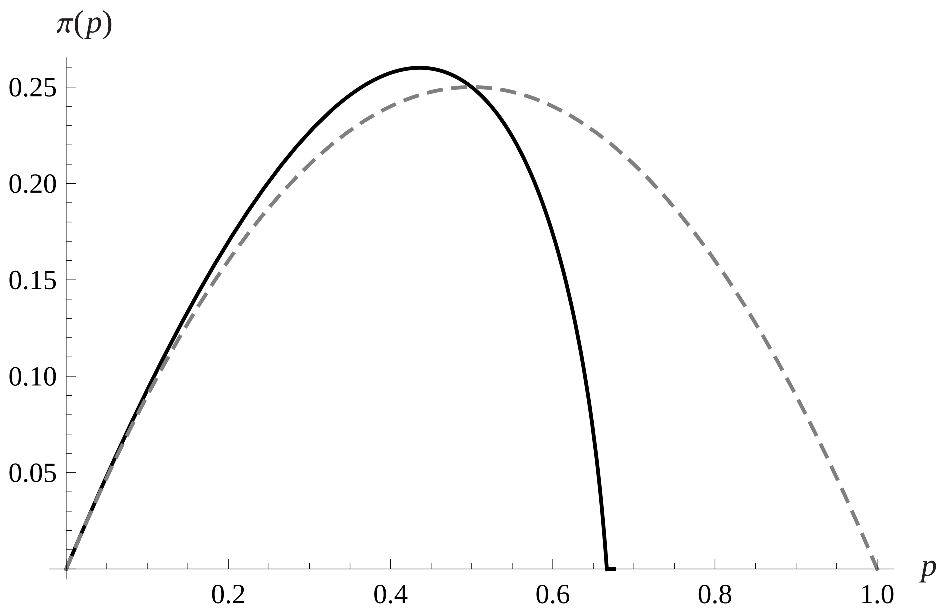
Figure 2 shows the case of non–complex goods. If the monopolist does not advertise match value, consumers form reference points ex ante and behave loss–averse ex post. Loss-averse consumers are more easily attractable by lower prices than standard ones (compare Figure 1 at $p < 0.5$). Figure 2 shows that not advertising match value but advertising a low price, p_N, is optimal in this case.

The next proposition describes the subgame perfect Nash equilibrium when advertising is constrained to full or no match information.

Proposition 1. *Suppose that only full or no match information can be released and that $\lambda \leq \lambda^c$ such that* (12) *is satisfied. Then, the monopolist always prefers to disclose no match value information in equilibrium. The equilibrium price is characterized by* (23)*. Equilibrium always exists.*

The proof of this proposition is relegated to the Appendix.

[29] The latter condition does not follow from concavity of $1 - F$. It additionally requires that λ is not too large. See Proposition 1.



Profit functions for $\lambda = 2$, solid: *no match value advertising* and dashed: *full match value advertising*; match values are uniformly distributed on $[a, b] = [0, 1]$ and marginal costs are $c = 0$. The optimal price in case of no match value advertising is $p_N^* = 0.4360$ and optimal price in case of full–disclosure is $p_A^* = 0.5$.

Figure 2: Non–Complex Product: No Match Value Advertising

4.2 Unconstrained Information Disclosure

We next consider the case of unconstrained match value advertising and also allow for the release of partial match information.

We show that the optimal mode of advertising for the monopolist is to inform consumers whether or not their match value lies above a threshold of $t = 2/(\lambda + 1) \cdot p = \underline{r}(p)$ given price p. It is crucial that consumers together with a positive signal do not receive any further information about their match value. Although the optimal threshold lies below the price, in equilibrium loss–averse consumers who receive the signal that their valuation is above the threshold correctly foresee that they will buy the product with probability one ex post. This is due to the fact that consumers would perceive a maximum loss in the match value dimension if they won't buy ex post. Expecting to buy with probability one leads to full attachment of consumers and to a maximum level of overpay of the marginal consumer located at $\underline{r}(p)$ whose intrinsic valuation lies $(\lambda - 1)/(\lambda + 1)p$ below the price p.

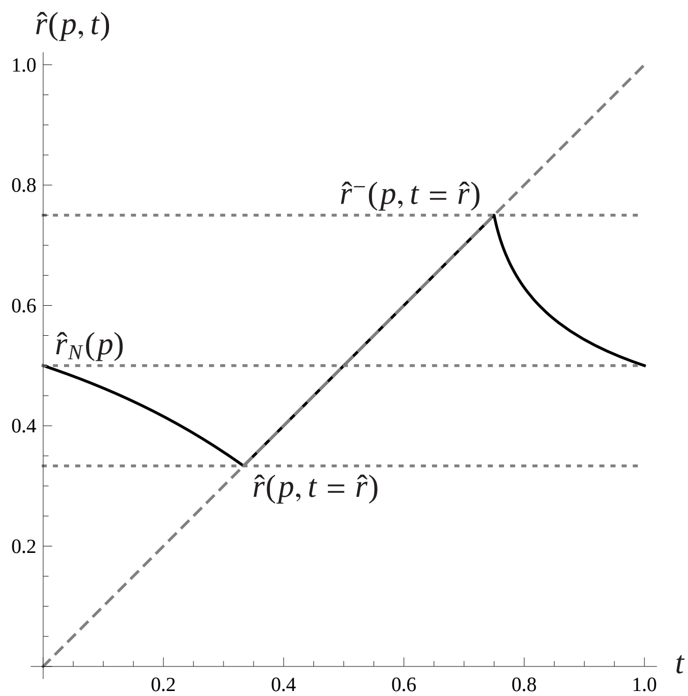
Threshold match advertising requires that the monopolist initially discloses a sufficient amount of features of its product to inform consumers who have a high valuation for this product that their match value lies above the threshold but without revealing any further information about consumers' match value (e.g. see TV spots for sports cars which often reveal attributes as design, horse power or being convertible but tend to conceal attributes as gas consumption and number of seats). In this paper, we apply the concept of threshold match advertising by Anderson and Renault (2006). Since, in our setup, consumers have a fixed, intrinsic product valuation about which they become informed by advertising or inspection, we can apply the concept of Anderson and Renault (2006) one–to–one without making any adjustment to non–standard preferences. We use that disclosing certain product attributes is equivalent to specifying a subset of products to which the advertised product belongs. For instance, revealing a high number of horse powers could be a threshold strategy for a monopolist selling a sports car if the set of potential new products contains some sports cars as well as some compact cars. A high number of horse powers would then signal that the advertised product must be a sports car without disclosing the exact product. Consumer who have a high valuation for sports cars would infer from the announcement that their match value is at least as high as that of their individually least preferred sports car, while the remaining consumers would expect a lower valuation.

The two main requirements for threshold match advertising are technological feasibility and message credibility. Technological feasibility means that the number of potential products (i.e., product characteristics) must be sufficiently large relative to the number of consumer types. Yet potential products do not have to contain any attribute and consumer types do not necessarily value any attribute. Message credibility requires that any disclosure strategy must be an equilibrium strategy for all potential product types which means that all product types must be pooling in a Perfect Bayesian Equilibrium. Given that these requirements are met, threshold information with respect to the same threshold can be transmitted to any consumer with a unique message. In this paper, we refer to products which satisfy this condition as complex products.

For given price p, the optimal threshold level can be derived by minimizing the cutoff match value $\hat{r}(p,t)$ over the threshold level $t \in [a,b]$. Note that $t = a$ is equal to the case of no match value disclosure. The next lemma characterizes the optimal threshold level for the monopolist for given price.

Lemma 3. *Suppose consumers observe price p and the monopolist engages in threshold match advertising with threshold $t \in [a,b]$. Then, for all $p \in [a,b]$ the monopolist optimally sets a threshold level of $t = \hat{r}(p,t)$, where $\hat{r}(p,t) \in [a,b]$ is the cutoff match value between buying and not buying for given price p when a consumer received the signal that her match value lies above t.*

The proof of this lemma is relegated to Appendix A. Figure 3 illustrates the cutoff match



Cutoff match value between buying and not buying $\hat{r}(p,t)$ as function of the threshold t for given price $p = 0.5$ and for $\lambda = 2$; match values are uniformly distributed on $[a,b] = [0,1]$.

Figure 3: Cutoff Match Value for Threshold t

value between buying and not buying $\hat{r}(p,t)$ as function of the threshold t. In the figure, we consider the strict interpretation of threshold advertising in which both, consumers above as well as below the threshold, only receive interval information. This resembles products for which high–type and low–type consumers care about a similar amount of product attributes. For $t = a$, $\hat{r}(p,t)$ is equal to the cutoff when no match information is advertised, $\hat{r}_N(p)$. For $t \in [a, \hat{r}(p, t = \hat{r})]$, $\hat{r}(p,t)$ is decreasing since consumers who receive a positive signal become increasingly attached (unless, for $t = \hat{r}(p, t = \hat{r})$, any consumer with a positive signals buys ex post), while consumers with valuation below the threshold do not buy ex post. For $t > \hat{r}(p, t = \hat{r})$, fewer consumers receive a positive signal but still buy ex post, while consumers who receive a negative signal only buy if $t > \hat{r}^-(p, t = \hat{r})$. The share of consumers with a negative signal who buy ex post is increasing—i.e., $\hat{r}(p,t)$ is decreasing—in $t \in [\hat{r}^-(p, t = \hat{r}), b]$. For $t = b$, the cutoff $\hat{r}(p,t)$ is equal to $\hat{r}_N(p)$ since any consumer receives a negative signal which is fully uninformative.

A second interpretation of threshold match advertising is compatible with the non–monotonicity result as well: if consumers below the threshold learn their full match valuation of the good, then $\hat{r}(p,t)$ shows the identical shape as in Figure 3 up to $t = p$ (note that in Figure 3, $p = \hat{r}_N(p)$). Only for $t > p$, $\hat{r}(p,t)$ is equal to p since any consumer with valuation above p buys ex post even if she received a negative signal. This second interpretation of threshold match advertising is related to products for which high–type consumers value more product attributes than lower types. Therefore, revealing an intermediate amount of attributes can inform low and intermediate types perfectly, while high types still face a residual uncertainty conditional on their valuation being above the threshold (e.g. sports cars with fancy extra equipment). Here, $t = b$ reflects full information disclosure and t can be interpreted as monotonically increasing in the amount of revealed product attributes.

For simplicity reasons, we refer to $\hat{r}(p, t = \hat{r})$ as $\hat{r}(p)$ in the following. We next derive $\hat{r}(p)$. Suppose the monopolist engages in optimal threshold match advertising with threshold at $t = \hat{r}(p)$ ex ante (i.e., the advertising signal is either $r < \hat{r}(p)$ or $r \geq \hat{r}(p)$). Then, consumers form expectations about their purchase expenditure (p or 0) and their match value ($r \in [\hat{r}(p), b]$ or $r = 0$). If a consumer receives a positive signal ($r \in [\hat{r}(p), b]$), then $h(p'|\hat{r}(p))$ equals

$$h(p'|\hat{r}(p)) = \begin{cases} 0, & \text{if } p' = 0; \\ 1, & \text{if } p' = p. \end{cases} \tag{25}$$

$g(r|\hat{r}(p))$ can be expressed as follows

$$g(r|\hat{r}(p)) = \begin{cases} 0, & \text{if } r \in [0, \hat{r}); \\ \frac{f(r)}{1-F(\hat{r})}, & \text{if } r \in [\hat{r}, b], \end{cases} \tag{26}$$

where $f(r)/(1 - F(\hat{r}))$ describes the conditional density of $F(r)$ for $r \geq \hat{r}$. The indirect utility function from buying ($\sigma = 1$) of a consumer $r \in [\hat{r}(p), b]$ who received the positive signal ex ante equals

$$u(r, p, 1|\Gamma(p)) = \underbrace{(r - p)}_{\text{intrinsic u.}} \underbrace{- \lambda \cdot \int_r^b \frac{(s - r)}{1 - F(\hat{r})} dF(s)}_{\text{loss in match value}} + \underbrace{\int_{\hat{r}}^r \frac{(r - s)}{1 - F(\hat{r})} dF(s)}_{\text{gain in match value}}. \tag{27}$$

Note that this consumer does not experience a loss in the price dimension since she already expected to buy the product with probability one. However, she receives a loss and a gain in the match value dimension whose seizes depend on the level of r. Next consider consumer's indirect utility function from not buying ($\sigma = 0$),

$$u(r, p, 0|\Gamma(p)) = \underbrace{0}_{\text{intrinsic u.}} + \underbrace{p}_{\text{gain in price}} \underbrace{- \lambda \cdot \int_{\hat{r}}^b \frac{s}{1 - F(\hat{r})} dF(s)}_{\text{loss in match value}}. \tag{28}$$

Since the consumer already expected to buy the product with probability one, she experiences a big loss in the match value dimension (proportional to the conditional expectation of r for $r \geq \hat{r}$) if not buying. Indifferent consumer's net utility from buying relatively to not buying can be expressed as

$$\Delta u = \underbrace{2(\hat{r} - p)}_{\text{net intrinsic u.}} + \underbrace{(\lambda - 1)\hat{r}}_{\text{net loss in match value}} - \underbrace{0 \cdot p}_{\text{net loss in price}} . \tag{29}$$

$\Delta u = 0$ is equivalent to

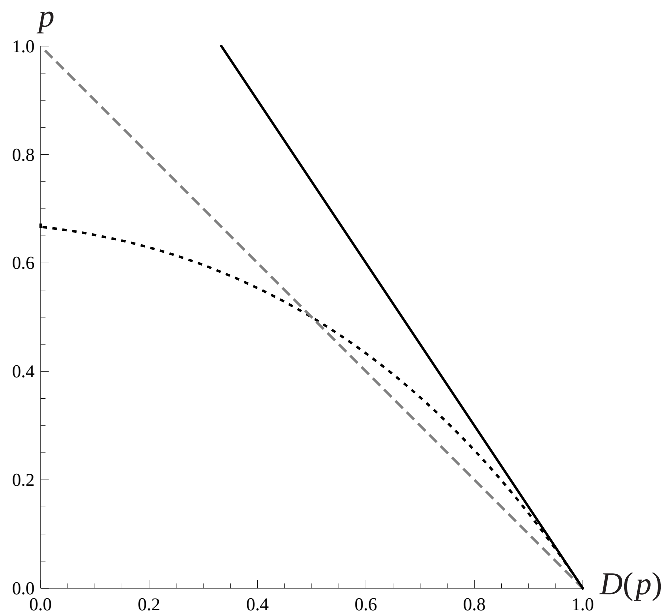
$$p(\hat{r}) = \frac{(\lambda + 1)}{2} \cdot \hat{r}. \tag{30}$$

This implies that the marginal consumer becomes fully attached by optimal threshold advertising, $\hat{r}(p) = 2/(\lambda + 1) \cdot p = \underline{r}(p) < p$ (compare Lemma 1 about maximal attachment). This is due to the fact that consumers do not face a loss in the price dimension on the equilibrium paths because they already expected to be paying the purchase price with probability one. On the other hand, the loss in the match value dimension would be maximal if a consumer with a positive signal decided not to buy the product ex post because receiving a match value equal to or higher than the threshold was expected with probability one. In particular, this holds true for the marginal consumer at $\hat{r}$ who buys the product to avoid this maximal loss in the match value dimension although she is not receiving any gain in the match value dimension from buying since her valuation is the lowest in the buyer interval $[\hat{r}(p), b]$. Analogously, not buying is optimal for consumers who received the negative signal ($r \in [a, \hat{r}]$). $\hat{r}(p) = \underline{r}(p)$ implies that, for given price, the interval of buyers is maximized.

Taken together, we receive that advertising threshold match information with threshold $t = 2/(\lambda+1) \cdot p$ is the optimal mode of match information transmission. No other mode of match information transmission leads to a higher level of consumer attachment for given price. The next lemma summarizes.

Lemma 4. *Suppose consumers observe price p. Then, for all $p \in [a, b]$, the monopolist cannot do better than informing a consumer whether or not her match value lies above the threshold $t = \hat{r}(p) = \max\{2/(\lambda + 1) \cdot p, a\}$.*

Proof. The result follows from Lemma 1, Lemma 3 and (30): since consumers who receive a positive signal buy with probability one, we receive by Lemma 1 that threshold advertising with $t = \hat{r}(p) = \max\{2/(\lambda + 1) \cdot p, a\}$ is the optimal mode of advertising in our setup. □



Inverse demand functions for $\lambda = 2$, solid: *optimal threshold advertising*, dotted: *no match value advertising* and dashed: *full match value advertising*; match values are uniformly distributed on $[a, b] = [0, 1]$.

Figure 4: Inverse Demand Functions: Complex Goods

The next proposition characterizes the subgame perfect Nash equilibrium under unconstrained advertising. We suggest that optimal threshold advertising is preferred over full and no match advertising. The equilibrium price exceeds the one in the case of full match advertising (or when consumers show standard preferences) by factor $(\lambda + 1)/2$.

Proposition 2. *Suppose that match value advertising is unconstrained—i.e., that full, partial and no information disclosure are feasible—and that $\lambda \leq \lambda^c$ such that* (12) *is satisfied. Then, the monopolist prefers advertising optimal threshold match information with $t = 2/(\lambda+1) \cdot p^{**}$ over any other mode of advertising. The equilibrium price is given by,*

$$p^{**} = \frac{(\lambda + 1)}{2} \cdot p_A^*, \tag{31}$$

where p_A^* is the equilibrium price under full match advertising (or when consumers show standard preferences), see (3)*. Equilibrium always exists.*

The proof of this proposition is presented in Appendix A.

Johnson and Myatt (2006) indicate that demand curve shifts can be attributed to the persuasive effect of advertising, while demand curve rotations (around the median) can be attributed to the informative effect. Figure 4 illustrates that the inverse demand curve under optimal threshold advertising (solid line) can be attained by a combination of a clockwise rotation around ($D = 0.5, p = 0.5$) and an outward shift of the inverse demand curve under no match value advertising (dotted line). On the other hand, the inverse demand curve under full match value advertising (dashed line) is attained by a clockwise rotation of the latter around ($D = 0.5$, $p = 0.5$) only. This shows that, with loss–averse consumers, purely informative advertising has a persuasive effect which is inversely U-shaped in the information content of advertising.

5 Extensions and Robustness

5.1 No Price Advertising

In this subsection, we discuss the consequences of relaxing the assumption that price is observable to consumers ex ante. We show that, in contrast to classical models of consumer search, non–observability of prices can lead to equilibrium non–existence when consumers are expectation–based loss averse. We then present additional assumptions under which an equilibrium exists even without prices being observable or advertised ex ante. Under any of these assumptions, the monopolist is essentially indifferent between advertising prices or not.

In the classical model of Anderson and Renault (2006) consumers face positive search costs and the monopolist has an incentive to advertise price information together with full match information due to a hold–up problem which resembles the Diamond paradox (cf. Diamond, 1971). This is due to the fact that, without being committed to a certain price level, the monopolist always finds it profitable to set a price higher than expected by consumers after search costs are sunk. Anticipating such a price increase, consumers would decide not to search and would not to buy the product.

In our model, we have to deal with a similar, yet more intense problem with respect to price deviations ex post which compromises equilibrium existence: due to imperfect consumer attachment ex ante—i.e., future attachment is not incorporated into consumers' initial willingness to pay as in the case of full match advertising—the monopolist might prefer to deviate from consumers' expected price level ex post. However, in contrast to Anderson and Renault (2006), such a price increase ex post can lead to non–existence in our model since consumers always visit the shop ex post and the price set by the monopolist might not meet consumers' expectations. We provide a formal proof of this claim in

Web Appendix B. We next discuss assumption which ensure equilibrium existence even if price is not advertised ex ante.

Different weights of the two dimensions of loss aversion: consider a consumer who shows a different parameter of loss aversion for each dimension—i.e., $\lambda_r \neq \lambda_p$ and $\lambda_r, \lambda_p \geq 1$. If no match value information is disclosed, the consumer's net utility from buying is equal to

$$\Delta u = 2\underbrace{(\hat{r} - p)}_{\text{net intrinsic u.}} + \underbrace{(\lambda_r - 1)(1 - F(\hat{r}))\hat{r}}_{\text{net loss in match value}} - \underbrace{(\lambda_p - 1)F(\hat{r})p}_{\text{net loss in price}}. \tag{32}$$

Her attachment is largest if the consumer only perceives loss aversion in the match value dimension, i.e., if $\lambda_r > \lambda_p = 1$,

$$\hat{r} < \frac{2 + (\lambda_r - 1)(1 - F(\hat{r}))}{2}\hat{r} = p$$

and her attachment is lowest and even negative if the consumer only experiences loss aversion in the price dimension, i.e., if $1 = \lambda_r < \lambda_p$,

$$\hat{r} > \frac{2}{2 + (\lambda_p - 1)F(\hat{r})}\hat{r} = p.$$

This indicates that loss aversion in the price dimension decreases attachment, whereas loss aversion in the match value dimension has the opposite effect. Furthermore, for $\lambda_r < \lambda_p$, the monopolist has less incentives to deviate from consumer's expected price if the price would not be observable ex ante. This is due to the fact that the relatively large weight on loss aversion in the price dimension increases consumers' losses of an unexpected price rise.

Only optimal threshold match advertising: since optimal threshold match advertising fully attaches consumers, the price consumers would anticipate without price observability ex ante is equal to the optimal price the monopolist can achieve. Therefore, the monopolist would not have an incentive to deviate from consumers' expectations if price was not observable ex ante.

Only niche products: niche products are products which are only bought by consumers who have a very high valuation for the product (e.g. role–play computer games). For those products, consumers often already know that they will buy the next version of the product even before it is released. In our model, this can be represented by consumers whose valuation shows a very high lower bound a. If $a \geq \underline{r}(p) = 2/(\lambda + 1) \cdot p$, buying for sure is a PPE (cf. Section 3.2). Moreover, if the price with niche consumers reaches that with fully attached consumers, the monopolist does not have an incentive to deviate from consumers' price expectations and thus price advertising is not required for an equilibrium to exist.

Informed consumers: A sufficiently large share of fully informed consumers who also know the price ex ante prevents the monopolist from deviating from uninformed consumers' expectations.

Utility shock: Another way to depart from price observability ex ante might be the introduction of an ex post utility shock for which consumers do not experience gain–loss utility (see Heidhues and Kőszegi, 2005). This is due to the fact that such a shock reduces consumer attachment ex post which could create a profitable price deviation otherwise.

5.2 Positive Search Costs

In this subsection, we analyze the case of positive search costs, $z > 0$, which consumers face when they want to learn their individual match value ex post. Suppose that the price is observable ex ante. Our results will not be affected if all consumers search even if no match information is advertised. Note that, in this case, any consumer will search to observe her match value ex post if expecting not to search (and not to buy) is not credible. By contradiction, consider a consumer who expects not to search with probability one. Her indirect utility of not searching (and not buying) is zero. Now, consider her indirect utility from searching and buying if she deviates from her initial plan and if she turns out to be of high type $r \geq \hat{r}_1$ (which happens with probability $(1 - F(\hat{r}_1))$),

$$u(r, p, 1) = \Big(r - p - \underbrace{\lambda p}_{\text{loss in price}} + \underbrace{r}_{\text{gain in match}}\Big)(1 - F(\hat{r}_1)) - z - \underbrace{\lambda z.}_{\text{loss in search costs}} \tag{33}$$

$\Delta u \geq 0$ for the indifferent consumer at $\hat{r}_1$ is equivalent to

$$(\frac{2}{(\lambda + 1)}\hat{r}_1 - p)(1 - F(\hat{r}_1)) \geq z. \tag{34}$$

For z sufficiently low, (34) is satisfied if $\hat{r}_1 > \overline{r}(p) = (\lambda + 1)/2 \cdot p$ which means that not searching is not credible. The only additional requirement for this condition to be satisfied is that $b > \overline{r}(p)$. This means that the price cannot be too high. Therefore, if (34) is satisfied, consumer search with probability one and face no net loss in search costs. Moreover, search cost are irrelevant for the location of the indifferent consumer between buying and not buying. Hence, our results are robust to search costs up to a certain limit specified by (34). With optimal threshold advertising, the critical level of search costs is higher than the one specified in (34). It is determined by

$$(\frac{2}{(\lambda+1)}\hat{r}_2 - p)\frac{1-F(\hat{r}_2)}{1-F(\hat{r})} \geq z,$$

where $\hat{r}_2 > \hat{r} = 2/(\lambda+1) \cdot p$.

For larger search costs, consumers would not search on their own without initially receiving further match value information by the monopolist's advertising signal. In such a case, the monopolist would additionally have an informative motive for match value disclosure but the persuasive motive would still be present and render full match value disclosure suboptimal.

6 Discussion

6.1 More General Marketing Instruments

Allowing for more general marketing instruments with loss–averse consumers, we predict that salespersons with a short–term perspective could exploit fully informed consumers by offering unexpected product add–ons ex post (e.g. extra insurances for cars) or by convincing consumers to switch to a more expensive product version ex post. A different way to accomplish optimal threshold advertising in our setting is by targeting high–type consumers directly based on consumer purchase history but without revealing full match information (e.g. see targeted ad newsletters by Amazon). When money–back guarantees are offered in addition to advertising, we predict that, in our model, firms will use the same advertising strategies even for experience goods—i.e., for products whose match value cannot be fully accessed by consumers at the moment of purchase.

6.2 Sophisticated vs. Naive Consumers

Although we assume that loss–averse consumers form rational expectations, loss–averse consumers behave time inconsistently in the sense that they potentially buy a product whose price exceeds their initial valuation (compare the classical models of hyperbolic discounting by Loewenstein and Prelec, 1992, Laibson, 1997, and O'Donoghue and Rabin, 1999). As an extension of our baseline model, self–contained information acquisition by consumers could be introduced. We argue that sophisticated consumers have an incentive to reduce the risk of overpay by acquiring additional information themselves after watching an ad but before making a purchase decision. This could shift their reference point back—i.e., increase their cutoff between buying and not buying up to p.

If we allow for consumers which are naive about their non–standard preferences, we make the following two predictions: first, due to incomplete Bayesian updating, naive consumers become less attached by optimal threshold advertising because they neglect the induced shift of their cutoff between buying and not buying. Second, they neither avoid potentially harmful advertisements nor search for more objective product information on their own in advance of their purchase decision. They also try (and finally buy) individually unfavorable experience goods too often when money–back guarantees are offered (together with informative advertising) because they do not anticipated their future attachment towards buying the good.[30]

6.3 Related Literature

In this subsection we continue to compare our results to those of the classical advertising literature and the literature on consumer loss aversion. Our focus is on papers not discussed in the introduction.

Classical advertising: there is large theoretical and empirical literature following Nelson (1974) on advertising as a signalling device. In this literature, firms may provide information about their product attributes indirectly through their advertising expenditures rather than directly through advertising content. Considering products which are horizontally and vertically differentiated, some of the papers in this literature also find that intermediate levels of horizontal information disclosure can be optimal. In a monopoly setup, Bar-Isaac, Caruana, and Cunat (2010) show that, with ex ante heterogeneous consumers, an intermediate disclosure strategy (which induces only some consumers to search for the value of the horizontal product component) can be optimal for two different reasons: first, it could be used as a discrimination device which induces some, but not all consumers to acquire information on their own and, second, it could be used as a signalling device when firm's investment in quality is unobservable. The main difference to our model is that the authors consider initial consumer heterogeneity in the taste for quality which facilitates separation of consumer groups. In a duopoly setup, Sun (2011) indicates that

[30] Compare Ariely (2009), Ch. 8. and consumer behavior described in the illustrative example in Section 2.

horizontal product attributes are less likely to be disclosed if the product is of high quality. Mayzlin and Shin (2010) show that providing no informative advertising content can be a signal of high quality in a monopoly setup with limited consumer attention and costly search opportunity for consumers. In Kraehmer (2006), costly advertising creates a brand image which increases consumers' willingness to pay. This describes a way to found the persuasive role of advertising on optimization behavior. In our setup, however, the persuasive role of advertising is based on arousing consumers' early desire for possessing the good (attachment effect). Consumers' attachment is created by the informative content of advertising rather than by its function as a signalling device. Anand and Shachar (2009) predict that, in a competitive environment, targeted advertising can signal match value information to consumers if the information content is noisy, but not fully uninformative.

Some other work has focussed on the fact that consumers' unawareness of the relevance of certain product attributes can be used by firms to induce consumers to make suboptimal product choices (see Zhou, 2008 for a monopoly setup and Eliaz and Spiegler, 2011 for a more general environment with competing firms). In this case, a firm only advertises the product attributes which are the most favorable to the firm. In our setup, consumers form rational expectation and do not overvalue advertised product attributes. The optimal advertising strategy implies the revelation of a larger number of product attributes. High–type consumer become more interested in the product but, at the same time, low–type consumers learn that they do not like the product.

Other papers consider advertising when consumer face a positive consumption externality from buying the same good (social goods).[31] Following Chwe (2001), this literature highlights that firms' advertising expenditures can serve as a coordination device for consumers who benefit from consuming a social good. In contrast to our paper, this literature focusses exclusively on the signalling interpretation of advertising instead of its information content.

Following the seminal paper of Resnik and Stern (1977), the marketing literature has provided a large number of studies which analyze the informative content of advertising in all media channels across countries and product categories and over time. In a meta–analysis, Abernethy and Franke (1996) show a summary of the results of these studies. They report that 84% of 91,438 ads show at least one cue, 58% show at least two cues, while 33% show at least three. The product categories with the highest information content are cars, furniture and electronics (with an average above 2.7 cues). This is in line

[31]See among others Chwe (2001), Pastine and Pastine (2002), Clark and Horstmann (2005), Sahuguet (2011).

with our theoretical prediction that the informative content of advertising should be high yet partial for complex and expensive durable goods. Shachar and Anand. (1998) and Anand and Shachar (2011) provide evidence for the effectiveness of informative advertising for TV tune–ins which are used by TV networks to advertise their own shows. As an identification strategy the authors use the fact that consumers' degree of experience varies substantially between regular shows and special shows which are only broadcasted once. Erdem and Keane (1996), Ackerberg (2001) and Ackerberg (2003) also aim at identifying the informative effect of advertising but have to adjust for its persuasive effect. Our paper provides a potential explanation for this.

Loss Aversion: we next review the related literature on consumer loss aversion. Kőszegi and Rabin (2006, 2007, 2009) introduced the concept of expectation–based reference points which we use in this paper. Heidhues and Kőszegi (2008) and Karle and Peitz (2011) apply this concept to model consumer behavior in oligopolistic product markets. [32] Zhou (2011) and Spiegler (2010) consider consumers with history–based and sampling–based reference points in an oligopolistic and a monopolistic setting and partly confirm the results of the two former papers. Departing from the Kőszegi and Rabin framework, Carbajal and Ely (2011) analyze a buyer–seller relationship with asymmetric information on the seller side when buyers are loss averse.

The behavioral model closest to ours is that of Heidhues and Kőszegi (2010) who examine a monopolist's optimal pricing strategy when loss–averse consumers decide about buying one unit of a product with known, common valuation. The authors show that the monopolist who is able to commit to a price distribution ex ante creates consumer attachment by infrequently offering variable sales prices for which not buying is not credible for consumers. In our setup, prices are uniform but the monopolist uses informative advertising with respect to consumers' horizontal product valuations to create consumer attachment. In contrast to Heidhues and Kőszegi (2010), we receive full attachment of the marginal consumer which means that the optimal advertising strategy fully exploits this consumer type. Moreover, we are able to quantify the resulting markup above the optimal price with

[32] Heidhues and Kőszegi (2008) predict less price variation across products (focal prices) and over time (sticky prices) when consumers are expectation–based loss averse. In a related setup in which consumers incorporate information about price levels into their reference points, Karle and Peitz find a pro–competitive effect of consumer loss aversion if firms are strongly asymmetric or if the degree of loss aversion in the price dimension is more pronounced. Loss aversion has an increasing anti–competitive effect if the number of firms is increasing (in an environment in which the effect would be competitively neutral with standard consumers) or if the degree of loss aversion in the match value dimension rises. Other papers like Herweg, Mueller, and Weinschenk (2010), Hahn, Kim, Kim, and Lee (2010) and Herweg and Mierendorff (forthcoming) show that expectation–based loss aversion can explain open questions in classical principal–agent theory.

standard consumers as a function of the degree of consumer loss aversion.

In line with our behavioral assumptions, Malmendier and Szeidl (2008) provide evidence from laboratory and field experiments that, in online auctions like in those on eBay, certain bidders tend to overbid due to loss aversion (with respect to not receiving the good).[33]

More broadly, this paper contributes to the analysis of behavioral biases in market settings, as in DellaVigna and Malmendier (2004), Eliaz and Spiegler (2006), Gabaix and Laibson (2006), and Grubb (2009).[34]

7 Conclusion

This paper has examined informative advertising for a single product when consumers are loss averse and form expectation–based reference points about their purchase expenditure and match value from the product. For this purpose, we embedded rational consumers with non–standard preferences à la Kőszegi and Rabin (2006) into the advertising model of Anderson and Renault (2006) which analyzes advertising content for inspection goods in a monopolistic setup. In our model, consumers who are initially uninformed about their individual valuation (or match value) of the good receive the monopolist's advertising signal containing match value information prior to forming their reference points. The monopolist can therefore influence consumers' reference points by his choice of advertising content.

We show that optimal advertising informs consumers about whether their intrinsic valuation lies above or below a certain threshold which is lower than the purchase price.[35] In contrast to Anderson and Renault (2006), we find that optimal informative advertising increases consumers' willingness to pay (i.e. has a persuasive effect) and that disclosing match value information is strictly preferred by the monopolist to no information disclosure even when consumers' search costs are relatively low. The former result is related to Ariely's (2009) concept of *virtual ownership* which suggests that disclosing certain product attributes to consumers can induce a perception of ownership for a good even before purchase takes place. *Virtual ownership* in turn increases consumers' valuation

[33] See also Heyman, Orhun, and Ariely (2004) and Ariely (2009, Ch.8). Other explanations for overbidding reported in this literature are bidding fever and joy of playing.

[34] For overviews, see Ellison (2006), DellaVigna (2009), and Spiegler (2011).

[35] Threshold match information can be released by the monopolist by disclosing a certain, intermediate number of product attributes if the number of product attributes is sufficiently large relative the number of consumer tastes.

of the good similar to an endowment effect. We also predict that low price advertising without disclosing match value information increases consumers' willingness to pay (or attaches consumers) to some extent,[36] while full information disclosure does not. More precisely, full information disclosure does not attach consumers initially when deciding about their cutoff of buying the good but rather ex post when purchase takes place given expectations. This means that full information disclosure does neither increase equilibrium prices nor equilibrium profits above the the level with standard consumers which, in our setup, reflects a long–term perspective of the firm. Without price commitment, the firm would have an incentive to increase prices ex post above the announced level (short–term perspective; fraud).[37]

Our paper provides a nuanced view of a monopolist's optimal policy for product information disclosure: first, it is optimal to maintain match value uncertainty above the threshold level because loss aversion in the match values dimension is attachment increasing. Second, it is optimal to reduce the initial uncertainty about whether a consumer will pay the purchase price ex post or not. This is due to the fact that loss aversion in the price dimension is attachment decreasing. Third, a monopolist dealing with non–standard consumers benefits from offering a product for which consumers face a sufficient amount of uncertainty with respect to their valuation of the horizontal product component. More generally, this can be interpreted as a preference for narrow product lines by the monopolist. This is opposed to the implications of the model of Anderson and Renault (2006) in which a reduction of consumers' uncertainty about match values decreases the need for informative advertising and, moreover, is profit enhancing (if search costs are sufficiently high).

In our paper, we find that, under optimal threshold advertising, marginal consumers are worse off than under full information disclosure due to overpay, while consumers with high valuations might be better off although prices are higher because of an extra gain in the match value dimension. Non–buyers are not affected. Under low price advertising, marginal consumers are worse off than under full information disclosure due to excess demand. Consumers with low valuations for the good are worse off due to an additional loss in the match values dimension when not buying the cheap product. Only consumers with

[36]This result is related to that of Heidhues and Kőszegi (2010) who predict that, for a product with known common value, variable sales prices occur in equilibrium with positive probability. While, in their setup, uncertainty with respect to consumers' purchase decision is created by stochastic price setting of the monopolist, in our setup, all consumer uncertainty at the reference–point–formation stage stems from undisclosed match value information by the monopolist.

[37]Kőszegi and Rabin (2006) raised the point that salespersons might want to use a "throwing a low ball" strategy which proposes to increase offered prices after consumers became attached to buying.

high valuations who would have bought the product under full information disclosure as well are better off because of lower prices. So overall, optimal consumer protection policy should highlight the importance of self–contained consumer information acquisition in advance of actual purchase decisions. Consumers should have access to consumer product rankings whose information content exceeds those of advertisements.

Future research might shed light on optimal advertising content with loss–averse consumers under firm competition. It may also be fruitful to apply this framework to contracting problems of firms, such as hiring new employees when employees are loss–averse.

Appendix

A Relegated Proofs

Proof of Lemma 1. Suppose, for given price p, a consumer located at r expects to buy with probability σ, $\sigma \in [0, 1]$. Then, her indirect utility of buying ex post equals

$$u(r, p, 1|\sigma) = r - p - \underbrace{\lambda(1-\sigma)p}_{\text{loss in } p} + \underbrace{(1-\sigma)r}_{\text{gain in } r},$$

where the probability of the complementary event "not buying" $(1-\sigma)$ affects the size of gains and losses. Her indirect utility of not buying ex post can be expressed as

$$u(r, p, 0|\sigma) = 0 + \underbrace{\sigma p}_{\text{gain in } p} - \underbrace{\lambda\sigma r}_{\text{loss in } r}.$$

The consumer will buy the product ex post if $\Delta u = u(r, p, 1|\sigma) - u(r, p, 0|\sigma) \geq 0$ which is equivalent to

$$r \geq \frac{2 + (\lambda-1)(1-\sigma)}{2 + (\lambda-1)\sigma} p \equiv \underline{r}(p|\sigma).$$

Note that the gap between p and $\underline{r}(p|\sigma)$ is maximized if $\underline{r}(p|\sigma)$ is minimized. Since $\underline{r}(p|\sigma)$ is strictly decreasing in σ, $\sigma = 1$ is the required minimizer. □

Proof of Lemma 2. Given the information provided in the main text, it is left to derive the critical degree of loss aversion λ^c such that the law of demand is satisfied for $\lambda \leq \lambda^c$. $p(\hat{r})$ from (18) can be expressed as follows

$$p(\hat{r}) = \frac{A(\hat{r}) \cdot \hat{r}}{B(\hat{r})}, \tag{35}$$

where $A(\hat{r}) \equiv 2 + (\lambda-1)(1-F(\hat{r}))$ and $B(\hat{r}) \equiv 2 + (\lambda-1)F(\hat{r})$. For reasons of brevity, we skip the index $\hat{r}$ where unambiguous in the following. The first derivative of $p(\hat{r})$ with respect to $\hat{r}$ is equal to

$$\begin{aligned} p'(\hat{r}) &= \frac{AB - (A+B)(\lambda-1)f \cdot \hat{r}}{B^2} \\ &= \frac{2(\lambda+1) + (\lambda-1)^2(1-F)F - ((\lambda+1)^2 - 4)f \cdot \hat{r}}{B^2}. \end{aligned} \tag{36}$$

Defining $C \equiv (\lambda - 1)^2(1 - F)F > 0$ and $D \equiv ((\lambda + 1)^2 - 4) f \hat{r} > 0$, $p'(\hat{r})$ can be expressed as

$$p'(\hat{r}) = \frac{2(\lambda + 1) + C - D}{B^2}.$$

Since, for $\lambda \to 1$, C and D approach zero, we can always find λ's sufficiently low but $\lambda > 1$ such that $p'(\hat{r}) > 0$. Denote the critical λ such that $p'(\hat{r}) = 0$ as λ^c.

The second derivative of $p(\hat{r})$ with respect to $\hat{r}$ equals

$$p''(\hat{r}) = \frac{B[C' - D'] - 2(\lambda - 1) f \cdot N}{B^3}, \tag{37}$$

where $N \equiv 2(\lambda + 1) + C - D$ is the numerator of $p'(\hat{r})$ and

$$C' - D' = -(\lambda - 1)\Big((4 + 2(\lambda - 1)) f F + 4(\lambda - 1) f' \hat{r}\Big). \tag{38}$$

Since by convexity of F, $f' \geq 0$, we receive that $C' - D' < 0$. Since $C' - D' < 0$, $B > 0$ and, for $\lambda \in (1, \lambda^c]$, $p'(\hat{r}) \geq 0$, it holds that $p''(\hat{r}) < 0$ for $\lambda \in (1, \lambda^c]$. Since $p''(\hat{r}) < 0$ for $\lambda \in (1, \lambda^c]$, $p'(\hat{r}) \geq 0$ $\forall \hat{r} \in [a, b]$ if $p'(b) \geq 0$—i.e., it suffices to focus on the highest value of $\hat{r}$, $\hat{r} = b$. Thus, from $p'(b) \geq 0$ we can derive λ^c.

$$\begin{aligned} p'(b) &\geq 0 \\ b f(b) \cdot \Lambda^2 - 2 \cdot \Lambda - 4 b f(b) &\geq 0, \end{aligned}$$

where $\Lambda = \lambda + 1$. The two square roots of this quadratic equation are described by

$$\Lambda_{1/2} = \frac{1 \pm \sqrt{1 + 4b^2 f^2(b)}}{b f(b)}.$$

Choosing the root which is consistent with $\lambda > 1$ leads to

$$\lambda^c = \frac{1 + \sqrt{1 + 4b^2 f^2(b)}}{b f(b)} - 1.$$

□

Proof of Proposition 1. The proof compares the results of Section 3 (full and no match advertising) and shows that an equilibrium exists in both subgames. Given that marginal costs are zero, the monopolist's profit function is equal to $\pi(p) = p[1 - F(\hat{r}(p))]$. As $\hat{r}(p)$ is strictly increasing in the relevant range (see Lemma 2), the profit function can also be expressed as a function of $\hat{r}$— $\pi(\hat{r}) = p(\hat{r})[1 - F(\hat{r})]$—and be maximized over $\hat{r}$. This yields

$$\pi'(\hat{r}) = p'(\hat{r})(1 - F(\hat{r})) - p(\hat{r})f(\hat{r}) \tag{39}$$

and

$$\pi''(\hat{r}) = p''(\hat{r})(1 - F(\hat{r})) - 2p'(\hat{r})f(\hat{r}) - p(\hat{r})f'(\hat{r}). \tag{40}$$

Note that, for $\lambda \in (1, \lambda^c]$, the second–order condition is always satisfied since F is convex, $f'(\hat{r}) \geq 0$: in the subgame without match information disclosure, for $\lambda \in (1, \lambda^c]$, $p'(\hat{r}) > 0$ and $p''(\hat{r}) < 0$ where $p(\hat{r})$ is given by (12). Therefore $\lambda \in (1, \lambda^c]$ is a sufficient condition for equilibrium existence in this subgame. In the subgame with full match value disclosure, $p(\hat{r}) = \hat{r}$ and an equilibrium always exists.

Since, for $\lambda \to 1$, the equilibrium profit in the subgame with no match information disclosure (N) approaches that with full match information disclosure (A), it suffices to show that, for $\lambda \in (1, \lambda^c]$,

$$\frac{d\pi^N(\hat{r})}{d\lambda} > 0.$$

Note that $\pi^N(\hat{r}(\lambda), \lambda) = p^N(\hat{r}(\lambda), \lambda)(1 - F(\hat{r}(\lambda)))$, where $\hat{r}$ is given by the first–order condition (**??**) and $p^N(\hat{r})$ by (12). By the envelope theorem, we receive that the sign of the equilibrium profit depends only on the sign of the equilibrium price,

$$\frac{d\pi^N(\hat{r})}{d\lambda} = \frac{\partial p^N(\hat{r})}{\partial\lambda}(1 - F(\hat{r})).$$

It holds that

$$\frac{\partial p^N(\hat{r})}{\partial\lambda} = \frac{2(1 - 2F)}{(2 + (\lambda - 1)F)^2}\begin{cases} > 0, & \text{if } \hat{r} < Median(r); \\ \leq 0, & \text{if } \hat{r} \geq Median(r). \end{cases} \tag{41}$$

This is in line with our observation made in Section 3.3 that consumers become attached without match information disclosure if price are sufficiently low—or equivalently if $\hat{r}$ is sufficiently low.

We next show that convexity of F implies that, for $\lambda \in (1, \lambda^c]$, $\hat{r} < Median(r)$. First note that, for $\lambda = 1$, convexity of F implies that $Median(r) \geq (b - a)/2$ and $f(Median(r)) \geq 1/(b-a)$. Now, by contradiction assume that, for $\lambda = 1$, $\hat{r} > Median(r)$. Then, $F(\hat{r}) > 1/2$. From the first–order condition it follows that $1 - F(\hat{r}) - \hat{r}f(\hat{r}) = 0$. Therefore, it must hold that $\hat{r} f(\hat{r}) < 1/2$ which states a contradiction to $\hat{r} f(\hat{r}) > Median(r) f(Median(r)) \geq (b-a)/(2(b-a)) = 1/2$. Hence, for $\lambda = 1$, $\hat{r} \leq Median(r)$ must hold. This property carries over with strict inequality to the case of $\lambda \in (1, \lambda^c]$ if $d\hat{r}^N/d\lambda < 0$. Applying the implicit function theorem to the first–order condition (**??**), we receive,

$$\frac{d\hat{r}^N}{d\lambda} = -\Big[\frac{(p')^2 - p''p}{(p')^2} - \frac{-f^2 - f'(1-F)}{f^2}\Big]^{-1} \cdot \frac{p'\partial p/\partial\lambda - p\partial p'/\partial\lambda}{(p')^2}. \tag{42}$$

The first term in square brackets is positive since, for $\lambda \in (1, \lambda^c]$, $p'' \leq 0$. The second term is also positive due to $f' \geq 0$. Since, for $\lambda \in (1, \lambda^c]$, $p' > 0$ and $\partial p/\partial\lambda > 0$, the third term is positive if $\partial p'/\partial\lambda$ is sufficiently low with

$$\partial p'/\partial\lambda = \frac{2(1-2F)(2+(\lambda-1)F) - 4[(\lambda+1)-(\lambda-1)F]\hat{r}f}{(2+(\lambda-1)F)^3} \lesseqgtr 0.$$

Simplifying the the numerator of the third term of (42) yields

$$p'\partial p/\partial\lambda - p\partial p'/\partial\lambda = \frac{2\hat{r}^2\Big(5+\lambda(\lambda+2) - 2(\lambda-1)^2(1-F)F\Big)f}{(2+(\lambda-1)F)^4},$$

which is always positive since $(1-F)F$ is bound above by $1/4$. Hence, $d\hat{r}^N/d\lambda < 0$ which implies that $d\pi^N/d\lambda > 0$. Thus, for $\lambda \in (1, \lambda^c]$, $\pi^N(p^N) > \pi^N(p^N)|_{\lambda=1} = \pi^A(p^A)$ which completes the proof. □

Proof of Lemma 3. Suppose the monopolist undertakes threshold match advertising with threshold $t \in [a, b]$ (i.e., consumers receive an advertising signal of either $r < t$ or $r \geq t$). Consumers then form expectations about their purchase expenditure (p or 0) and their match value ($r \in [\hat{r}(p,t), b]$ or $r = 0$).

First consider the case in which $t \leq \hat{r}(p,t)$, where $\hat{r}(p,t) \in [a,b]$ reflects the cutoff match value between buying and not buying after receiving a positive signal ($r \geq t$) for threshold t at given price p. If a consumer receives a positive signal ($r \in [t, b]$), then, due to Bayesian updating, $h(p'|\hat{r}(p,t))$ equals

$$h(p'|\hat{r}(p,t)) = \begin{cases} \frac{F(\hat{r})-F(t)}{1-F(t)}, & \text{if } p' = 0; \\ \frac{1-F(\hat{r})}{1-F(t)}, & \text{if } p' = p, \end{cases} \tag{43}$$

where $(1-F(\hat{r}))/(1-F(t))$ reflects the probability of buying conditional on receiving a positive signal. The density function of the reference point distribution in the match value dimension $g(r|\hat{r}(p,t))$ is equal to

$$g(r|\hat{r}(p,t)) = \begin{cases} \frac{F(\hat{r})-F(t)}{1-F(t)}, & \text{if } r = 0; \\ 0, & \text{if } r \in [a,\hat{r})\backslash\{0\}; \\ \frac{f(r)}{1-F(t)}, & \text{if } r \in [\hat{r},b], \end{cases} \tag{44}$$

where $f(r)/(1-F(t))$ describes the conditional density of $F(r)$ for $r \geq t$. Given the conditional density functions, the indifferent consumer's net utility from buying relatively to not buying can be derived in the common way. It equals

$$\Delta u = 2(\hat{r}-p) + (\lambda-1)\frac{1-F(\hat{r})}{1-F(t)}\hat{r} - (\lambda-1)\frac{F(\hat{r})-F(t)}{1-F(t)}p. \tag{45}$$

$\Delta u = 0$ is equivalent to

$$p = \frac{2+(\lambda-1)\frac{1-F(\hat{r})}{1-F(t)}}{2+(\lambda-1)\frac{F(\hat{r})-F(t)}{1-F(t)}} \cdot \hat{r}. \tag{46}$$

Analogously, it can be shown that consumers who receive a negative signal do not buy for any threshold $t \in [a,\hat{r}]$ since their cutoff match value between buying and not buying $\hat{r}^{-}(p,t)$ lies above t. Hence, minimizing the cutoff match value between buying and not buying $\hat{r}(p,t)$ over the threshold t is optimal for the monopolist for any given price level $p \in [a,b]$. Applying the implicit function theorem to (46), it can be shown that $d\hat{r}(p,t)/dt$ is negative for $t \leq \hat{r}(p,t)$. Thus, $\hat{r}(p,t)$ is minimized at $t = \hat{r}(p,t)$.[38] Using (46), $\hat{r}(p,\hat{r})$ can be determined: $\hat{r}(p,\hat{r}) = 2/(\lambda+1)\cdot p$. Note that this implies that the marginal consumer becomes fully attached by optimal threshold advertising $\hat{r}(p,\hat{r}) = \underline{r}(p) < p$ (compare Lemma 1 about maximal attachment). For simplicity reasons, we refer to $\hat{r}(p,t=\hat{r})$ as $\hat{r}(p)$ in the following.

It is left to show that choosing the threshold $t = \hat{r}$ is more profitable for the monopolist than choosing any higher threshold $t' \in (\hat{r},b]$. The intuition for this result is that sending a negative signal instead of a positive one to a consumer with r above $t = \max\{a,\hat{r}\}$ decreases her willingness to pay without increasing any other consumer's willingness to pay by a sufficient amount to compensate the monopolist for the loss with the former consumer. High–type consumers who receive a positive signal also under the new threshold level ($r \geq t' > \hat{r}$) keep on buying with probability one, while high–type consumers who receive a negative signal under the new threshold level ($t' > r > \hat{r}$) start to buy with a

[38] Note that if p is sufficiently close to a, $\hat{r}(p,t)$ is bound below at a (corner solution) and (46) is no longer satisfied with equality.

probability smaller than one or do not buy at all. Low–type consumers who already received a negative signal before ($r < \max\{a, \hat{r}\}$) keep on not buying because, by Lemma 1, the lowest type who can be attracted into buying via attachment for given price p is located at $r = \hat{r}(p)$. Thus, choose a threshold $t' \in (\hat{r}, b]$ is strictly dominated by the threshold $t = \hat{r}$. $\square$

Proof of Proposition 2. The proof combines the results of Section 3 and 4 and shows that an equilibrium always exists. We first consider equilibrium existence. An existence proof for the case of full and no match information is provided in Proposition 1. Concerning existence in the subgame with threshold match advertising when $t \in [a, \hat{r}]$, note that no match advertising is simply a special case of this subgame when the threshold t is equal to a. It can be shown that existence for $t = a$ carries over for all $t \in [a, \hat{r}]$ since $p(\hat{r}, t)$ in (46) becomes less non–linear when t increases in the interval $[a, \hat{r}]$. For $t = \hat{r}$, $p(\hat{r}, t)$ becomes linear, in fact. Therefore, convexity of F and $\lambda \in (1, \lambda^c]$ ensure existence in any subgame.

Second, optimality of threshold match advertising (T) with threshold $t = \hat{r}$ (compare Lemma 3) relatively to any other mode of information transmission (including full (A) or no (N) match advertising) follows from a revealed preference argument: note that by Lemma 1, for any price $p \in [a, b]$, the cutoff match value between buying and not buying is at minimum level under optimal threshold advertising (cf. Lemma 1),

$$\hat{r}^T(p) = \max\{2/(\lambda + 1) \cdot p, a\} = \max\{\underline{r}(p), a\} = \arg\min_{r \in [a,b]} \Delta u(r, p|\Gamma(p, \sigma = 1)) \geq 0,$$

where $\Gamma(p, \sigma = 1)$ means that, for given price, the consumer expected to buy with probability one. Hence, demand under optimal threshold advertising is largest for any price $p \in [a, b]$. Hence, profit under optimal threshold advertising is largest for any price $p \in [a, b]$. Thus, by revealed preferences, the equilibrium profit under optimal threshold advertising must be higher than that under full or no match advertising.

It is left to show that the optimal price under optimal threshold advertising is $(\lambda + 1)/2$ larger than that under full match advertising, $p^{**} = (\lambda + 1)/2 \cdot p_A^*$. This follows directly from the first–order conditions. Given that $\hat{r}(p) = 2/(\lambda + 1) \cdot p$, the first–order condition under optimal threshold advertising is equivalent to

$$p = \frac{1 - F(\frac{2}{(\lambda+1)} \cdot p)}{f(\frac{2}{(\lambda+1)} \cdot p) \cdot \frac{2}{(\lambda+1)}}.$$

Next, multiplying by $2/(\lambda + 1)$ and substituting $2/(\lambda + 1) \cdot p$ by p_A^* delivers the result, where $p = p^{**}$. $\square$

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