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Uninformative Advertising as an Invitation to Search

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What the firm should say in an advertising message, the choice of *content*, is a critical managerial decision. Here, we focus on a particular aspect of the advertising content choice: an attribute-focused appeal versus an appeal with no direct information on product attributes. We make two assumptions that capture the reality of the advertising context. First, we assume that the bandwidth of advertising is limited: a firm can only communicate about a limited number of attributes. Second, we assume that consumers are active: they can choose to engage in a costly search to obtain additional product-related information. In this setting, we show that there exists an equilibrium where the high-quality firm chooses to produce messages devoid of any attribute information in order to invite the consumer to engage in search, which is likely to uncover positive information about the product. Whereas most of the previous literature has focused on the decision to advertise as a signal of quality, we show that message content, coupled with consumer search, can also serve as a credible signal of quality. In an extension, we show that our results are robust to endogenizing the firm's decision on the amount of advertising spending.

Key words: advertising; advertising content; attribute; nonattribute-focused advertising; uninformative advertising; quality signal; consumer search
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1. Introduction

Many markets are characterized by imperfect consumer information—consumers are often poorly informed about the existence, price, and attributes of products. Because of this uncertainty, firms invest large amounts of resources into developing effective advertising campaigns to influence consumer learning. Given this, it is surprising to observe that in practice a large proportion of advertising contains no direct information on product attributes (Abernethy and Butler 1992 find that 37.5% of U.S. TV advertising has no product attribute cues). In this paper, we provide a novel explanation for the firm's decision to strategically withhold information on product attributes in its advertising.

In particular, we explain when a firm would choose to make vague claims (or no claims) as opposed to mention specific product attributes in its advertising. We will refer to a campaign that emphasizes product attributes as "attribute-focused" advertising. By definition, this type of advertising contains "hard" information (Tirole 1986) about product benefits, and hence, the claims are credible and verifiable. In contrast, we will refer to a campaign that does not emphasize any particular product attribute as ostensibly "uninformative" or "nonattribute-focused" advertising.[1]

As an example of attribute-focused advertising, consider the credit card issuer Capital One's "What's in Your Wallet?" campaign, which focuses on one specific attribute, such as the convenience of claiming rewards or the low interest rate. Other firms in the same industry pursue a different advertising strategy in that they convey no direct information about their credit cards' benefits. For example, the American Express's "My Life. My Card." campaign made no mention of the card's benefits such as its excellent rewards program.[2] We will refer to this type of message as nonattribute-focused.[3]

How will these different types of advertising campaigns affect consumers' inference about product quality? What is the relationship between product

[1] Previous advertising literature uses the term "uninformative" advertising to designate advertising that has no direct information on product attributes (Milgrom and Roberts 1986, Bagwell and Ramey 1994, Bagwell 2007). Here, however, the term "uninformative" is confusing because in our model "uninformative" ads do convey information about quality to the consumer in equilibrium. Hence, we mostly use the term "nonattribute-focused" advertising to avoid confusion.

[2] Since it started ranking credit cards in 2007, J.D. Power and Associates has consistently ranked American Express as number one in customer satisfaction (see J.D. Power and Associates 2010).

[3] In practice, the discrete classification of all ads into "attribute-focused" or "nonattribute-focused" is difficult. For example, some nonattribute-focused ads provide basic information about the product, whereas some attribute-focused ads focus on irrelevant or nondifferentiating attributes. Hence, the simple classification of "attribute-focused" or "uninformative" is an approximation of what is really a continuum.

quality and the firm's decision to make attribute-focused claims? In particular, why do we sometimes observe high-quality brands choosing ads that make no mention of their product's attributes, as was the case for American Express during the duration of the "My Life. My Card." campaign? One may think that the high-quality firm would choose to emphasize the its product's benefits that are, by definition, strong. However, the limited bandwidth of communication inherent in any form of advertising implies that a firm can talk about only a small subset of its product's attributes. It is impossible for a firm to accurately communicate all of the features associated with its product in a 30-second commercial or a print ad (Shapiro 2006, Bhardwaj et al. 2008). Hence, if the firm claims to be good on a few selected attributes, its advertising will be indistinguishable from the advertising of the firm that is *only* good at those attributes. If, on the other hand, the firm makes no attribute-focused claims, its advertising will be indistinguishable from the advertising of a firm that cannot deliver high quality on any attributes.

For example, consider the digital camera Canon PowerShot SD940 IS. This camera is high quality on a large number of attributes: the Canon website lists 18 technologies that were contained within the camera (consistent with this, in 2010, the camera was ranked second out of 55 in the subcompact digital camera category by ConsumerReports.org). Clearly, Canon cannot emphasize all of PowerShot's superior attributes in a 30-second commercial or a print ad. On the other hand, if Canon decides to focus on one of the PowerShot's attributes, such as the quality of its flash photos, it cannot distinguish itself from a camera such as Nikon Coolpix S3000, which happens to have high-quality flash photos but is dominated by the PowerShot on the versatility dimension. If Canon instead chooses to emphasize the versatility dimension, then it cannot distinguish itself from Pentax Optio I-10, which is equally versatile but is dominated by the PowerShot on LCD quality.[4]

The argument above highlights the point that the firm may not be able to entirely resolve the uncertainty about its product through advertising alone under limited bandwidth in advertising communication. However, a consumer who is uncertain about the product's features following exposure to advertising may take actions to resolve this uncertainty (i.e., the consumer is "active"): she can conduct her own search to discover the product's quality prior to purchase by engaging in activities such as reading online product reviews or talking to her friends. Therefore, the high-quality firm may actually prefer to withhold product attribute information in its advertising (i.e., engage in nonattribute-focused advertising) in order to encourage the consumer to search because it is confident that the information uncovered will be positive. In contrast, an average firm that imitates this strategy risks losing its customer in cases when she uncovers negative information as part of her search. Hence, an average firm may choose to engage in an attribute-focused appeal, despite the fact that this perfectly reveals its type. Upon seeing a nonattribute-focused ad, the consumer may choose to search because she is unsure whether the advertiser is the high-type product, who says little because it has so much to say, or the low-type product, who says little because it has nothing to say. Hence, nonattribute-focused advertising serves as an invitation to search.

In this paper, we formalize the above argument and analyze the firm's simultaneous price and advertising content decisions. We also endogenize the consumer's search behavior, which is again affected by the firm's price and advertising content. By taking into account the fact that consumers may choose to search for additional information after seeing its advertising, the high-quality firm may strategically withhold information on product attributes in its advertising message, and therefore, advertising content can signal product quality. In an extension we show that advertising content can signal quality even when the amount of advertising spending can serve as a signal of quality (which is the case in "money-burning" models of advertising) as long as the consumer's observability of advertising spending is imperfect. We also show that our results are robust to several other alternative model specifications, such as allowing heterogeneity of consumer preferences, asymmetric attributes, and multiple attributes cases.

The rest of this paper is organized in the following manner. In §2, we relate our paper to the existing literature in economics and marketing. Section 3 presents the model setup. We discuss the model results and its extensions in §§4 and 5, and we conclude in §6.

2. Literature Review

This paper contributes to the literature on informative advertising.[5] The information that advertising provides can be direct, such as the existence of the product or its price (for example, Grossman and Shapiro 1984), or indirect, where the mere fact that the firm advertises signals the quality of the product (for example, Nelson 1974).

In the existing literature, "indirect" information has been associated with quality signaling. The most

[4] Our quality information is based on the ranking of digital cameras on ConsumerReports.org (accessed September 2010).

[5] There are also other perspectives on advertising, such as the persuasive and complementary views of advertising (see Bagwell 2007 for a comprehensive survey of the literature).

prominent theory of the quality-signaling role of advertising is known as the *money-burning* theory of advertising (see Nelson 1974, Kihlstrom and Riordan 1984, Milgrom and Roberts 1986, Bagwell and Ramey 1994, and Bagwell 2007 for a comprehensive review). According to this theory, the seller of an experience good (a product whose quality cannot be ascertained prior to experience) cannot credibly make direct claims about product quality in its ads. Instead, the high-quality firm can credibly convey its quality information *indirectly* through its advertising expenditure. Hence, one of the important takeaways of this theory is that it is the *level* of spending that signals the quality of the product, not the content of the message.

On the other hand, for search goods (whose quality can be ascertained before purchase), firms may convey quality information directly through the advertising message. Of course, if the information can be conveyed directly through advertising content, there may be no room for quality-signaling through advertising.[6] However, we show that the signaling role of advertising is important even for search goods because of limited bandwidth. As we mentioned before, the limited bandwidth in advertising (Shapiro 2006, Bhardwaj et al. 2008) implies that the firm cannot perfectly convey quality information directly through its advertising message alone, and therefore, it cannot fully resolve the uncertainty concerning the product quality. Thus, the firm may choose to take further action to resolve this remaining uncertainty.

There are several papers that relate to the issue of advertising content. In particular, a number of papers have focused on direct information contained in the advertising message, such as price information or information about product existence. For example, Butters (1977), Grossman and Shapiro (1984), and Janssen and Non (2009) allow the firm to announce the existence of its product or price through advertising. Simester (1995) and Shin (2005) examine the credibility of price claims in advertising messages.

Recently, researchers have also started to incorporate advertising content (other than price) explicitly in their models. Anand and Shachar (2007) show that although advertising content plays no role in equilibrium, it may shape off-equilibrium beliefs. Anderson and Renault (2006) investigate the amount of and the type of information that a seller of search goods would choose to reveal in its advertising messages when consumers are imperfectly informed about product attributes and prices. That is, they investigate whether a firm would choose to inform consumers about product attributes and/or prices in the presence of consumer travel costs. Although our work is similar to Anderson and Renault (2006) in that we also find that the firm may strategically choose to withhold information in its advertising, the model setups and, hence, the mechanisms behind the two results are very different.[7] In Anderson and Renault (2006), the travel cost creates a misalignment of incentives between the firm and the consumer. That is, whereas the firm wants to convey to a high-valuation consumer precise match information in order to encourage her to visit the store, the firm may not want to convey precise match information to a lower-valuation consumer before her visit. Because of this trade-off, the firm chooses to reveal only partial match information in its advertising. In this paper, on the other hand, the firm chooses to withhold information in order to encourage the consumer to obtain additional information on her own.

Researchers also find that the firm can signal its quality through actions other than advertising, such as product warranties (Moorthy and Srinivasan 1995), umbrella branding (Wernerfelt 1988), and the selling format (Bhardwaj et al. 2008). In particular, our model relates to Bhardwaj et al. (2008) in that both papers consider quality signaling in the presence of limited bandwidth in communication. However, there are important differences between the two papers. First, we focus on the content of the communication, whereas Bhardwaj et al. (2008) focus on who initiates the communication. That is, our model assumes that the firm always initiates communication and investigates whether attribute information should be communicated in an ad, whereas Bhardwaj et al. (2008) assume that attribute information is always sent and ask who should initiate the communication. Second, in our model the costly search is a decision variable on the part of the consumer, whereas in Bhardwaj et al. (2008), the search is costless and always occurs.

To summarize, our paper contributes to two different research streams in advertising: (1) the signaling role of advertising (or advertising as indirect information) and (2) the role of advertising content (or advertising as direct information). Existing literature finds that in the search goods case, the signaling role of advertising is irrelevant. However, under the limited bandwidth of advertising, the firm cannot perfectly

[6] One notable exception is Anand and Shachar (2009), who investigate the signaling role of advertising for search goods. They suggest that the targeting of ads can also serve as a signal on the *horizontal* attributes of the product, whereas our model concerns a quality signal in a *vertical* setting.

[7] Sun (2011) also investigates the monopolistic seller's incentive to disclose the horizontal matching attributes of a product. Kuksov (2007) studies the incentives of consumers to reveal or conceal information about themselves to others through brand choices in the consumer-matching context. Yoganarasimhan (2009) finds that firms sometimes prefer to conceal information to increase the social value of their products.

convey its quality information in its advertising even for search goods. In this case, we show that advertising content can serve as an invitation for the consumer to search for further information on product quality. Hence, advertising content can signal product quality.

Also, our model contributes to the literature on countersignaling (Teoh and Hwang 1991, Feltovich et al. 2002, Araujo et al. 2007, Harbaugh and To 2008).[8] In contrast to the standard signaling models where high types send a costly signal to separate themselves from the low types, in countersignaling models the high type chooses not to undertake a costly signaling action. People of average abilities, for example, get more education than bright people in labor markets (Hvide 2003). Mediocre firms reveal their favorable earnings information while both high-quality and low-quality firms tend to conceal their earnings information in the financial market (Teoh and Hwang 1991). Feltovich et al. (2002) formalize this intuition and show that in the presence of an external signal, the high type may pool with the low type while the medium type prefers to separate. Their motivating example is one of a job seeker, who has not seen his letters of recommendation, deciding whether or not to reveal his high school grades during an interview. We follow the setup of Feltovich et al. (2002) in that we also have three possible types of senders (in our case, the firm), and the receiver (the consumer in our case) can obtain an additional noisy signal on the firm's type.

Although our model's result *is* similar to the results in countersignaling models in that the high and low types pool on the same action, the advertising context makes it necessary for us to define a model that is significantly different from the extant countersignaling models. First, and most importantly, whereas in the previous countersignaling models (for example, Feltovich et al. 2002, Harbaugh and To 2008) the receiver is assumed to *always* receive the second signal, in our model the receiver (i.e., the consumer) is active and, hence, only receives this additional information if she chooses to search after observing the price and content of the advertising message. That is, we endogenize the presence of a second signal, which plays a critical role in enabling the equilibrium where the high and the low types pool on nonattribute-focused advertising. Second, we also allow price to be a potential signal, which was not an issue in the earlier models. This has a substantive as well as a technical implication for the model. Substantively, the consumer's decision to search is critically affected by the price that the firm charges. Hence, depending on the level of price that the firm charges, different types of equilibria arise. Technically, endogenizing price and search allows us to identify conditions under which our focal equilibrium is unique. In contrast, in most countersignaling models, the countersignaling equilibrium is not unique. Finally, in existing countersignaling models, the high and low types do not undertake the costly signaling action (hence, the term "countersignaling"), whereas in our basic model all types engage in advertising, where the exact content differs by type.

Although we have focused on rational explanations for uninformative advertising, there are a number of behavioral-based explanations for this phenomenon (see Carpenter et al. 1994, Holbrook and O'Shaughnessy 1984, Kardes 2005, Scott 1994).[9] These models emphasize the importance of both the cognitive and emotional responses to advertising. Because we predict that firms may choose to engage in uninformative advertising even in the absence of these psychological forces, our work complements these explanations.

3. Model

The game consists of one firm and one consumer. There is an informational asymmetry about the quality of the firm's product: the firm knows the quality of its product, whereas the consumer must infer the product's quality from signals that she receives from the firm as well as information that she may obtain on her own. In particular, the product consists of two attributes, $\alpha \in \{A, a\}$ and $\beta \in \{B, b\}$, where the capital letter stands for higher quality on that dimension. We also assume that an attribute is equally likely to be high or low quality, $P(\alpha = A) = P(\beta = B) = 1/2$; and that there may be correlation between levels of the two attributes, $P(\beta = B \mid \alpha = A) = P(\alpha = A \mid \beta = B) = P(\beta = b \mid \alpha = a) = P(\alpha = a \mid \beta = b) = \rho$, where $0 < \rho < 1$. Hence, there are three possible types (θ) of products based on the quality levels of the attributes: $\theta \in \{H, M, L\} = \{\{A, B\}, \{A, b\}$ or $\{a, B\}, \{a, b\}\}$, with the a priori probabilities of $(\rho/2, 1-\rho, \rho/2)$, respectively.[10]

The consumer has the following utility function:

$$u = u_0 + \tfrac{1}{2}\bar{V} \cdot \mathbf{1}\{\alpha = A\} + \tfrac{1}{2}\bar{V} \cdot \mathbf{1}\{\beta = B\}, \qquad (1)$$

[8] A similar phenomenon is known in the sociology literature as the middle-status conformity theory: the high- and low-status players may deviate from conventional behavior while the middle-status players conform to social norms (Phillips and Zuckerman 2001). These models, however, do not involve a signaling story.

[9] Lauga (2010) incorporates a behavioral insight to propose a novel role of advertising as affecting the distribution of prior beliefs that consumers have about product quality. In this setting she shows that advertising does not necessarily signal the quality of the product.

[10] Note that if $\rho = 1$ (perfect positive correlation), only $\{A, B\}$ and $\{a, b\}$ products exist, and if $\rho = 2/3$, all products are equally likely.

where $\mathbf{1}\{\cdot\}$ indicates whether the attribute is high quality, and u_0 is the basic utility from the product consumption. The consumer receives extra utility $(1/2)\bar{V}$ when the quality of each attribute is high.[11] Hence, a priori, the H-type product delivers utility $u_0 + \bar{V}$ to the consumer, the M-type delivers utility $u_o + \bar{V}/2$, and the L-type delivers u_0 utility. We further normalize $u_0 = 0$ for simplicity.

Note that although the exact utility levels are not important to our results (for example, we can renormalize $u_0 > 0$ to better capture the reality that even inferior products yield some utility to the consumer), the rank ordering of products from the consumer's perspective is important. Hence, all else equal, the consumer would prefer H to M, and M to L, which in turn implies that L wants to imitate H and M; M wants to separate itself from L and imitate H, and H wants to separate itself from M and L.

We also assume that the cost of advertising is zero, and the firm always advertises for awareness. This allows us to focus on the role of advertising content above and beyond the well-known effect of money burning, where the firm can signal its quality through the amount of its advertising spending. In §5.1, we investigate a nonzero advertising cost case where we allow the firm to decide the amount of advertising.

The firm's action space consists of its choice of price, p, and advertising, a. In particular, the firm has two possible advertising choices. First, the firm can choose an ad that centers on the product's attributes, an "attribute-focused" advertising ("attribute" advertising for short). Here, we impose the truth-telling assumption following the literature (Anderson and Renault 2006, Bhardwaj et al. 2008, Simester 1995): the firm cannot claim to be high quality on an attribute on which it is in fact low quality.[12] This implies that while H and M can engage in either attribute-focused or nonattribute-focused advertising (because both are high quality on at least one attribute), L can only engage in nonattribute-focused advertising because he cannot claim to be high quality on either attribute.[13]

To capture the reality of limited bandwidth inherent in a communication medium such as TV, we allow the firm to transmit information about only one attribute—either α or β: $a = a_j$, where $j \in (\alpha, \beta\}$. In practice, a product contains a large number of features. However, given the constraints on the time available for communication as well as the limited cognitive resources available to the consumer for processing advertisement information (Shapiro 2006), the firm is only able to communicate about a small subset of these features (Bhardwaj et al 2008).[14] In §5.3, we extend this two-attribute model to a more general multiattribute setting. We show that the critical assumption is whether the bandwidth of advertising is low enough so that the H type cannot distinguish itself from the M type through the message alone.

Table 1 **All Types and Possible Actions**

Product type	Attribute α	Attribute β	Expected utility	Possible ads	Price
L	a	b	0	a_0	$p \geq 0$
M	A (or a)	b (or B)	$\bar{V}/2$	a_0, aj	$p \geq 0$
H	A	B	$\bar{V}$	a_0, aj	$p \geq 0$

In contrast to attribute-focused advertising, the firm can choose not to emphasize any particular attribute: $a = a_0$. We refer to this as "nonattribute-focused" advertising ("nonattribute" advertising for short). In Table 1 we summarize the possible types and the actions available to them.

Following Meurer and Stahl (1994), we assume that the consumer can costlessly obtain information on the firm price p after observing the ad.[15] After the consumer receives the advertising message and observes the price, she can choose to invest a cost c in order to discover the quality of the product. After incurring this cost of search, the consumer obtains extra noisy information about the product quality.[16] This may involve searching for online reviews (Chevalier and Mayzlin 2006), observing word of mouth (Chen and

[11] For now, we assume that both attributes are equally important to the consumer, but we relax this assumption in §5.2.

[12] The Federal Trade Commission (FTC) requires that "advertising be truthful and nondeceptive" and that all claims must have a "reasonable basis" (http://www.ftc.gov/bcp/conline/pubs/buspubs/ad-faqs.shtm). Whether in reality the FTC can perfectly enforce truth-telling is an interesting question but is beyond the scope of this paper.

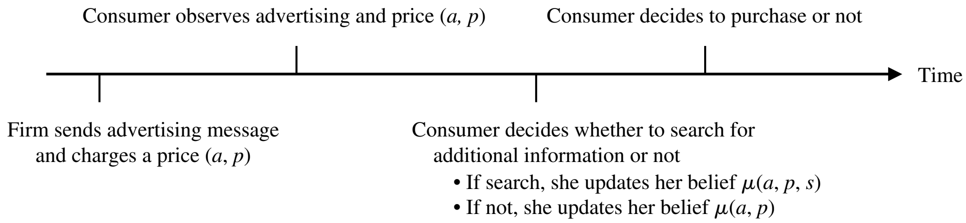
[13] Advertisers often advertise irrelevant or basic attributes. For example, any credit card can be used as a payment method and offers convenience to the consumer. Because all types can deliver these basic attributes, this type of ad is uninformative to the consumer. Therefore, we regard such an ad as nonattribute focused.

[14] There are two possible sources of limited bandwidth in advertising. First, any one channel of communications has limited bandwidth, which is the supply-side source. The firm, however, may be able to bypass this limit by communicating through multiple channels. However, even if the firm is able to communicate about all of its attributes through multiple channels, it would be difficult for a consumer to process such a large amount of information as a result of limited cognitive resources. This demand limitation is the second source of limited bandwidth.

[15] If the firm is not able to commit to the price initially, the consumer would not choose to invest in search because she would fear that the firm would charge a price that would extract all of her surplus. This is very similar to a holdup problem that occurs in the presence of consumer travel costs (see Wernerfelt 1994).

[16] In reality, consumers may search for more than one signal (in particular, this may be more likely when the price is high). However, we abstract away from this and assume that the consumer can choose to obtain only one additional signal at cost c to capture our main result in the simplest possible way.

Figure 1 Timing of the Game



Xie 2008, Godes and Mayzlin 2004), reading *Consumer Reports*, or doing other types of search activities. We assume that consumer search yields a binary signal on the product quality, $s \in \{\underline{s}, \bar{s}\}$, where $\bar{s}$ denotes positive news, and $\underline{s}$ denotes negative news. The search outcome is related to the product's quality level, $\theta \in \{L, M, H\}$, according to the following probabilities:

$$\Pr(\bar{s} \mid \theta) = \gamma_\theta, \quad \text{and} \quad \gamma_L < \gamma_M < \gamma_H. \tag{2}$$

The firm knows that the consumer can obtain this extra information with the above probabilities but does not observe whether the consumer actually chooses to search for this extra signal, let alone what signal the consumer ultimately receives if she chooses to do so. The signal space of each type has the same support so that no signal is perfectly informative. Also, Equation (2) implies that the higher-quality firm is more likely to generate favorable information. This amounts to the *MLRP* (monotone likelihood ratio property) assumption over the signal space across types. In other words, positive news ($\bar{s}$) is really "good news" regarding the firm's quality (Milgrom 1981).

For example, suppose that after viewing an ad for Canon PowerShot, Bob posts an inquiry about this camera on a digital photography forum. Because this camera's quality is excellent, Bob is likely to receive a positive recommendation. Bob is less likely to receive a positive review for Nikon Coolpix, which is more likely to disappoint a random consumer. This example illustrates several important points. First, the information the consumer receives through search is potentially richer than the information she can obtain after viewing an ad. The binary signal above can be viewed as a summary of all the product attributes. Second, even an excellent product may generate a negative signal: there is noise in the signal because of factors such as individual taste idiosyncrasies or promotional chat generated by firms, for example. However, a better product is more likely to yield a positive signal (Mayzlin 2006). Hence, the additional signal is informative but noisy.

After the consumer receives information regarding the product (through either advertising, prices, or own research), she forms a belief on the quality of the product. Here, we signify by Ω the consumer's information set and by $\mu(\Omega)$ the consumer's belief. In particular, $\mu(\Omega) = (\mu_L(\Omega), \mu_M(\Omega), \mu_H(\Omega))$, where $\mu_L(\Omega) = \Pr(L \mid \Omega)$, $\mu_M(\Omega) = \Pr(M \mid \Omega)$, $\mu_H(\Omega) = \Pr(H \mid \Omega)$. The consumer's information set (Ω) includes the observation of advertising (a), the price (p), and the consumer's own search (s), if that takes place.

The consumer then decides whether to purchase the product at its posted price based on the posterior belief on its quality: $\mu(a, p, s)$ in the case of consumer research and $\mu(a, p)$ in the case of no search. We assume that a consumer who is indifferent between purchasing and not purchasing the product chooses to purchase it. The timing of the model is summarized in Figure 1.

4. Perfect Bayesian Equilibrium

We start with the consumer's problem and then turn to the firm's strategy. The consumer observes advertising and price, (a, p), and decides whether to search for additional information before making the final purchase decision. If the consumer is uncertain about the firm's type even after observing the price and advertising, she can either (1) forgo search for additional information and make a purchase decision based on her belief, $\mu(a, p)$, which we abbreviate to μ; or (2) search for additional information s at cost c. In the absence of additional search, the consumer buys the product if and only if $\mathrm{E}(V \mid \mu) - p \geq 0$. That is, she buys the product if the prior belief is relatively favorable or the price is relatively low. The consumer will search for additional information if

$$\mathrm{E}\,U(\text{search}) \geq \mathrm{E}\,U(\text{no search}) \equiv \max(0, \mathrm{E}(V \mid \mu) - p). \tag{3}$$

Note that the consumer undertakes a costly search only if her decision to purchase differs depending on the outcome of the signal (i.e., there must be value in the information acquired). In other words, when the consumer chooses to search, she buys only if the signal is high ($s = \bar{s}$). The conditions for when the consumer chooses to search are specified in the following lemma.

Lemma 1 (Consumer Search). 1. *If* $E(V \mid \mu) - p \geq 0$, *the consumer will search for additional information iff*

$$c \leq \Pr(\underline{s} \mid \mu)[p - E(V \mid \mu, \underline{s})] \Leftrightarrow E(V \mid \mu, \underline{s}) + \frac{c}{\Pr(\underline{s} \mid \mu)} \leq p. \tag{4}$$

2. *If* $E(V \mid \mu) - p < 0$, *the consumer will search for additional information iff*

$$c \leq \Pr(\bar{s} \mid \mu)[E(V \mid \mu, \bar{s}) - p] \Leftrightarrow p \leq E(V \mid \mu, \bar{s}) - \frac{c}{\Pr(\bar{s} \mid \mu)}. \tag{5}$$

Moreover, when $p = E(V \mid \mu)$,

$$\Pr(\underline{s} \mid \mu) \cdot [p - E(V \mid \mu, \underline{s})] = \Pr(\bar{s} \mid \mu)[E(V \mid \mu, \bar{s}) - p].$$

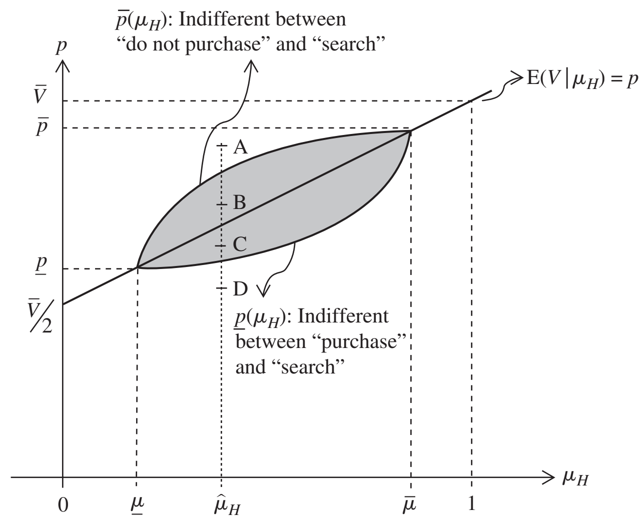
Proof. See the appendix. □

Equations (4) and (5) compare the marginal cost and the marginal benefit of search. The marginal cost of search (the left-hand side of Equations (4) and (5)) is c. The marginal benefit is represented by the right-hand side of these equations and differs depending on the price. If $E(V \mid \mu) - p \geq 0$, the consumer would choose to buy the product based on the prior alone in the absence of an additional signal. Hence, the marginal benefit of search is in preventing purchase in the case when the signal is negative ($s = \underline{s}$). On the other hand, when $E(V \mid \mu) - p < 0$, the consumer would not purchase the product in the absence of an additional signal. Therefore, the marginal benefit of search is in enabling the consumer to purchase the product in the case when the signal is positive ($s = \bar{s}$). Note that if the conditions in either Equation (4) or Equation (5) hold, then Equation (3) holds; that is, the consumer chooses to search before making her purchase decision.

One implication of Lemma 1 is that given a belief, the consumer chooses to search for additional information only if the product's price is within a certain range (see Lemma 2 in the appendix for more details). Hence, we can identify the range of prices and beliefs that ensures the existence of consumer search. For example, Figure 2 illustrates the consumer's decision to search for extra information when the consumer is not certain whether the firm is H or M type. This can occur if the consumer observes an attribute ad, which implies that the product is not L type but could be either H or M type. In Figure 2, the prior belief μ_H (the probability that the product is H type) is graphed on the x axis (where $0 \leq \mu_H \leq 1$).

For a given belief ($\hat{\mu}_H$), if the price is low enough ($p < \underline{p}(\hat{\mu}_H)$), the consumer prefers to buy the product without further search (see point D in Figure 2). As

Figure 2 **Consumer Beliefs and Optimal Response Behaviors**



we mentioned in our discussion of Lemma 1, at relatively low levels of p, i.e., $p \leq E(V \mid \hat{\mu}_H)$, the value of additional search is in preventing purchase when the outcome of search is negative, which in this case is captured by $p - E(V \mid \hat{\mu}_H, \underline{s})$. Hence, when p is low, the marginal benefit of search is not high enough to justify the cost of search. At any point on the convex curve $p = \underline{p}(\mu_H)$, the consumer is indifferent between buying without search or engaging in further search. At a higher price ($\underline{p} < p(\hat{\mu}_H) < \bar{p}$), the consumer prefers to search (see points B and C in Figure 2). That is, here the consumer incurs a cost c to obtain an additional signal and purchases if and only if the outcome is positive, $s = \bar{s}$, since $E(V \mid \hat{\mu}_H, \bar{s}) > p$ and $E(V \mid \hat{\mu}_H, \underline{s}) < p$. On the other hand, at any point on the concave curve $p = \bar{p}(\mu_H)$, the consumer is indifferent between no purchase and engaging in further search, and at $p > \bar{p}(\hat{\mu}_H)$ the price is so high that the consumer surplus obtained even in the case when the outcome of search is positive ($E(V \mid \hat{\mu}_H, \bar{s}) - p$) is not high enough to justify the cost of search (see point A in Figure 2). As we can see from the figure, given $\hat{\mu}_H$, the consumer chooses to search for additional information only if $p \in [\underline{p}(\hat{\mu}_H), \bar{p}(\hat{\mu}_H)]$. Moreover, if the belief is extreme, ($\mu_H < \underline{\mu}$ or $\mu_H > \bar{\mu}$), and therefore there is little uncertainty, the consumer does not engage in search at any price. Only at the high level of uncertainty, which occurs at the intermediate level of the belief, $\mu_H \in [\underline{\mu}, \bar{\mu}]$, does there exist a price range at which search occurs. Note that the cutoff beliefs, $\underline{\mu}, \bar{\mu}$, are a function of the search cost c. As c increases, the range $[\underline{\mu}, \bar{\mu}]$ decreases and becomes empty when $c > (\bar{V}(\gamma_H - \gamma_M))/8\bar{V}$ (see Lemma 2 in the appendix). That is, search will not occur under any belief if the search cost is sufficiently high. Because we want to model an active consumer who can choose to engage in her own search, we focus on the region of the parameter space where the cost c is low enough such that search is a feasible option to the consumer.[17]

Assumption. *Search cost is low enough such that* $c \leq \bar{V}(\gamma_H - \gamma_M)/8\bar{V}$.

What is the potential role of search in our model? As we can see from Figure 2 above, given the prior belief $\hat{\mu}_H$, the possibility of consumer search allows the firm to charge a higher price (see point B in Figure 2, for example) compared with a situation where no consumer search is possible, in which case the maximum the firm can charge is $p = \mathrm{E}(V \mid \hat{\mu}_H)$. That is, the fact that the consumer can undertake an action to resolve the uncertainty surrounding the firm's quality enables the firm to charge a higher price. In this sense, the firm may want to invite the consumer to search. We can think of this as the benefit of search to the firm. However, whereas the possibility of search increases the upside of a transaction through higher price, it also introduces the possibility that no transaction occurs in the case when the consumer receives a negative signal, which may happen even for the highest type because the signal is noisy. We can think of the no-transaction outcome as the cost of search (or alternatively as the risk inherent in search) to the firm. Because the probability of a negative signal differs across different types, search is differentially costly to different quality types. Therefore, the firm that "invites" the consumer to search through an advertising action may be able to signal its quality by credibly demonstrating its confidence in the outcome of the search.

We next consider the firm's strategy and the equilibrium of the game. We focus on pure strategies only. Hence, each type chooses an advertising and price combination: (a_θ, p_θ), where $\theta \in \{L, M, H\}$. There are a number of equilibria that are possible, ranging from full separation to full pooling (see Table 2). For example, in HM equilibrium, the H and M types send out the same advertising message and post the same price, whereas the L type differs in at least one of these actions: $(a_H, p_H) = (a_M, p_M) \equiv (a_{HM}, p_{HM}) \neq (a_L, p_L)$. This in turn implies that if the consumer observes (a_L, p_L), she infers that the product is L type. On the other hand, if she observes (a_{HM}, p_{HM}), she is uncertain whether the firm is H type or M type. Her decision to search for extra information depends on her prior belief as well as the price p. Although the advertising action choice is discrete (an advertising action can be either attribute focused or nonattribute focused), the price variable is continuous, which implies that a continuum of prices is possible for each type of equilibrium.

[17] This low search cost assumption guarantees that there always exists a consumer belief under which search is the best response for the consumer if she observes either a_0 or a_j. See Lemma 2 in the appendix for more details.

Table 2 All Possible Equilibria

Equilibrium type	Description	Notation
Full separating	H, M, L separate	FS
Semi-separating	H, M pool	HM
Semi-separating	H, L pool	HL
Semi-separating	M, L pool	ML
Full pooling	H, M, L pool	HML

We can quickly rule out two potential equilibria: the fully separating equilibrium (FS) and the semi-separating equilibrium, where M and L pool (ML) by contradiction. Suppose that there exists a fully separating equilibrium, FS. Full separation implies that the consumer can simply infer the product's type by examining its advertising and the price. Furthermore, in this equilibrium, the consumer does not search because search is costly and the product's type can be perfectly observed. That is, $(a_L, p_L) \neq (a_M, p_M) \neq (a_H, p_H)$. From our model assumptions, the L type can only send a nonattribute-focused uninformative ad: $a_L = a_0$. Also, note that if $p_H > p_M$, the M type will deviate to H strategy, and if $p_H < p_M$, the H type will deviate to M's strategy because the consumer will not search in this equilibrium. This implies that $p_H = p_M = \tilde{p}$. This in turn implies that it must be the case that $a_H \neq a_M$ in equilibrium. Hence, either H or M must engage in nonattribute advertising in the FS equilibrium. Suppose that $a_H = a_0$, and let $\tilde{p} < p_L$. This, of course, implies that H will mimic L's strategy. If, on the other hand, $\tilde{p} > p_L$, L will mimic H's strategy. Hence, it must be the case that $\tilde{p} = p_L$, which implies that $(a_L, p_L) = (a_H, p_H) = (a_0, \tilde{p})$. This contradicts the initial assertion that $(a_L, p_L) \neq (a_M, p_M) \neq (a_H, p_H)$; therefore, a fully separating equilibrium does not exist in our model.

Proposition 1. *A fully separating equilibrium does not exist.*

The result above illustrates the importance of search in enabling signaling in our model. Consumer search cannot occur in a fully separating equilibrium because the consumer has no uncertainty about the firm type after observing price and advertising. The assumption that there are more types (three types) than possible advertising actions (two possible actions: attribute versus nonattribute ad) results in at least some pooling between different types in advertising action. The remaining question is then whether price can differentiate between types in the absence of search by the consumer. As is illustrated in the proof above, price alone cannot signal quality because our model does not have any of the elements (such as differential costs, demand, or profits from repeat purchases) that would ordinarily enable price to be a signal of quality in standard signaling models. Instead, as we show below, it is consumer search (coupled with price) that enables signaling in our model.[18]

Similarly, we can show that the semi-separating equilibrium *ML*, where *M* and *L* types pool, cannot exist. In *ML*, it must be the case that $p_L = p_M \equiv p_{ML}$, and $a_L = a_M = a_0$. Note that $p_{ML} < \bar{V}/2$, since even with search the consumer cannot be absolutely certain that the product is not *L* type. However, if the *M* type deviates to a_j, $j \in \{\alpha, \beta\}$, it can charge at least $\bar{V}/2$ because an attribute message credibly signals that it is not *L*. Intuitively, because *M* is able to perfectly separate itself from *L* through advertising, it prefers to do so. Hence, an equilibrium where *M* and *L* pool does not exist.

Proposition 2. *ML equilibrium does not exist.*

The remaining three equilibria (*HML*, *HM*, and *HL*) can be categorized into two types: one in which *H* separates from *M* (*HL*) and one in which *H* pools with *M* (*HML* and *HM*).

As is the case for any signaling model, we have to deal with the technical issue of specifying the out-of-equilibrium beliefs. There are two main approaches to dealing with this. The first is to assume a particular set of beliefs following a deviation (see, for example, McAfee and Schwartz 1994). Although this method is often used, it is vulnerable to the criticism that any specific set of chosen beliefs is, by definition, arbitrary. The second approach is to start with an unconstrained set of out-of-equilibrium beliefs but then narrow it using an existing refinement. The strength of this approach is that it imposes some structure on the out-of-equilibrium beliefs—a belief that is consistent with a refinement is more "reasonable." A number of signaling models employ the intuitive criterion (Cho and Kreps 1987) to refine the beliefs (for example, Simester 1995, Desai and Srinivasan 1995). The idea behind this criterion is as follows. Suppose that the consumer observes the deviation $A_1 = (a, p)$. If type θ makes a lower profit in deviation than in equilibrium under *all* possible consumer beliefs, the consumer does not believe that the product could be type θ. That is, if the *L* type would not benefit from the deviation even under the most optimistic belief, $\mu_H = 1$, the consumer does not think that the deviating firm could be type *L*. In our model, however, no search occurs under extreme beliefs, such as $\mu_H = 1$, because the consumer would rationally choose not to search under certainty. Of course, if search does not occur, all types equally benefit (or are hurt) by a deviation, as was illustrated in our discussion following Proposition 1. Hence, the intuitive criterion does not narrow the beliefs in our model; in other words, *any* out-of-equilibrium belief in our model can survive the intuitive criterion.

Instead, and following other countersignaling papers (for example, Feltovich et al. 2002, Harbaugh and To 2008), we use a stronger refinement, the D1 criterion (Fudenberg and Tirole 1991), to eliminate unreasonable out-of-equilibrium beliefs. The idea behind this refinement is roughly as follows. Consider the set of best responses associated with a particular out-of-equilibrium belief. Suppose that the *H* type benefits from the deviation under a bigger set of best responses than the *L* type. Moreover, this is the case for all possible beliefs. D1 then requires that the consumer does not believe that the deviating type is *L*. More generally, suppose that in deviation $A_1 = (a, p)$, type θ' makes higher profit than in equilibrium under a strictly bigger set of best responses from the consumer than type θ does. D1 then requires that the consumer does not believe that the product could be type θ.

Unlike the intuitive criterion, D1 does not require that the *L* type must not benefit from the deviation under *any* possible belief. Instead, it requires that the set of consumer's best responses, which are based on the consumer's beliefs, should be strictly smaller than that of *H* type. We require that a potential equilibrium must be supported by out-of-equilibrium beliefs that survive not only the intuitive criterion but also even the stronger D1 refinement. We discuss the D1 criterion and its application in the appendix.

4.1. The Countersignaling *HL* Equilibrium

We first consider the equilibrium that is the core of this paper: *HL* equilibrium. In this equilibrium, the *H* and *L* types pool on nonattribute advertising and price, whereas the *M* type engages in attribute advertising and perfectly reveals its type to the consumer. Since in Feltovich et al. (2002), the high and the low types undertake the same action, we refer to this equilibrium as the *countersignaling* equilibrium. Surprisingly, in this equilibrium the type with the most to say (the *H* type) chooses a message devoid of any information on product attributes, whereas the mediocre type (the *M* type) chooses to make product attribute claims in its ads. It is this *HL* equilibrium

[18] A separating equilibrium result in signaling models requires that the single-crossing property be imposed across types. In existing models, the single-crossing property is *exogenously* imposed through differential production costs or demand (Schmalensee 1978, Milgrom and Roberts 1986, Bagwell and Ramey 1994). Our model departs from these models in that the single-crossing property here arises from the consumer's *endogenous* search. If we also allow for production costs to differ across types (see Schmalensee 1978) and for firms to be able to convey this cost information to the consumer, our main results unravel because the consumer can perfectly infer the product quality from the product cost information. However, credibly conveying cost information in an advertising message is very difficult because product cost information is not easily observable or verifiable. Hence, we assume that fully conveying cost or attribute information is not possible. We thank the associate editor for raising this issue.

that explains the fact that we observe both types of ads (attribute and nonattribute) in practice and why sometimes high-quality brands choose not to mention specific product attributes in their advertisements.

We first characterize the equilibrium and demonstrate its existence. Second, we show that *HL* equilibrium survives the D1 refinement, and we highlight that search is necessary for the existence of the *HL* equilibrium. Finally, we show that the *HL* equilibrium is unique in §4.2.

Proposition 3. *A semi-separating HL equilibrium exists if*

$$\max\left\{\frac{(1-\gamma_H)\bar{V}+2c}{2-\gamma_H-\gamma_L},\frac{\bar{V}}{2\gamma_H}\right\}<\min\left\{\frac{\gamma_H\bar{V}-2c}{\gamma_H+\gamma_L},\frac{\bar{V}}{2\gamma_M}\right\}.$$

In this equilibrium, H and L types pool on (a_0, p^*_{HL}), *where*

$$\max\left\{\frac{(1-\gamma_H)\bar{V}+2c}{2-\gamma_H-\gamma_L},\frac{\bar{V}}{2\gamma_H}\right\}\le p^*_{HL}<\min\left\{\frac{\gamma_H\bar{V}-2c}{\gamma_H+\gamma_L},\frac{\bar{V}}{2\gamma_M}\right\},$$

whereas the M type separates on $(a_j, p_M=\bar{V}/2)$. *The consumer chooses to search when she observes* (a_0, p^*_{HL}) *and purchases the product only if she receives good news* $(s=\bar{s})$. *Here,* $\Pi^*(H)>\Pi^*(M)>\Pi^*(L)$.

Proof. See the appendix. □

The proposition demonstrates the existence of the *HL* equilibrium with consumer search. The condition for existence presented in Proposition 3 summarizes several restrictions on the model parameters. First, consider the consumer's optimal strategy, given the firm's equilibrium pricing and advertising strategy. Based on Lemma 1 and given equilibrium beliefs, the consumer chooses to search for additional information following (a_0, p^*_{HL}) as long as the equilibrium price is not too low or too high:

$$\frac{(1-\gamma_H)\bar{V}+2c}{2-\gamma_H-\gamma_L}\le p^*_{HL}<\frac{\gamma_H\bar{V}-2c}{\gamma_H+\gamma_L}.$$

If the price is too low such that $p^*_{HL}<((1-\gamma_H)\bar{V}+2c)/(2-\gamma_H-\gamma_L)$, the consumer's best response is to buy without search. Also, if the price is too high such that $p^*_{HL}>(\gamma_H\bar{V}-2c)/(\gamma_H+\gamma_L)$, the consumer's best response is not to purchase. In the proof in the appendix, we show that if the search cost is low enough ($c\le\bar{V}(\gamma_H-\gamma_M/8)\bar{V}$), there always exists a price p^*_{HL} such that the consumer would choose to search in equilibrium.

Next, we turn to the firm's problem. In equilibrium, all types prefer their equilibrium strategies to the optimal deviation. Of course, the optimal deviation depends on the out-of-equilibrium beliefs. To show existence, we assume the following out-of-equilibrium beliefs: $\mu_L=1$ for all $(a_0, p\neq p^*_{HL})$ and $\mu_H=0$ for all $(a_j, p\neq\bar{V}/2)$ (below we show that this belief is indeed reasonable, i.e., survives the D1 refinement). Given this, the firm's nondeviation conditions are the following:

$$\begin{aligned}\Pi^*(a_0,p^*_{HL}\mid q=H)&=\gamma_Hp^*_{HL}>\max_{A_1}\Pi(A_1\mid q=H)=\frac{\bar{V}}{2},\\ \Pi^*(a_j,p_M\mid q=M)&=\frac{\bar{V}}{2}>\max_{A_1}\Pi(A_1\mid q=M)=\gamma_Mp^*_{HL},\\ \Pi^*(a_0,p^*_{HL}\mid q=L)&=\gamma_Lp^*_{HL}>\max_{A_1}\Pi(A_1\mid q=L)=0.\end{aligned}\tag{6}$$

This reduces to the following conditions: $\gamma_Hp^*_{HL}>\bar{V}/2$ and $\gamma_Mp^*_{HL}<\bar{V}/2$, which implies that for the equilibrium to hold, it must be the case that γ_H is high relative to γ_M. We can equivalently express this as a condition on price: $\bar{V}/(2\gamma_H)<p^*_{HL}<\bar{V}/(2\gamma_M)$.

Combining these two conditions, we obtain the result that *HL* equilibrium with search exists if the equilibrium price is in the right range such that

$$\max\left\{\frac{(1-\gamma_H)\bar{V}+2c}{2-\gamma_H-\gamma_L},\frac{\bar{V}}{2\gamma_H}\right\}<p^*_{HL}<\min\left\{\frac{\gamma_H\bar{V}-2c}{\gamma_H+\gamma_L},\frac{\bar{V}}{2\gamma_M}\right\}.$$

Hence, there exists a pooling price, p^*_{HL}, that supports the *HL* equilibrium with search if

$$\max\left\{\frac{(1-\gamma_H)\bar{V}+2c}{2-\gamma_H-\gamma_L},\frac{\bar{V}}{2\gamma_H}\right\}<\min\left\{\frac{\gamma_H\bar{V}-2c}{\gamma_H+\gamma_L},\frac{\bar{V}}{2\gamma_M}\right\}.$$

From the condition on price, it is clearly the case that $p^*_{HL}>\bar{V}/2$, which implies that the *H* type can charge a quality premium based on the reduced consumer uncertainty under consumer search. That is, in the case when the consumer receives good news $(s=\bar{s})$, she is willing to pay a higher price compared with the price she is willing to pay for the *M* type. Hence, the *H* type may prefer to extend an invitation to search to the consumer by pooling with the *L* type on nonattribute advertising when it is confident that the consumer is more likely to receive good news (i.e., γ_H is sufficiently large).

Next, we show that this equilibrium can survive the D1 refinement.

Proposition 4. *A semi-separating HL equilibrium where the consumer chooses to search after observing* (a_0, p^*_{HL}) *exists and survives D1 if*

$$\frac{(\gamma_H-\gamma_M)\bar{p}^j+(\bar{V}/2)(1-\gamma_H)}{\gamma_H(1-\gamma_M)}<\min\left\{\frac{\gamma_H\bar{V}-2c}{\gamma_H+\gamma_L},\frac{\bar{V}}{2\gamma_M}\right\},$$

where

$$\bar{p}^j = \frac{3}{4}\bar{V} + \frac{\sqrt{(\bar{V}^2/4)(\gamma_H-\gamma_M)^2 - 2\bar{V}c(\gamma_H-\gamma_M)}}{2(\gamma_H-\gamma_M)}.$$

Proof. See the appendix. □

In Lemma 3 in the appendix, we characterize the properties of beliefs imposed by D1 and show that the belief we assumed above, $\mu_L = 1$ for all $(a_0, p \neq p^*_{HL})$ and $\mu_H = 0$ for all $(a_j, p \neq \bar{V}/2)$, is consistent with D1. Note that in addition to the conditions we had in Proposition 3, D1 imposes a new lower limit on price.[19] Because not all of the conditions are binding, the constraints reduce to the ones given in Proposition 4.

To summarize, we have shown in Proposition 3 that the countersignaling *HL* equilibrium, where the best and the worst types pool on nonattribute advertising, can exist. In other words, advertising content can signal quality. In Proposition 4 we show that this equilibrium survives the D1 refinement. This demonstrates the robustness of *HL* equilibrium because D1 eliminates equilibria that are supported by unreasonable out-of-equilibrium beliefs.

4.1.1. Discussion. When do we expect to observe the *HL* equilibrium? From Equation (6), for the *HL* equilibrium with consumer search to exist, it must be the case that γ_H is sufficiently *large* and γ_M is sufficiently *small*. Here, the *H* type prefers to pool with the *L* type on nonattribute advertising rather than pursue an attribute-focused strategy that perfectly signals that the firm is *not* the *L* type. Because the additional signal associated with each type is noisy, after a nonattribute ad and own search, the consumer may mistake the *H* type for the *L* type. Therefore, the risk *H* bears by pooling with *L* must be relatively small (γ_H is *large*) such that the *H* type prefers this to the certain outcome of pretending to be the *M* type by engaging in an attribute ad. Moreover, when γ_H is sufficiently large relative to γ_L, the consumer is willing to pay a higher price following good news ($s = \bar{s}$) because she is confident that the product is the *H* type and not the *L* type. Hence, when γ_H is large, not only is the probability of a transaction high but also the price charged can increase. This is the source of *H*'s confidence in extending the invitation to search to the consumer. On the other hand, the *M* type prefers to separate itself from the *L* type rather than pool with it. This can happen only if the additional signal cannot effectively separate between *M* and *L* types (in other words, γ_M is small). Hence, *M* lacks *H*'s confidence and prefers not to mimic *H* because the probability that it may be misjudged as *L* is too high. That is, whereas the *H* type is willing to relinquish control in its communication strategy (by engaging in nonattribute advertising with an uncertain outcome following consumer search), the *M* type prefers the lower-risk attribute-focused strategy.

Finally, note that in equilibrium, all types make a positive profit. In particular, the *L* type is able to extract rents that arise as a result of the consumer's mistakes as the result of search. However, *L*'s profit is strictly lower than those of the *H* and *M* types:

$$\Pi^*(H) = \gamma_H p^*_{HL} > \Pi^*(M) = \frac{\bar{V}}{2} > \Pi^*(L) = \gamma_L p^*_{HL} > 0.$$

As the noise associated with *L*'s signal decreases (γ_L decreases), *L*'s profit decreases.

As we see from the discussion above, consumer search is the core mechanism which enables signaling in equilibrium. In fact, we can formally show that this equilibrium does not exist without consumer search (see the electronic companion, available as part of the online version that can be found at http://mktsci.pubs.informs.org/, for the formal proof). Without consumer search, the firm is constrained to charge a relatively low price because of the consumer's uncertainty about product quality. The maximum price that *H* and *L* can charge in equilibrium when the consumer decides not to search is strictly less than $\bar{V}/2$ when the search cost is sufficiently low. Hence, the *H* type would prefer to deviate in order to signal that it is not type *L*, which destroys this potential equilibrium.

4.2. Other Equilibria and Uniqueness of *HL*

In the preceding section, we show that the *H* type can signal its quality by extending an invitation to search to the consumer through nonattribute advertising. Can there be other equilibria where the *M* type extends this invitation? As we show below, there indeed exist other equilibria (*HML* and *HM*) where *M* extends an invitation to search. In the *HML* full pooling equilibrium, all types engage in nonattribute advertising, and the consumer chooses to search in equilibrium following a nonattribute ad. Note that while nonattribute advertising is an invitation to search in *HML*, it is not a signal of higher quality. In contrast, in the *HM* semi-separating equilibrium, *H* and *M* types engage in attribute advertising, and the consumer chooses to search following an attribute ad. Hence, in this equilibrium an *attribute* ad serves as an invitation to search, while a nonattribute ad reveals that the firm is *L* type. In this semi-separating equilibrium, and in contrast to *HL*, both *H* and *M* types choose to emphasize their strong attribute: the firm

[19] We find that if p^*_{HL} is low enough, then there exists a deviation $A_1 = (a_j, p^{\text{dev}} > p^*_{HL})$ such that D1 imposes $\mu_H(A_1) = 1$. This, of course, would destroy *HL*. Hence, to rule this out, we need the additional constraint that $p^*_{HL} \geq ((\gamma_H - \gamma_M)\bar{p}_j + (\bar{V}/2)(1-\gamma_H))/\gamma_H(1-\gamma_M)$. See the appendix for more details.

that has anything positive to say about its product chooses to do so. In this sense, this equilibrium is a very intuitive one.

We show that these other equilibria exist only if γ_M is high enough; the mediocre type is willing to extend an invitation to search only if it is fairly certain that the outcome of search will be positive. In other words, if γ_M is low or the mediocre type is not confident in the outcome of the search process, only the *HL* countersignaling equilibrium exists, as we show in Proposition 6.

Proposition 5. *Suppose that search cost is low enough such that* $c \le (\bar{V}/2)\rho(1-\rho)(\gamma_H - \gamma_M)$.

1. *A full pooling equilibrium HML, where the consumer chooses to search after observing* (a_0, p^*_{HML}), *exists and survives D1 if* γ_M *is sufficiently high and the price is in the intermediate range.*
2. *A semi-separating HM equilibrium, where the consumer chooses to search after observing* (a_j, p^*_{HM}), *exists and survives D1 if* γ_M *is sufficiently high and the price is in the higher range.*
3. *Without consumer search, HML and HM do not survive D1.*

Proof. See the electronic companion. □

The basic conditions for the existence of an equilibrium with consumer search are the same for *HM* and *HML*. That is, for either equilibrium to exist, (1) the cost search must be small enough compared to $\gamma_H - \gamma_M$, (2) the price must be in a range that ensures that the consumer chooses to search in equilibrium, and (3) γ_M must be high enough.[20]

Finally, we show that when γ_H is large and γ_M is low, *HL* is the *only* equilibrium that survives the D1 refinement.

Proposition 6. *Under D1, HL equilibrium is unique when* γ_H *is sufficiently large and* γ_M *is sufficiently small such that*

1.
$$\max\left\{\frac{(1-\gamma_H)\bar{V}+2c}{2-\gamma_H-\gamma_L}, \frac{\bar{V}}{2\gamma_H}\right\} < \min\left\{\frac{\gamma_H\bar{V}-2c}{\gamma_H+\gamma_L}, \frac{\bar{V}}{2\gamma_M}\right\},$$

2. $c < (\bar{V}/2)\rho(1-\rho)(\gamma_H - \gamma_M)$ *and* $\gamma_M < \bar{V}/(2\bar{p}_{HM})$. *Moreover, this region is nonempty.*

Proof. See the appendix. □

In summary, in *HML* and *HM*, the *M* type extends an invitation to search, which implies that the consumer only buys the product with probability γ_M (the probability that *M* receives a positive signal following search). In contrast, in *HL*, by revealing its type, *M* faces lower risk because the consumer has no uncertainty. This decrease in uncertainty, however, comes with a lower upside potential, because in this case *M* cannot charge more than $\bar{V}/2$. The amount of risk that *M* faces—summarized by γ_M, where a higher γ_M entails a lower risk—determines whether *M* is willing to extend the invitation to search. That is, for *HML* and *HM* to exist, γ_M must be high enough. However, if γ_M is low or the mediocre type is not confident in the outcome of the search process, the *HL* countersignaling equilibrium is the only equilibrium that survives D1.

5. Extensions

We extend our basic model by relaxing several key assumptions. First, we introduce a cost of advertising (which we assumed to be zero in our basic model) and let the firm choose the amount of its advertising spending. Second, we allow for heterogeneity of consumer preferences and consider the case where the consumer has asymmetric preferences over product attributes. Finally, we relax our assumption of two attributes and extend the model to include multiple attributes. All the proofs of the propositions can be found in the electronic companion.

5.1. Advertising Costs and Endogenous Advertising Spending

First, we introduce a cost of advertising and expand the model by allowing the firm to choose the level of advertising spending that optimizes the reach of the message.[21] Following Grossman and Shapiro (1984), we assume that the consumer becomes aware of the product's existence and price only by receiving an ad from the firm. If, however, she does not receive an ad, she is not aware of the product's existence and hence does not purchase it. This specification highlights the distinction between *no advertising*, in which case the consumer is unaware of the product, and *nonattribute advertising*, in which case the consumer becomes aware of the product's existence. The probability that the consumer receives the advertising is Φ, and the firm can invest resources into increasing Φ,

[20] Please see the electronic companion for the exact statement of the existence conditions, such as the conditions on γ_M and the price bounds. In *HM* equilibrium, ρ plays an important role in the decision to search. Recall that ρ is the correlation between attributes, which in this equilibrium translates to a prior belief about the product's type following a_j since $\Pr(H \mid a_j) = \Pr(\beta = B \mid \alpha = A) = \rho$. The consumer chooses to search only if the search cost is low enough relative to the benefit that can be obtained through seeking additional information, that is, resolving the uncertainty. Therefore, if ρ is either close to 1 or 0, there is little remaining uncertainty on whether the firm is an *H* type or *M* type following a_j. This, in turn, implies that search would not arise in equilibrium unless the search cost is also close to zero. Hence, depending on the magnitude of the search cost c and the correlation ρ, *HM* equilibrium with search may or may not exist.

[21] We thank the associate editor for encouraging us to pursue the implications of a positive advertising cost.

the reach of the advertising campaign. We assume a simple cost function, $C(\Phi)=\Phi^2/2$, as in Tirole (1988).

Here, we assume that the firm's total advertising expenditure, or the reach of advertising campaign (Φ), is not perfectly observable to the consumer. That is, the consumer only observes whether an ad successfully reaches her, which can potentially serve as a noisy signal of quality, because in equilibrium, different types choose different levels of advertising spending. The imperfect observability of advertising expenditure is a realistic assumption under many circumstances given the fact that firms usually adopt several advertising campaigns over various media to reach different consumer segments (Hertzendorf 1993). This is what differentiates our model from money-burning models, where the consumer is assumed to perfectly observe the firm's advertising spending. Because total ad spending is perfectly observable in the latter, it serves as a perfect signal of quality, and advertising content becomes redundant. However, as long as the consumer has limited observability, a countersignaling *HL* equilibrium exists, and thus advertising content can signal quality.

Proposition 7. *HL equilibrium with consumer search exists if*

$$\max\left\{\frac{\gamma_H(1-\gamma_H)\bar V+c(\gamma_L+\gamma_H)}{\gamma_H+\gamma_L-\gamma_L^2-\gamma_H^2},\frac{\bar V}{2\gamma_H}\right\}<\min\left\{\frac{\gamma_H^2\bar V-c(\gamma_L+\gamma_H)}{\gamma_H^2+\gamma_L^2},\frac{\bar V}{2\gamma_M}\right\}.$$

Here, $\Phi_H^*=\gamma_H p_{HL}^*>\Phi_M^*=\bar V/2>\Phi_L^*=\gamma_L p_{HL}^*>0$ *and*

$$\Pi^*(H)=\frac{\gamma_H^2(p_{HL}^*)^2}{2}>\Pi^*(M)=\frac{\bar V^2}{2}>\Pi^*(L)=\frac{\gamma_L^2(p_{HL}^*)^2}{2}.$$

As we can see from the proposition above, while all types advertise in equilibrium, the reach of the advertising campaign is increasing in the firm type ($\Phi_H^*>\Phi_M^*>\Phi_L^*$). This is consistent with the finding in the money-burning literature where the higher type invests more in advertising. This implies that the consumer who observes (a_0,p_{HL}^*) infers that the sender is more likely to be H type than L type since $\Phi_H^*>\Phi_L^*$. In other words, the mere fact that the ad reached the consumer signals that it is more likely to be the H type. However, because the L type does advertise ($\Phi_L^*>0$), there is remaining uncertainty on whether the firm is H or L type, which results in search if the price is in the appropriate range.

5.2. Consumer Heterogeneity and Asymmetric Attributes

Next, we introduce *heterogeneity in consumer valuations* and *asymmetry between the two attributes*. Here, we assume that there are two types of consumers. The first segment (of size $1-\lambda$) derives only a basic utility ($u=u_0$) from the product, and its utility function is not sensitive to the attributes that the product possesses. Because search is costly, the consumers in this segment never search for quality information. In contrast, the second segment (of size λ) is affected by the quality of the product and therefore may choose to search for additional information on product quality. Moreover, we assume that the utility derived from the high quality level differs across the attributes. Hence, the consumer in the second segment derives the utility, $u=u_0+\phi\bar V\cdot\mathbf{1}(\alpha=A)+(1-\phi)\bar V\cdot\mathbf{1}(\beta=B)$, where the parameter ϕ captures the relative importance of attribute α. Without loss of generality, we assume that attribute α is relatively more important ($\frac{1}{2}\le\phi\le1$).

Note that under this asymmetric specification, there are four possible types (θ) of products based on the quality levels of the attributes: $\theta\in\{H,M_\alpha,M_\beta,L\}=\{\{A,B\},\{A,b\},\{a,B\},\{a,b\}\}$. In contrast, under the symmetric case of our basic model, where the consumer values the two attributes equally, the type space essentially reduces to three types, $\theta\in\{H,M,L\}$, because the consumer is indifferent between types M_α and M_β. Hence, in the asymmetric case, we have to consider the incentives of all four types. In Proposition 8, we show that *HL* still exists in the presence of customer heterogeneity and attribute asymmetry.[22]

Proposition 8. *HL equilibrium with consumer search exists if*

$$\min\left\{\frac{(1-\gamma_H)(u_0+\bar V)+(1-\gamma_L)u_0+2c}{2-\gamma_H-\gamma_L},\frac{u_0}{\lambda\gamma_L},\frac{u_0+\phi\bar V}{\lambda\gamma_H}\right\}<\max\left\{\frac{\gamma_H(u_0+\bar V)+\gamma_L u_0-2c}{\gamma_H+\gamma_L},\frac{u_0+(1-\phi)\bar V}{\gamma_M}\right\}.$$

Here,

$$\Pi^*(H)=\lambda\gamma_H p_{HL}^*>\Pi^*(M_\alpha)=\lambda(u_0+\phi\bar V)>\Pi^*(M_\beta)=\lambda(u_0+(1-\phi)\bar V)>\Pi^*(L)=\lambda\gamma_L p_{HL}^*.$$

Proposition 8 not only serves as a robustness check of our basic results but also suggests several important boundary conditions for the existence of the *HL* equilibrium. Consider the nondeviation conditions for L, M, and H (which are contained in the condition given in Proposition 8):

$$\gamma_L>\frac{u_0}{\lambda p_{HL}^*},\quad \gamma_M<\frac{u_0+(1-\phi)\bar V}{p_{HL}^*},\quad\text{and}$$

[22] In this equilibrium, H and L types pool on nonattribute advertising and price (a_0,p_{HL}^*), whereas the M types engage in attribute advertising and, therefore, perfectly reveal their types to the consumer ($a_M=a_j$, $p_{M_\alpha}=u_0+\phi\bar V$, $p_{M_\beta}=u_0+(1-\phi)\bar V$).

$$\frac{u_0 + \phi\bar{V}}{p^*_{HL}} < \gamma_H. \tag{7}$$

We can see that for the L type not to deviate from its equilibrium, the ratio $u_0/\lambda p^*_{HL}$ must be low enough. That is, for the HL equilibrium to hold, it must be the case that a sizable segment of the population values the quality of the attributes (large λ), and the basic utility derived from the product should be relatively small (small u_0). Otherwise, the L type would find it profitable to deviate and reveal its type perfectly by charging the lower price u_0, which ensures that it can serve both segments and therefore earn a profit of u_0. This condition highlights the point that HL holds only when the attribute levels and, hence the quality of the product, is relatively important.

Second, Proposition 8 suggests that when the attribute asymmetry is sufficiently large such that essentially only one attribute matters, the HL equilibrium does not exist. Consider the scenario where attribute α is far more important than attribute β (i.e., high ϕ). This implies that the M_α type is perceived as very similar to the H type from the consumer's perspective because only the quality of attribute α matters to her. Therefore, the H type would prefer to claim to be the M_α type rather than take the risk of being confused with the L type by pooling (i.e., H's nondeviation condition $(u_0 + \phi\bar{V})/p^*_{HL} < \gamma_H$ does not hold as $\phi \to 1$ because the consumer would not be willing to pay $p^*_{HL} > u_0 + \phi\bar{V}$).

5.3. n-Attribute Case ($n > 2$)

Finally, we consider the more general model where products have more than two attributes. Suppose that a product has n (>2) attributes: $\{b_1, b_2, \ldots, b_n\}$, where $b_j = \{Q, q\}$, with the capital letter representing higher quality on that dimension. The H type is high quality on h attributes, the M type is high quality on m attributes, and the L type is high quality on only the basic l attributes ($n > h > m > l$). A priori, the consumer's expected utilities from H, M, and L types are $h\bar{V}/n$, $m\bar{V}/n$, and $l\bar{V}/n$, respectively.

Because of limited bandwidth, the firm can only communicate up to k attributes in an advertising message. The crucial assumption is how large k (communication bandwidth) is relative to the number of attributes along which the M type is high quality.[23] That is, if $k > m$, an attribute ad that emphasizes $m+1$ attributes would allow the H type to perfectly separate itself from the M type. On the other hand, if $k \le m$, the ad alone cannot separate the M and H types because the number of attributes at that the M type is high quality is greater than the number of attributes that can be communicated in an ad. Hence, in the multiattribute setting, the latter assumption represents the case of limited bandwidth. To link it back to our main model, we can think of α as the set of the k attributes that the firm emphasizes in an ad and β as the remaining set of attributes. Not surprisingly, as long as there exists limited bandwidth in communication ($k \le m$), our main results continue to hold.[24]

Proposition 9. *When $k \le m$, HL equilibrium with consumer search exists if* (1) $c \le (h-m)\bar{V}(\gamma_H - \gamma_M)/4n$, *and* (2)

$$\max\left\{\frac{h(1-\gamma_H)\bar{V} + 2nc}{n(2-\gamma_H-\gamma_L)}, \frac{m\bar{V}}{n\gamma_H}, \frac{l\bar{V}}{n\gamma_L}\right\} < \min\left\{\frac{h\gamma_H\bar{V} - 2nc}{n(\gamma_H+\gamma_L)}, \frac{m\bar{V}}{n\gamma_M}\right\}.$$

Here, $\Pi^*(H) = \gamma_H p^*_{HL} > \Pi^*(M) = m\bar{V}/n > \Pi^*(L) = \gamma_L p^*_{HL}$.[25]

6. Conclusion and Limitations

We show that advertising content can be a credible quality signal under the realistic assumptions of limited bandwidth of communication and active consumers. The desire to signal one's quality may result in the surprising phenomenon that the firm with the most to say may choose not to make any hard claims at all. This withholding strategy may be rational in that vague claims can be made by either the superior or the terrible products, which necessitates search for further information on the part of the consumer. Hence, vague claims serve as an invitation to search. Consumer search that is determined endogenously is crucial in enabling this type of equilibrium. Whereas most of the previous literature has focused on the decision to advertise (the mere fact that the firm is willing to burn its money) as a signal of quality, we show that message content, coupled with consumer

[23] We thank the editor and an anonymous reviewer for pointing this issue out to us.

[24] Interestingly, we can also endogenize the γ (the probability of positive signal following search) as a function of the number of attributes along which the product is high quality (h, m, and l). Suppose that the consumer talks to her friend about the product, and her friend focuses on a few attributes in her recommendation. Clearly, this would imply that the probability that the word of mouth about the product is positive would be a function of the number of high-quality attributes that the product possesses. In this setting, we would expect γ_H to be increasing in h, γ_M to be increasing in m, and γ_L to be increasing in l (in the simplest specification, $\gamma_H = h/n$, $\gamma_M = m/n$, $\gamma_L = l/n$). Hence, this specification would provide a microfoundation for (1) our assumption that $\gamma_H > \gamma_M > \gamma_L$ because the probability of good news for each type is a function of the number of attributes on which it is high quality, and (2) our assumption that $\gamma_L > 0$ and $\gamma_H < 1$ because even the highest type is low quality on some attributes, and the lowest type is high quality on some attributes.

[25] Our main result is a special case of this general result when $n = 2$, $h = 2$, and $m = 1$.

search, can also serve as a credible signal of quality. Hence, we provide an explanation for why we sometimes observe high-quality brands choosing ads that make no mention of their product's strong attributes.

In the electronic companion, we provide an example of consumer behavior in a laboratory setting that is consistent with our theoretical predictions. That is, we show that (1) consumers may not always view nonattribute ads as being associated with high-quality products, and (2) compared with attribute ads, nonattribute ads may increase consumers' likelihood to search for information about the product.

There are a number of limitations to the current work. First, our model abstracts away from a number of phenomena that may be important in practice. We investigate a monopoly setting, where the firm can be one of three types. Although it is technically challenging to extend the signaling mechanism to a competitive setting, it would be interesting to investigate how the current insights can be extended to a competitive situation in the future. We also abstract away from the possibility that firms can employ several different advertising campaigns. Allowing multiple campaigns relates to the important marketing issue of targeting and segmentation. As the firms gain the ability to personalize their ads to the viewers (through technologies such as search advertising), they can target each segment through emphasizing those attributes that it particularly values. In this case, the truly excellent firm may not need to invite consumers to search. It may instead persuade the consumer to buy its product by emphasizing the attributes that are tailored to her segment.

Also, there are several simplifying assumptions in the model that can be relaxed in future work. First, we impose the truth-telling assumption: we assume that a firm cannot claim to be strong on an attribute on which it is in fact weak. In reality, firms may be able to exaggerate their claims while staying within the bounds of government regulation. Whether and when the firm would choose to tell the truth in advertising in the presence of imperfect government monitoring is an interesting question for future research. Note also that in the absence of the truth-telling in advertising assumption, consumers may be more likely to search for information on their own and would consider the information obtained through their own search to be more credible. Second, we also assume that the consumer faces a discrete search decision—she can either choose to search or choose not to search. Realistically, the decision is continuous—the amount of search will be affected by the uncertainty faced by the consumer along with the product price. We leave these for future research.

Finally, there can be other alternative explanations for the existence and effectiveness of nonattribute advertising (in particular, image advertising). For instance, image advertising may be used to increase consumer trust. We do not wish to claim that our explanation is the only possible theory for this phenomenon. Nevertheless, we offer a novel explanation for nonattribute advertising as an invitation to search.

7. Electronic Companion

An electronic companion to this paper is available as part of the online version that can be found at http://mktsci.pubs.informs.org/.

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Appendix

Proof of Lemma 1. The consumer will search if and only if $\mathrm{E}\,U(\text{search}) = \Pr(\bar{s} \mid \mu)[\mathrm{E}(V \mid \mu, \bar{s}) - p] - c \geq \mathrm{E}\,U(\text{no search}) = \max(0, \mathrm{E}(V \mid \mu) - p)$. Therefore,

(1) If $\mathrm{E}(V \mid \mu) - p \geq 0$, then $\mathrm{E}\,U(\text{search}) \geq \mathrm{E}\,U(\text{no search})$ iff

$$\begin{aligned}
&\Pr(\bar{s} \mid \mu)[\mathrm{E}(V \mid \mu, \bar{s}) - p] - c \geq \mathrm{E}(V \mid \mu) - p \\
&\quad\Leftrightarrow \Pr(\bar{s} \mid \mu)\,\mathrm{E}(V \mid \mu, \bar{s}) - \Pr(\bar{s} \mid \mu)p - c \\
&\qquad \geq \Pr(\bar{s} \mid \mu)\,\mathrm{E}(V \mid \mu, \bar{s}) + \Pr(\underline{s} \mid \mu)\,\mathrm{E}(V \mid \mu, \underline{s}) - p \\
&\quad\Leftrightarrow c \leq \Pr(\underline{s} \mid \mu)[p - \mathrm{E}(V \mid \mu, \underline{s})] \equiv g. \qquad (8)
\end{aligned}$$

(2) If $\mathrm{E}(V \mid \mu) - p < 0$, then $\mathrm{E}\,U(\text{search}) \geq \mathrm{E}\,U(\text{no search})$ if

$$\begin{aligned}
&\Pr(\bar{s} \mid \mu)[\mathrm{E}(V \mid \mu, \bar{s}) - p] - c \geq 0 \\
&\quad\Leftrightarrow c \leq \Pr(\bar{s} \mid \mu)[\mathrm{E}(V \mid \mu, \bar{s}) - p] \equiv f. \qquad (9)
\end{aligned}$$

Next, we show that $f = g$ at $p = \mathrm{E}(V \mid \mu)$:

$$\begin{aligned}
f - g &= \Pr(\bar{s} \mid \mu)[\mathrm{E}(V \mid \mu, \bar{s}) - p] - \Pr(\underline{s})[p - \mathrm{E}(V \mid \mu, \underline{s})] \\
&= \Pr(\bar{s} \mid \mu)\,\mathrm{E}(V \mid \mu, \bar{s}) - \Pr(\bar{s} \mid \mu)p - \Pr(\underline{s} \mid \mu)p \\
&\quad + \Pr(\underline{s} \mid \mu)\,\mathrm{E}(V \mid \mu, \underline{s}) \\
&= \Pr(\bar{s} \mid \mu)\,\mathrm{E}(V \mid \mu, \bar{s}) + \Pr(\underline{s} \mid \mu)\,\mathrm{E}(V \mid \mu, \underline{s}) - p \\
&= \mathrm{E}(V \mid \mu) - p = 0. \qquad (10)
\end{aligned}$$

This completes the proof. Q.E.D.

D1 Refinement

We apply D1 (Fudenberg and Tirole 1991) to eliminate unreasonable out-of-equilibrium beliefs. Following Fudenberg and Tirole (1991, p. 452), we define $\Pi^*(\theta)$ to be the equilibrium profit of type θ. We also define the set of mixed-strategy best responses of the consumer, α_2 ($\alpha_2 = \{\alpha_{21}, \alpha_{22}, \alpha_{23}\} = \{$Pr(purchase without search), Pr(no purchase), Pr(search)$\}$) to a deviation by the firm, $A_1 = (a, p)$, such that type θ strictly prefers A_1 to the equilibrium strategy:

$$D(\theta, A_1) = \{\alpha_2 \in MBR(\mu(A_1), A_1) \text{ s.t. } \Pi^*(\theta) < \Pi(A_1, \alpha_2, \theta) \mid \mu_H(A_1) + \mu_M(A_1) + \mu_L(A_1) = 1\}. \quad (11)$$

Note that the consumer's best response depends on her belief, $\mu(A_1) = (\mu_H(A_1), \mu_M(A_1), \mu_L(A_1))$.

Similarly, we define a set of the consumer's best responses such that the firm is indifferent between deviating and playing the equilibrium strategy:

$$D^0(\theta, A_1) = \{\alpha_2 \in MBR(\mu(A_1), A_1) \text{ s.t. } \Pi^*(\theta) = \Pi(A_1, \alpha_2, \theta) \mid \mu_H(A_1) + \mu_M(A_1) + \mu_L(A_1) = 1\}. \quad (12)$$

The criterion D1 puts zero probability on type θ if there exists another type θ' such that

$$D(\theta, A_1) \cup D^0(\theta, A_1) \subset D(\theta', A_1). \quad (13)$$

Using Lemma 1, we derive the set of the consumer's mixed best responses, $MBR(\mu(A_1), A_1)$:

1. If $E(V \mid \mu(A_1)) - p > 0$,
   (a) The consumer will search: $\alpha_2 = \{0, 0, 1\}$, if $c < \Pr(\underline{s} \mid \mu(A_1))[p - E(V \mid \mu(A_1), \underline{s})]$.
   (b) The consumer will purchase without search: $\alpha_2 = \{1, 0, 0\}$, if $c > \Pr(\underline{s} \mid \mu(A_1))[p - E(V \mid \mu(A_1), \underline{s})]$.
   (c) The consumer mixes between search and purchase without search: $\alpha_2 = \{\alpha_{21}, 0, 1 - \alpha_{21}\}$, if $c = \Pr(\underline{s} \mid \mu(A_1)) \cdot [p - E(V \mid \mu(A_1), \underline{s})]$.
2. If $E(V \mid \mu(A_1)) - p < 0$,
   (a) The consumer will search: $\alpha_2 = \{0, 0, 1\}$, if $c < \Pr(\bar{s} \mid \mu(A_1))[E(V \mid \mu(A_1), \bar{s}) - p]$.
   (b) The consumer will not purchase: $\alpha_2 = \{0, 1, 0\}$, if $c > \Pr(\bar{s} \mid \mu(A_1))[E(V \mid \mu(A_1), \bar{s}) - p]$.
   (c) The consumer mixes between search and no purchase: $\alpha_2 = \{0, \alpha_{22}, 1 - \alpha_{22}\}$, if $c = \Pr(\bar{s} \mid \mu(A_1)) \cdot [E(V \mid \mu(A_1), \bar{s}) - p]$.
3. If $E(V \mid \mu(A_1)) - p = 0$ and $c = \Pr(\underline{s} \mid \mu(A_1)) \cdot [E(V \mid \mu(A_1)) - E(V \mid \mu(A_1), \underline{s})]$, the consumer chooses either $\alpha_2 = \{0, \alpha_{22}, 1 - \alpha_{22}\}$ or $\alpha_2 = \{\alpha_{21}, 0, 1 - \alpha_{21}\}$.

Note that $\alpha_2 = \{\alpha_{21}, 1 - \alpha_{21}, 0\} \notin MBR(\mu(A_1), A_1)$ because we assume that if the consumer is indifferent between purchasing the product and no purchase, she chooses to purchase it.

Bounds on Prices and Beliefs for Consumer Search

Next, using the results above, we derive explicit bounds on prices and beliefs such that the consumer searches as a best response to A_1.

Lemma 2.

1. Consider the case where the firm engages in attribute advertising, $A_1 = (a_j, p)$, and the consumer's belief is $\mu^j = (0, \mu^j_M, \mu^j_H)$. There exists a consumer belief under which search is a best response for the consumer if $c \leq \bar{V}(\gamma_H - \gamma_M)/8$ and $p \in [\underline{p}^j, \bar{p}^j]$, where

$$\underline{p}^j = \frac{3}{4}\bar{V} - \frac{\sqrt{(\bar{V}^2/4)(\gamma_H - \gamma_M)^2 - 2\bar{V}c(\gamma_H - \gamma_M)}}{2(\gamma_H - \gamma_M)} \geq \frac{\bar{V}}{2},$$

$$\bar{p}^j = \frac{3}{4}\bar{V} + \frac{\sqrt{(\bar{V}^2/4)(\gamma_H - \gamma_M)^2 - 2\bar{V}c(\gamma_H - \gamma_M)}}{2(\gamma_H - \gamma_M)} \leq \bar{V}.$$

Moreover, for a given μ^j_H, consumer chooses to search iff

$$\underline{p}^j(\mu^j_H) = \frac{\mu^j_H(1-\gamma_H)\bar{V} + (1-\mu^j_H)(1-\gamma_M)(\bar{V}/2) + c}{\mu^j_H(1-\gamma_H) + (1-\mu^j_H)(1-\gamma_M)} \leq p \leq \frac{\mu^j_H\gamma_H\bar{V} + (1-\mu^j_H)\gamma_M(\bar{V}/2) - c}{\mu^j_H\gamma_H + (1-\mu^j_H)\gamma_M} = \bar{p}^j(\mu^j_H).$$

2. Consider the case where the firm engages in uninformative advertising, $A_1 = (a_0, p)$, and the consumer's belief is $\mu^0 = (\mu^0_L, \mu^0_M, \mu^0_H)$, where $\mu^0_L \leq \hat{\mu}_L = \frac{1}{2}(1 + \sqrt{1 - 4c/(\bar{V}(\gamma_H - \gamma_L))})$. There exists a consumer belief (μ^0) under which search is a best response for the consumer if $c \leq \bar{V}(\gamma_H - \gamma_L)/4$ and $p \in [\underline{p}^0, \bar{p}^0]$, where $\underline{p}^0 \equiv \min_{0 \leq \mu^0_L \leq \hat{\mu}_L} \underline{p}^0(\mu^0_L) \leq \underline{p}^j$, $\bar{p}^0 \equiv \max_{0 \leq \mu^0_L \leq \hat{\mu}_L} \bar{p}^0(\mu^0_L) \geq \bar{p}^j$.

Moreover, for a given μ^0, the consumer chooses to search iff

$$\underline{p}^0(\mu^0) = \frac{\mu^0_H(1-\gamma_H)\bar{V} + \mu^0_M(1-\gamma_M)(\bar{V}/2) + c}{\mu^0_H(1-\gamma_H) + \mu^0_M(1-\gamma_M) + \mu^0_L(1-\gamma_L)} \leq p \leq \frac{\mu^0_H\gamma_H\bar{V} + \mu^0_M\gamma_M(\bar{V}/2) - c}{\mu^0_H\gamma_H + \mu^0_M\gamma_M + \mu^0_L\gamma_L} = \bar{p}^0(\mu^0).$$

Proof. See the electronic companion.

We can easily show that $\bar{V}(\gamma_H - \gamma_M)/8 < \bar{V}(\gamma_H - \gamma_L)/4$, since $\gamma_L < \gamma_H$ and $\gamma_L < \gamma_M$. This of course implies that if $c \leq \bar{V}(\gamma_H - \gamma_M)/8$, there exists a belief under which the consumer chooses to search after observing a_j and a_0.

HL **Equilibrium**

Proof of Proposition 3. We show that *HL* equilibrium with consumer search exists if

$$c < \frac{\bar{V}(\gamma_H - \gamma_M)}{8}, \quad \frac{(1-\gamma_H)\bar{V} + 2c}{2 - \gamma_H - \gamma_L} \leq p^*_{HL} < \frac{\gamma_H\bar{V} - 2c}{\gamma_H + \gamma_L}, \quad \text{and} \quad \gamma_H p^*_{HL} > \frac{\bar{V}}{2} > \gamma_M p^*_{HL}.$$

We first turn to the consumer's problem. As we can see from Lemma 2, for the consumer to search in equilibrium, it must be the case that $c \leq \bar{V}(\gamma_H - \gamma_M)/8$ and $p_{HL} \in [\underline{p}^0(\mu_L), \bar{p}^0(\mu_L)]$, where

$$\bar{p}^0(\mu_L) = \frac{\mu^0_H\gamma_H\bar{V} + \mu^0_M\gamma_M(\bar{V}/2) - c}{\mu^0_H\gamma_H + \mu^0_M\gamma_M + \mu^0_L\gamma_L},$$

and

$$\underline{p}^0(\mu_L) = \frac{\mu^0_H(1-\gamma_H)\bar{V} + \mu^0_M(1-\gamma_M)(\bar{V}/2) + c}{\mu^0_H(1-\gamma_H) + \mu^0_M(1-\gamma_M) + \mu^0_L(1-\gamma_L)}.$$

In addition, on the equilibrium path, the probabilities that the firm is H type and L type following (a_0, p^*_{HL}) are $\frac{1}{2}$ and $\frac{1}{2}$ (i.e., $(\rho/2)/(\rho/2+\rho/2)$ and $(\rho/2)/(\rho/2+\rho/2)$ for H and L types, respectively). Hence, $\bar{p}^0(\frac{1}{2}) = (\gamma_H \bar{V} - 2c)/(\gamma_H + \gamma_L) > \frac{1}{2}\bar{V}$ and $\underline{p}^0(\frac{1}{2}) = ((1-\gamma_H)\bar{V} + 2c)/(2-\gamma_H-\gamma_L) < \bar{V}/2$ since $c \le \bar{V}(\gamma_H - \gamma_M)/8$. Hence, for the consumer to search in equilibrium, the price must be in the appropriate range:

$$p^*_{HL} \in \left[\frac{(1-\gamma_H)\bar{V}+2c}{2-\gamma_H-\gamma_L}, \frac{\gamma_H\bar{V}-2c}{\gamma_H+\gamma_L}\right].$$

Next, we need to ensure that all types prefer their equilibrium strategy to an optimal deviation. To show existence, as we discuss in the body of the paper, we impose the following out-of-equilibrium belief: $\mu_L = 1$ for all $(a_0, p \neq p^*_{HL})$ and $\mu_H = 0$ for all $(a_j, p \neq \bar{V}/2)$. Given the assumed out-of-equilibrium beliefs, the nondeviation conditions for the H type and M type, respectively, reduce to the following:

$$\begin{aligned}\Pi^*(a_0, p^*_{HL} \mid q=H) &= \gamma_H p^*_{HL} > \max_{A_1} \Pi(A_1 \mid q=H) = \frac{\bar{V}}{2},\\ \Pi^*(a_j, p_M \mid q=M) &= \frac{\bar{V}}{2} > \max_{A_1} \Pi(A_1 \mid q=M) = \gamma_M p^*_{HL}.\end{aligned} \tag{14}$$

Finally, the L type, by definition, cannot deviate on advertising. A deviation on price only yields a maximum profit of 0 under the off-equilibrium beliefs. Hence, $\Pi^*(a_0, p_{HL} \mid q=L) = \gamma_L p^*_{HL} > 0$, which is trivially satisfied.

Therefore, as long as the condition

$$\max\left\{\frac{(1-\gamma_H)\bar{V}+2c}{2-\gamma_H-\gamma_L}, \frac{\bar{V}}{2\gamma_H}\right\} < \min\left\{\frac{\gamma_H\bar{V}-2c}{\gamma_H+\gamma_L}, \frac{\bar{V}}{2\gamma_M}\right\}$$

holds, we can always find p^*, which satisfies

$$\frac{(1-\gamma_H)\bar{V}+2c}{2-\gamma_H-\gamma_L} \le p^*_{HL} < \frac{\gamma_H\bar{V}-2c}{\gamma_H+\gamma_L} \quad \text{and}$$

$$\gamma_H p^*_{HL} > \frac{\bar{V}}{2} > \gamma_M p^*_{HL}. \quad \text{Q.E.D.}$$

Proof of Proposition 4. We examine the restrictions on the out-of-equilibrium beliefs that are imposed by D1. First, we assume that $p^*_{HL} < \bar{V}/(2\gamma_M)$. We will return to this assumption below and confirm that it is indeed the case in equilibrium.

Lemma 3. *Suppose that* $p^*_{HL} < \bar{V}/(2\gamma_M)$. *D1 imposes the following constraints on out-of-equilibrium beliefs*:

1. *Let* $\hat{p} \equiv ((\gamma_H-\gamma_M)\bar{p}_j + (\bar{V}/2)(1-\gamma_H))/(\gamma_H(1-\gamma_M))$. *If the consumer observes* $A_1 = (a_j, p^{dev})$,
   (a) *when* $\bar{V}/2 < p^{dev} < \min(\gamma_H p^*_{HL}, \underline{p}^j)$, $\mu_H(A_1) = 0$;
   (b) *if* $\hat{p} \le p^*_{HL}$, *when* $\underline{p}^j \le p^{dev} \le \bar{p}^j = \min(\hat{p}, \bar{p}^j)$, $\mu_H(A_1) = 0$;
   (c) *if* $\hat{p} > p^*_{HL}$, *when* $\max(\underline{p}^j, \hat{p}) < p^{dev} \le \bar{p}^j$, $\mu_H(A_1) = 1$.
2. *If the consumer observes the deviation* $A_1 = (a_0, p^{dev})$,
   (a) *when* $\gamma_L p^*_{HL} < p^{dev} < \min(\gamma_H p^*_{HL}, \underline{p}^0)$, $\mu_H(A_1) = 0$;
   (b) *when* $\gamma_M p^*_{HL} < \bar{V}/2$, *and* $\max(\underline{p}^0, \gamma_L p^*_{HL}) < p^{dev} < \min(p^*_{HL}, \bar{p}^0)$, $\mu_L(A_1) = 1$;
   (c) *when* $\gamma_M p^*_{HL} < \bar{V}/2$, *and* $p^*_{HL} < p^{dev} < \bar{p}^0$, $\mu_M(A_1) = 0$.

Proof. Let us first define the sets for $\theta = \{L, M, H\}$:

$$\begin{aligned}&D^0(H, A_1) \cup D(H, A_1)\\ &\quad = \hat{X}_H \cup \hat{Y}_H = \left\{(0, \alpha_{22}, 1-\alpha_{22}) \mid \alpha_{22} \le \frac{p^{\text{dev}} - p^*_{HL}}{p^{\text{dev}}}\right\}\\ &\qquad \cup \left\{(\alpha_{21}, 0, 1-\alpha_{21}) \mid \alpha_{21} \ge \frac{\gamma_H(p^*_{HL} - p^{\text{dev}})}{(1-\gamma_H)p^{\text{dev}}}\right\},\\ &D^0(M, A_1) \cup D(M, A_1)\\ &\quad = \hat{X}_M \cup \hat{Y}_M = \left\{(0, \alpha_{22}, 1-\alpha_{22}) \mid \alpha_{22} \le \frac{\gamma_M p^{\text{dev}} - \bar{V}/2}{\gamma_M p^{\text{dev}}}\right\}\\ &\qquad \cup \left\{(\alpha_{21}, 0, 1-\alpha_{21}) \mid \alpha_{21} \ge \frac{\bar{V}/2 - \gamma_M p^{\text{dev}}}{(1-\gamma_M)p^{\text{dev}}}\right\},\\ &D^0(L, A_1) \cup D(L, A_1)\\ &\quad = \hat{X}_L \cup \hat{Y}_L = \left\{(0, \alpha_{22}, 1-\alpha_{22}) \mid \alpha_{22} \le \frac{p^{\text{dev}} - p^*_{HL}}{p^{\text{dev}}}\right\}\\ &\qquad \cup \left\{(\alpha_{21}, 0, 1-\alpha_{21}) \mid \alpha_{21} \ge \frac{\gamma_L(p^*_{HL} - p^{\text{dev}})}{(1-\gamma_L)p^{\text{dev}}}\right\}.\end{aligned}$$

1. Consider a deviation to a price such that the consumer chooses not to purchase at any off-equilibrium belief: $A_1 = (a_j, p^{\text{dev}})$, where $p^{\text{dev}} > \bar{p}^j$; or $A_1 = (a_0, p^{\text{dev}})$, where $p^{\text{dev}} > \bar{p}^0$; i.e., $\alpha_{22} = 1$. Here, D1 does not apply.

2. Next, consider a deviation to a price such that the consumer chooses to purchase without search at any off-equilibrium belief: $A_1 = (a_j, p^{\text{dev}})$, where $p^{\text{dev}} < \underline{p}^j$; or $A_1 = (a_0, p^{\text{dev}})$, where $p^{\text{dev}} < \underline{p}^0$; i.e., $\alpha_{21} = 1$. Therefore, D1 imposes that $\mu_H(A_1) = 0$ if $A_1 = (a_j, p^{\text{dev}})$ for all $\bar{V}/2 \le p^{\text{dev}} < \min(\gamma_H p^*_{HL}, \underline{p}^j)$. Similarly, if $A_1 = (a_0, p^{\text{dev}})$ for all $\gamma_L p^*_{HL} \le p^{\text{dev}} < \min(\gamma_H p^*_{HL}, \underline{p}^0)$, $\mu_H(A_1) = 0$.

3. Consider $A_1 = (a_j, p^{\text{dev}})$ and $\underline{p}^j \le p^{\text{dev}} \le \bar{p}^j$. First, we assume that

$$\frac{(\gamma_H-\gamma_M)\bar{p}_j + (\bar{V}/2)(1-\gamma_H)}{\gamma_H(1-\gamma_M)} \le p^*_{HL}$$
$$\Leftrightarrow \ \bar{p}_j \le \frac{\gamma_H(1-\gamma_M)p^*_{HL} - (\bar{V}/2)(1-\gamma_H)}{\gamma_H-\gamma_M}.$$

If $p^{\text{dev}} < (\gamma_H(1-\gamma_M)p^*_{HL} - (\bar{V}/2)(1-\gamma_H))/(\gamma_H-\gamma_M)$, we can show, using simple calculus, that

$$\frac{\gamma_H(p^*_{HL} - p^{\text{dev}})}{(1-\gamma_H)p^{\text{dev}}} > \frac{\gamma_M p^{\text{dev}} - \bar{V}/2}{(1-\gamma_M)p^{\text{dev}}},$$

which implies that $\hat{Y}_H \subset Y_M$. Also, we can see that $(\gamma_H(1-\gamma_M)p^*_{HL} - (\bar{V}/2)(1-\gamma_H))/(\gamma_H - \gamma_M < p^*_{HL})$ as long as $p^*_{HL} < \bar{V}/(2\gamma_M)$. Hence, we have

$$p^{\text{dev}} < \frac{\gamma_H(1-\gamma_M)p^*_{HL} - (\bar{V}/2)(1-\gamma_H)}{\gamma_H-\gamma_M} < p^*_{HL}.$$

This, in turn, implies $X_M = \hat{X}_H = \varnothing$. Therefore, for

$$\underline{p}^j < p^{\text{dev}} < \min\left(\frac{\gamma_H(1-\gamma_M)p^*_{HL} - (\bar{V}/2)(1-\gamma_H)}{\gamma_H-\gamma_M}, \bar{p}^j\right),$$

D1 constrains the belief to be $\mu_H = 0$ following A_1. Of course, since $\bar{p}_j \le (\gamma_H(1-\gamma_M)p^*_{HL} - (\bar{V}/2)(1-\gamma_H))/(\gamma_H-\gamma_M)$ for $\underline{p}^j < p^{\text{dev}} < \bar{p}^j$, $\mu_H = 0$ following A_1. Second, consider

$$\frac{(\gamma_H-\gamma_M)\bar{p}_j + (\bar{V}/2)(1-\gamma_H)}{\gamma_H(1-\gamma_M)} > p^*_{HL}$$
$$\Leftrightarrow\ \bar{p}_j > \frac{\gamma_H(1-\gamma_M)p^*_{HL} - (\bar{V}/2)(1-\gamma_H)}{\gamma_H-\gamma_M}.$$

Then, there exists an interval such that

$$\frac{\gamma_H(1-\gamma_M)p^*_{HL} - (\bar{V}/2)(1-\gamma_H)}{\gamma_H-\gamma_M} \le p^{\text{dev}} < \min(\bar{p}^j, p^*_{HL}).$$

Using the same argument as in (a) above, we can show that here $\hat{Y}_M \subset Y_H$, and $X_H = \hat{X}_M = \varnothing$. Hence, as long as

$$\max\left(\underline{p}^j, \frac{\gamma_H(1-\gamma_M)p^*_{HL} - (\bar{V}/2)(1-\gamma_H)}{\gamma_H-\gamma_M}\right) < p^{\text{dev}} < \min(\bar{p}^j, p^*_{HL}),$$

D1 constrains the belief to be $\mu_H = 1$ following A_1. Next, consider $p^{\text{dev}} \ge p^*_{HL}$. We can see that when $p^*_{HL} < \bar{V}/(2\gamma_M)$, $(\gamma_M p^{\text{dev}} - \bar{V}/2)/\gamma_M p^{\text{dev}} < (p^{\text{dev}} - p^*_{HL})/p^{\text{dev}} < 1$, which implies that $\hat{X}_M \subset X_H$. Also, we know that in this region $\hat{Y}_M \subset Y_H$. Hence, D1 implies that $\mu_H = 1$ following p^{dev}, where $\max(p^*_{HL}, \underline{p}^j) < p^{\text{dev}} < \bar{p}^j$. In summary, D1 implies that for

$$\max\left(\underline{p}^j, \frac{\gamma_H(1-\gamma_M)p^*_{HL} - (\bar{V}/2)(1-\gamma_H)}{\gamma_H-\gamma_M}\right) < p^{\text{dev}} \le \bar{p}^j,$$

$\mu_H = 1$.

4. Consider $A_1 = (a_0, p^{\text{dev}} \ne p^*_{HL})$ and $\underline{p}^0 \le p^{\text{dev}} \le \bar{p}^0$. First, consider the case $p^{\text{dev}} < p^*_{HL}$, which implies that $X_H = X_M = X_L = \varnothing$. Also, if $p^{\text{dev}} > \gamma_L p^*_{HL}$,

$$\frac{\gamma_L(p^*_{HL} - p^{\text{dev}})}{(1-\gamma_L)p^{\text{dev}}} < \frac{\gamma_H(p^*_{HL} - p^{\text{dev}})}{(1-\gamma_H)p^{\text{dev}}},\ \frac{\gamma_L(p^*_{HL} - p^{\text{dev}})}{(1-\gamma_L)p^{\text{dev}}} < 1.$$

And if $p^{\text{dev}} < \dfrac{(\bar{V}/2)(1-\gamma_L) - \gamma_L(1-\gamma_M)p^*_{HL}}{\gamma_M-\gamma_L}$,

$$\frac{\gamma_L(p^*_{HL} - p^{\text{dev}})}{(1-\gamma_L)p^{\text{dev}}} < \frac{\bar{V}/2 - \gamma_M p^{\text{dev}}}{(1-\gamma_M)p^{\text{dev}}}.$$

Moreover, we can see that when

$$\gamma_M p^*_{HL} < \frac{\bar{V}}{2},\quad p^*_{HL} < \frac{(\bar{V}/2)(1-\gamma_L) - \gamma_L(1-\gamma_M)p^*_{HL}}{\gamma_M-\gamma_L}.$$

Hence, when $\gamma_M p^*_{HL} < \bar{V}/2$, $\hat{Y}_H \subset Y_L$ and $\hat{Y}_M \subset Y_L$ if $\max(\underline{p}^0, \gamma_L p^*_{HL}) < p^{\text{dev}} < \min(p^*_{HL}, \bar{p}^0)$, which implies that D1 constrains the belief to be $\mu_L = 1$ following $A_1 = (a_0, p^{\text{dev}})$. Second, consider the case $p^{\text{dev}} > p^*_{HL}$, which implies that $\hat{X}_H = \hat{X}_L \ne \varnothing$ and $Y_H = Y_L = \{\forall\, \alpha_{21} \in [0,1]\}$. Also, if

$$\gamma_M p^*_{HL} < \frac{\bar{V}}{2},\quad \frac{\gamma_M p^{\text{dev}} - \bar{V}/2}{(1-\gamma_M)p^{\text{dev}}} < \frac{p^{\text{dev}} - p^*_{HL}}{p^{\text{dev}}},$$

which implies that $\hat{X}_M \subset X_L$ and $\hat{X}_M \subset X_H$. Hence, $D^0(M, A_1) \cup D(M, A_1) \subset D(L, A_1)$ and $D^0(M, A_1) \cup D(M, A_1) \subset D(H, A_1)$, which implies that D1 constraints the belief to be $\mu_M = 0$ following $A_1 = (a_0, p^{\text{dev}})$.

Given the out-of-equilibrium beliefs that are consistent with D1, if $p^*_{HL} < ((\gamma_H - \gamma_M)/\bar{p}_j + (\bar{V}/2)(1-\gamma_H))/\gamma_H(1-\gamma_M)$, there always exists a profitable deviation under D1. To show this, consider $A_1 = (a_j, p^{\text{dev}})$, where $(\gamma_H(1-\gamma_M)p^*_{HL} - (\bar{V}/2)(1-\gamma_H))/(\gamma_H-\gamma_M) < p^{\text{dev}} \le \bar{p}^j$.

Based on Lemma 3, 1(c), $\mu_H = 1$: the consumer buys the product without search. Both H and M types prefer to deviate to A_1, which, in turn, destroys this equilibrium. Hence, for the HL equilibrium to exist, it must be the case that $((\gamma_H-\gamma_M)\bar{p}_j + (\bar{V}/2)(1-\gamma_H))/\gamma_H(1-\gamma_M) \le p^*_{HL}$. When

$$\frac{(\gamma_H-\gamma_M)\bar{p}_j + (\bar{V}/2)(1-\gamma_H)}{\gamma_H(1-\gamma_M)} < p^*_{HL} < \frac{\bar{V}}{2\gamma_M},$$

one example of an off-equilibrium belief that is consistent with the properties described above is $\mu_L = 1$ for all $(a_0, p \ne p^*_{HL})$ and $\mu_H = 0$ for all $(a_j, p \ne \bar{V}/2)$. This is the belief that we assume to demonstrate existence below.

From Equation (14) in the proof of Proposition 3 above and the search condition that

$$p^*_{HL} \in \left[\frac{(1-\gamma_H)\bar{V} + 2c}{2-\gamma_H-\gamma_L}, \frac{\gamma_H\bar{V} - 2c}{\gamma_H+\gamma_L}\right],$$

as well as the condition from D1, $((\gamma_H-\gamma_M)\bar{p}_j + (\bar{V}/2)\cdot(1-\gamma_H))/\gamma_H(1-\gamma_M) \le p^*_{HL}$, we can see that the equilibrium price must be

$$\max\left\{\frac{\bar{V}}{2\gamma_H}, \frac{(1-\gamma_H)\bar{V}+2c}{2-\gamma_H-\gamma_L}, \frac{(\gamma_H-\gamma_M)\bar{p}_j + (\bar{V}/2)(1-\gamma_H)}{\gamma_H(1-\gamma_M)}\right\} \le p^*_{HL} < \min\left\{\frac{\gamma_H\bar{V}-2c}{\gamma_H+\gamma_L}, \frac{\bar{V}}{2\gamma_M}\right\}.$$

Also note that

$$\frac{(1-\gamma_H)\bar{V}+2c}{2-\gamma_H-\gamma_L} < \frac{\bar{V}}{2} < \frac{\bar{V}}{2\gamma_H}.$$

Moreover, we can see that $\bar{p}_j \ge \bar{V}/2$ implies that

$$\frac{\bar{V}}{2\gamma_H} \le \frac{(\gamma_H-\gamma_M)\bar{p}_j + (\bar{V}/2)(1-\gamma_H)}{\gamma_H(1-\gamma_M)}.$$

This reduces the price condition for the existence of the HL equilibrium under D1 to the following:

$$\frac{(\gamma_H-\gamma_M)\bar{p}_j + \bar{V}/2(1-\gamma_H)}{\gamma_H(1-\gamma_M)} \le p^*_{HL} < \min\left\{\frac{\gamma_H\bar{V}-2c}{\gamma_H+\gamma_L}, \frac{\bar{V}}{2\gamma_M}\right\}.$$

Hence, as long as the condition

$$\frac{(\gamma_H-\gamma_M)\bar{p}_j + (\bar{V}/2)(1-\gamma_H)}{\gamma_H(1-\gamma_M)} < \min\left\{\frac{\gamma_H\bar{V}-2c}{\gamma_H+\gamma_L}, \frac{\bar{V}}{2\gamma_M}\right\}$$

holds, we can always find p^*_{HL}, which satisfies the above conditions. Q.E.D.

Proof of Proposition 6. The first condition ensures that HL exists (see Proposition 4). The remaining equilibria that survive the D1 refinement are HM with search and HML with search (see Proposition 5).

We first turn to HM. Note that for the consumer to search in equilibrium, $p^*_{HM} \le \bar{p}_{HM}$ when $c < (\bar{V}/2)\rho(1-\rho)\cdot(\gamma_H - \gamma_M)$, where $\bar{p}_{HM} = (\gamma_H\rho\bar{V} + \gamma_M(1-\rho)\bar{V} - c)/(\gamma_H\rho + \gamma_M(1-\rho)) \equiv \bar{p}^j(\rho)$ (see the proof of Proposition 5 in the electronic companion). Suppose that $\gamma_M\bar{p}_{HM} < \bar{V}/2$, which of course implies that $\gamma_M p^*_{HM} < \bar{V}/2$. Consider a deviation by M to $A_1 = (a_j, p^{\text{dev}} = \bar{V}/2)$. The consumer is willing to purchase the product with no additional search (see Lemma 2). This implies that M prefers to deviate, which destroys this equilibrium. Hence, we demonstrated that HM does not exist if $\gamma_M\bar{p}_{HM} < \bar{V}/2$.

Next, for the consumer to search in HML equilibrium, $p^*_{HML} \le \bar{p}^0_{HML}$, where

$$\bar{p}^0_{HML} = \bar{p}^0(\rho) = \frac{\rho\gamma_H\bar{V} + (1-\rho)\gamma_M\bar{V} - 2c}{\rho(\gamma_H+\gamma_L) + 2(1-\rho)\gamma_M}$$

(see the proof of Proposition 5 in the electronic companion). Similarly, we can show that HML does not exist if $\gamma_M\bar{p}^0_{HML} < \bar{V}/2$. Therefore, HM and HML do not exist if $\gamma_M \max[\bar{p}^0_{HML}, \bar{p}_{HM}] < \bar{V}/2$. Finally, using algebra, we can show that $\bar{p}_{HM} > \bar{p}^0_{HML}$, which reduces the sufficient "nonexistence" condition to $\gamma_M\bar{p}_{HM} < \bar{V}/2$. To demonstrate that this region is nonempty, consider the following example: $\gamma_H = 0.9$, $\gamma_M = 0.5$, $\gamma_L = 0.1$, $\bar{V} = 100$, $c = 5$, $\rho = 2/3$, and $p^*_{HL} = [77.491, 80]$. Here, HL is the only equilibrium that survives D1. Q.E.D.

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