Salience and Information Asymmetry*

Elias Carroni† Andrea Mantovani‡ Antonio Minniti§

March 12, 2019

Abstract

This paper considers a signaling game between two vertically differentiated firms when consumers are salient thinkers and uninformed about the firms’ qualities. Firms can use prices and dissipative advertising as signals of quality. Our analysis reveals that when price is the salient attribute and the salience bias is relevant, the high-quality firm has to resort to both signaling devices. On the contrary, when quality is the salient attribute, price alone is sufficient for signaling quality. Moreover, when the salience bias is relatively high, the asymmetric information problem disappears and prices need not be distorted upwards with respect to the full-information scenario. We also find that the low-quality is never worse off under asymmetric information, whereas the high-quality firm may lose out when consumers are price salient. Finally, we consider quality choice and show that firms maximize product differentiation. Quality becomes the salient attribute and quality levels increase with the salience bias.

Keywords: Salience, Quality, Oligopoly, Signaling, Advertising

JEL classification: L10, L13, D43, D82

---

*We are grateful for helpful comments to Emre Aytimur, Emanuele Bacchiega, Robert Edwards, Giuseppe Pig-nnataro, Carlo Reggiani, and seminar participants at Frankfurt School of Finance & Management, University of Liverpool, and the 2017 EARIE Conference (Maastricht). We also thank Lucy Scioscia for editorial assistance. The usual disclaimer applies.

†Department of Economics, University of Bologna, Piazza Scaravilli 2 - 40126- Bologna (Italy). E-mail: elias.carroni@unibo.it.

‡Department of Economics, University of Bologna, Strada Maggiore 45 - 40125 - Bologna (Italy). E-mail: a.mantovani@unibo.it.

§Department of Economics, University of Bologna, Piazza Scaravilli 2 - 40126- Bologna (Italy). E-mail: antonio.minniti@unibo.it.
Non-technical Summary

There are many situations in which consumers are unable to distinguish products of high quality from products of low quality, as they may lack the necessary information about the characteristics of the products available in the market. For example, consumers willing to buy a bottle of Chianti face a myriad of options. Only a wine expert (maybe an oenologist) can fully evaluate the relative quality of different grapes, but a regular consumer may not know which is the top-notch quality. In addition, even if the ranking along the quality ladder were unambiguous, a wine connesseur may differ from a wine amateur in terms of the willingness to pay for quality differences. In these circumstances, high-quality producers not only face the problem of signaling their type, but they also have to consider the impact of consumer heterogeneity on their strategic decisions.

We study this problem in a context where consumers are salient thinkers, i.e., they compare price and quality with their respective average, and tend to overweight the attribute that is more distant from the average. Their choices can then be tilted towards goods with higher quality/price ratios. In a signaling game, firms can use prices and dissipative advertising. We also investigate the impact of salience on equilibrium prices and profits, and draw conclusions in terms of the applicability of our results to real-world situations.

Our analysis reveals that salient thinking has a contrasting impact on the signaling game. On the one hand, it exacerbates the asymmetric information problem when consumers are price salient. On the other hand, it mitigates such a problem when consumers are quality salient, and may even eliminate the usual upward price distortion. This last result contributes to explain the presence of particularly high prices in markets where the relative quality of products is unknown to consumers, such as the organic food sector. We show that such high prices might not be due to a signaling motive, but simply depend on the fact that firms exploit consumers’ saliency-augmented appreciation for quality.

We also investigate the impact of salience on equilibrium profits and show that the low-quality firm is never worse off under asymmetric information, whereas the high-quality firm obtains lower profits than the full-information ones when price is salient and the intensity of the salience bias is sufficiently high. Finally, we consider endogenous quality choice under the assumption that firms select their respective qualities before price competition takes place. For instance, this extension may describe a situation of firms seeking to enter a new market. We prove that firms have incentives to pursue maximal differentiation which, in our setting, results in quality salience. This, in turn, implies that the quality levels provided at equilibrium by firms increase with the salience distortion.
The seminal papers by Bordalo et al. (2012, 2013, 2016) introduced the basic concept of salient thinking and its impact on consumer choice. According to their research, consumers’ attention can be directed towards certain attributes more than others, leading them to place a higher weight on such salient features. Price and quality are the most relevant attributes of a product, as consumers tend to compare price and quality with their respective average, thereby overweighting the attribute that is more distant from the average. Their choices can then be tilted toward products with higher quality/price ratios.

In the motivating example by Bordalo et al. (2013), a consumer compares a bottle of French syrah with a bottle of Australian shiraz. The two wines are made by the same grape, yet they sell at different prices. The consumer knows that the French wine is of higher quality. However, her choice is crucially affected by which attribute turns out to be salient, and this ultimately depends on the comparison between the products’ quality/price ratios. Moreover, as we know from Bordalo et al. (2016), if two vertically differentiated sellers compete for consumer attention, the resulting equilibrium supports either price or quality salience. Price competition entails that the firm capturing the attention of salient consumers ends up dominating the market.

In many real-world situations, however, consumers are often unable to distinguish products of high quality from products of low quality, as they may lack the necessary information about the characteristics of the products available in the market. Regarding the aforementioned example, the fact that one is a French wine may convey an useful information on relative quality, but what about the comparison between two types of French syrah? Only a wine expert (maybe an oenologist) can fully evaluate the relative quality of the two grapes, but a regular consumer may not know which one is of top-notch quality. In addition, even if the ranking along the quality ladder were unambiguous, a wine connesseur may differ from a wine amateur in terms of the willingness to pay for quality differences. In these circumstances, high-quality producers not only face the problem of signaling their type, but they also have to consider the impact of consumer heterogeneity on their strategic decisions.

On these grounds, this paper aims at investigating quality signaling in markets in which consumers are salient thinkers and have different appreciation for quality differences. More specifically, we consider a scenario in which a low-basic and a high-end quality coexist in the market. These qualities are exogenously given and produced by two different firms. Each firm knows its own quality and that of its rival. Consumers are aware of the existence of two qualities in the market, but are not informed about which firm produces what. They equally value the basic quality of the product and differ in the valuation of the high-end quality. As a result, there is consumer
heterogeneity in the appreciation of the quality difference between the high- and the low-quality product. Firms compete for consumer attention via their choices of price. In addition, they may resort to dissipative advertising if price alone is not sufficient to signal quality. Consumers have a diffuse prior regarding which firm offers the high quality. Upon observing a pair of prices, they update their beliefs and make their purchasing decisions, buying at most one unit of the good.

The salience bias does not affect consumer choice when a firm mimics the rival’s strategy, as the expected quality/price ratios of the two products are the same. This bias is instead relevant when the high-quality producer is able to reveal its type to consumers and separate from its competitor. When the quality differential is small, price becomes the salient attribute. The high-quality firm distorts its price above the full-information level in order to signal its quality. In any separating equilibrium, if the salience bias is relatively modest, an increase in the bias decreases the profit of the high-quality firm, whereas increases that of the low-quality firm. This reduces both the incentive of the low-quality firm to mimic its competitor and that of the high-quality firm to reveal its type to consumers. The latter effect is stronger than the former, and therefore a high price alone may not suffice to signal high quality. Indeed, if the salience bias is relatively intense, the high-quality firm should adopt a combination of price and advertising expenditure in order to prevent mimicking of the low-quality type.

Conversely, when the quality differential is high, quality becomes the salient attribute. In any separating equilibrium, if the salience bias is modest, the profit of the high-quality firm increases in the bias, whereas that of the low-quality firm decreases. As a result, both the incentive of the low-quality firm to mimic and that of the high-quality firm to separate from its rival are stronger. Again, it is the latter effect that dominates the former and, consequently, the high-quality type can signal its quality through price only. Interestingly, if the salience bias is high enough, prices can reveal the true type without any distortion with respect to full information. As a consequence, our analysis reveals that salient thinking has a contrasting impact on the signaling game. On the one hand, it exacerbates the asymmetric information problem when consumers are price salient. On the other hand, it mitigates such a problem when consumers are quality salient, and may even eliminate the usual upward price distortion.

As it is usually the case in signaling games, multiple equilibria can occur. By adopting an appropriate refinement, we prune the set of separating equilibria, eliminating all but one. Consumer salience affects prices and profits at the refined equilibrium. When price is salient, both prices decrease in the magnitude of the salience distortion. If the salience bias is low, the profit of the low-quality firm increases in salience, whereas that of the high-quality firm follows the opposite pattern. However, if this bias is relatively intense, the high-quality firm must resort to advertising.
This has a two-fold effect: it decreases prices even further, and equalizes firms’ profits, which are now decreasing in salience. Conversely, when quality is salient, both prices increase in the salience distortion. If the magnitude of this distortion is moderate, the profit of the high-quality firm increases in salience, whereas that of the low-quality type decreases. Instead, if this distortion is particularly relevant, the asymmetric information problem disappears and firms end up realizing full-information payoffs, which are both increasing in salience. Overall, we find that the low-quality firm is never worse off under asymmetric information, whereas the high-quality firm obtains lower profits than the full-information ones when price is salient and the intensity of the salience bias is high.

To complete our analysis, we consider endogenous quality choice under the assumption that firms can costly set their qualities before price competition takes place. For instance, this extension may describe a situation of firms seeking to enter a new market. We prove that firms have incentives to pursue maximal product differentiation which, in our setting, results in quality salience. This, in turn, implies that the quality levels provided at equilibrium by firms are increasing with the salience bias.

The results of our analysis can be traced back to some real-world examples outlining the signaling problem faced by high-quality firms in different contexts. On the one hand, in sectors in which quality differences are not that relevant, consumers are more attentive to prices rather than quality. Consequently, producers of higher quality usually resort to dissipative advertising to signal their type. Case in point, in the soda market, Coke and Pepsi regularly invest in advertisement campaigns in order to differentiate their colas from low-quality rivals, such as Sam’s Cola and Freeway Cola.\footnote{Sam’s Cola is produced by Sam’s Choice and only available at Wal-Mart discount stores, supercenters, and neighborhood markets. Freeway Cola is specifically produced for and sold in the European supermarket chain Lidl.} On the other hand, in sectors in which quality differences are substantial, consumers are more likely to be quality salient. For instance, in the organic food sector high prices usually indicate top-notch qualities, even in the absence of significant advertising expenditures.\footnote{Leading organic food producers, such as Eden Foods Inc. and Nature’s Path Organic Foods, have only recently launched advertising campaigns. However, their content is mainly informative as it aims at raising the consumers’ awareness that organic food is healthier than conventional food. This is in sharp contrast with the scope of dissipative advertising, which is mainly adopted by high-quality firms to reveal their type by means of expensive advertising efforts without directly referring to the product’s characteristics.} In this sector, one may wonder whether high prices are due to the asymmetric information problem. Yet, our analysis reveals that prices are driven up by the salience bias to such an extent that in some cases it is not necessary to distort them further to signal quality. In particular, this is the only scenario emerging when firms can decide upon their quality levels.
Related literature. This paper proposes a model of quality signaling with salient-thinking consumers. Salience theory relies on the idea that consumer’s attention is limited and focuses on outstanding features of a product.\textsuperscript{3} In particular, following Bordalo et al. (2013, 2016), we assume that consumers tend to overweigh quality or price in their choices, depending on how each of the two product attributes differs from its average in the market.\textsuperscript{4} The most related paper to ours is Bordalo et al. (2016). The authors develop a standard model of vertical differentiation with homogeneous consumers in which firms compete for consumer attention through the choice of both prices and qualities. They show that, depending on the cost of producing quality, some markets exhibit price salient equilibria, in which consumers are more attentive to price differences, whereas in other markets equilibria are quality salient, with consumers more sensitive to quality differences. We differ from Bordalo et al. (2016) as we explicitly consider an incomplete information set up with consumers that have different appreciation for quality differences.

Previous literature has studied the impact of quality signaling on market outcomes under the assumption of rational consumers. The seminal contributions consider monopoly settings. Milgrom and Roberts (1986) introduce the notion of “burning money” or dissipative advertising, showing that it may represent a credible signal of quality. Bagwell and Riordan (1991) and Judd and Riordan (1994) demonstrate that high prices may be effectively used by a high-quality seller.\textsuperscript{5} This literature shows that signaling leads to market distortions at equilibrium in comparison with full information. In different contexts, Ellingsen (1997) and Adriani and Deidda (2009) highlight a possible detrimental effect of signaling on the market outcome, namely the impossibility to trade the high-quality product. Similarly, in a multiple-seller setup, Adriani and Deidda (2011) show that high-quality sellers may be driven out of the market as competition intensifies.

Our paper is most closely related to some contributions that analyze price signaling in duopolistic markets. Hertzendorf and Overgaard (2001) examine a duopoly model in which two vertically differentiated firms are informed about their rivals’ qualities and use price and, possibly, advertising

\textsuperscript{3}Similar approaches to salience have been developed by Köszegi and Szeidl (2013) and Bushong et al. (2017).

\textsuperscript{4}Recently, salience theory has been tested and used in various applications of industrial organization. Dertwinkel-Kalt et al. (2017) provide experimental evidence confirming the main predictions of salience in terms of consumer choice for vertically differentiated products. Inderst and Obrovčić (2015) study the implications of salient thinking on the emergence of loss leading strategies. Helfrich and Herweg (2017) point out how salience may explain the existence of vertical restraints in e-commerce. Finally, Herweg et al. (2017) show how a seller may benefit from offering a decoy good if consumers are salient thinkers.

\textsuperscript{5}Linnemer (2002) and Yehezkel (2008) extend Bagwell and Riordan (1991). The former includes uninformative advertising, showing that consumers interpret both high prices and advertising as quality signals. The latter considers a duopoly in which only some consumers are informed, finding an inverse U-shaped relationship between prices and the proportion of informed consumers.
to signal the qualities of their products. Assuming that unit costs are independent of qualities, they find that price alone can signal quality when the quality differential is sufficiently high, whereas both price and advertising are required when the quality differential is relatively low. Prices are usually distorted upwards. However, when advertising is used, prices may be driven below their full-information levels. Fluet and Garella (2002) share the same information structure in a slightly different framework with quality-dependent unit costs. In their model, separation generally requires an upward price distortion or positive advertising (or both), but it may also occur with no price distortion when the cost difference across qualities is sufficiently high. In our model, which assumes cost symmetry, separation may be achieved either through upward price distortion (and possibly advertising) or it may occur without any distortion in relation to full information. The mechanism behind the absence of price distortion is due to consumer salience. Indeed, quality salience mitigates the informational problem of the high-quality seller, until reaching cases in which the need of signaling is fully eliminated and equilibrium prices become the full-information ones. Daughety and Reinganum (2008) examine a horizontally and vertically differentiated duopoly and assume that firms have private information only about their own quality. They find that incomplete information may lead to higher profits for both types of firm with respect to a situation of complete information. In our model, the low-quality firm always benefits from asymmetric information, whereas the high-quality firm may prefer playing the full-information game to the incomplete information analog, depending on the intensity of the salience bias.

The structure of the paper is the following. Section 2 describes the theoretical setting. Section 3 provides the equilibrium analysis, whereas Section 4 discusses how the equilibrium outcomes of the signaling game are affected by consumer salience. Section ?? extends the model to quality choice and, finally, Section 5 concludes.

2 The model

Let us consider a duopoly environment, in which two firms $i \in \{H, L\}$ compete in prices and differ in the quality $q_i$ they provide. We will label as $H$ the high-quality firm and as $L$ the low-quality firm, with $q_H > q_L$. When setting prices, firms observe both their own and their rival’s quality. Consumers, conversely, are not informed about firms’ qualities. Prices are observed by consumers before making their purchase decisions. Prices, if different, may signal the quality of the products to consumers who update their beliefs accordingly. At equal prices, all consumers prefer the high-quality to the low-quality product. Marginal production costs do not differ across qualities and are also normalized to zero.
As in Fluet and Garella (2002), consumers are heterogeneous in their appreciation of the quality difference between the high- and the low-quality product. In particular, there is a unitary mass of consumers who are uniformly distributed in the interval $[0, 1]$ according to their valuation of the quality difference, $\theta$. Each consumer buys at most one unit of the good. When no purchase is made, her utility is zero. Without salience distortion, the utility deriving from purchasing the low quality is $U_L = q_L - p_L$, and that of buying the high quality $U_H = q_L + \theta(q_H - q_L) - p_H$, where $p_L$ and $p_H$ are the prices of the low- and the high-quality product, respectively. Notice that, when $\theta = 1$, consumers’ preferences are the same as in Bordalo et al. (2016).

Salience distorts consumer valuation by attaching a lower weight, $\delta \in (0, 1]$, to the least salient attribute of the product. Utility functions are therefore given by:

1. $U_L = \begin{cases} 
\delta q_L - p_L & \text{if price is salient}, \\
q_L - \delta p_L & \text{if quality is salient}, \\
q_L - p_L & \text{if equally salient}.
\end{cases}$

2. $U_H = \begin{cases} 
\delta q_L + \delta \theta(q_H - q_L) - p_H & \text{if price is salient}, \\
q_L + \theta(q_H - q_L) - \delta p_H & \text{if quality is salient}, \\
q_L + \theta(q_H - q_L) - p_H & \text{if equally salient}.
\end{cases}$

Following Bordalo et al. (2016), salience in a given attribute is determined by a function $\sigma(x, y)$ assumed to be symmetric, continuous and satisfying two properties, namely ordering and homogeneity of degree zero. According to ordering, whenever the interval $[x, y]$ is contained in a larger interval $[x', y']$, then $\sigma(x', y') > \sigma(x, y)$. According to homogeneity of degree zero, for any $\epsilon > 0$, it holds that $\epsilon \sigma(x, y) = \sigma(\epsilon x, \epsilon y)$, with $\sigma(0, 0) = 0$. In words, a given attribute (price or quality) $a$ is compared with the reference level $\bar{a}$, which is the average. Then, quality is salient whenever $\sigma(q, \bar{q}) > \sigma(p, \bar{p})$, i.e., the difference between the quality of a product and the reference quality is larger than the difference between that product’s price and the average price. The salience function that we use is $\sigma(a, \bar{a}) = |a - \bar{a}|/\bar{a}$. The two properties of this function imply that the salience of a product’s quality is an increasing function of the percentage difference between the good’s quality and the average quality, and similarly for price. For example, quality is salient if $\sigma(q_H, \bar{q}) > \sigma(p_H, \bar{p})$, which implies that $q_H/q_L > p_H/p_L$.\footnote{An alternative way of introducing salience in a vertical differentiation set-up would have been the one à la Mussa and Rosen (1978). However, regardless of the quality ratio, with these consumers’ preferences, price salience would always emerge at equilibrium.}
Consumers’ purchase decisions depend on their appreciation for quality differences. Under full information, for given prices \( p_H \) and \( p_L \), there exists a cutoff \( \theta^* \) such that all consumers below \( \theta^* \) purchase the low-quality good, whereas all those above \( \theta^* \) buy the high-quality one.\(^7\) Provided that \( 0 < \theta^* < 1 \), demands are given by \( D_H(p_H, p_L) = 1 - \theta^*(p_H, p_L) \) and \( D_L(p_H, p_L) = \theta^*(p_H, p_L) \). This also holds under asymmetric information if the two firms adopt different pricing strategies (separating equilibrium). On the contrary, if they charge the same price (pooling equilibrium), consumers cannot distinguish between the two qualities, and therefore, salience becomes irrelevant. In this case, for a given price \( p \), all agents with sufficiently high \( \theta \) (\( \theta > \tilde{\theta} \)) randomly purchase one of the two products. The demand facing each firm is \( D(p) = \frac{1}{2} \max \{1 - \tilde{\theta}(p), 1\} \). Notice that, when \( p < q_L \), the two firms equally split the entire market, as every consumer is willing to buy either product at price \( p \).

Firms’ profits are contingent on posterior consumer beliefs, denoted by \( \mu(p_i, p_j) \), where \( \mu : [0, 1]^2 \times R^2_+ \to [0, 1] \). This function \( \mu(p_i, p_j) \) represents the posterior probability that the firm charging the price \( p_i \) offers the high-quality product, provided that the other firm charges the price \( p_j \). Since there is only one firm of each type, it follows that \( \mu(p_i, p_j) + \mu(p_j, p_i) = 1 \).

In what follows, we proceed by backward induction. We first analyze the model for given qualities and characterize the conditions under which a separating equilibrium can be supported (Sections 3 and 4).

### 3 Analysis

This section is devoted to the analysis of the price competition and the signaling game played by the two firms for given qualities \( q_H \) and \( q_L \). We restrict our attention to situations in which the low-quality firm is active in the market, i.e., leaves its consumers with weakly positive surplus. For this to be the case, we need that the difference in quality is not excessively large, i.e., \( q_H \leq 4q_L \). For the sake of exposition, we first analyze in Section 3.1 the asymmetric information game when the price is the only signaling device.\(^8\) Then, in Section 3.2, we allow firms to also use dissipative advertising.

#### 3.1 Signalling through prices

Throughout the paper, we restrict our analysis to pure-strategy equilibria. As in Hertzendorf and Overgaard (2001), the equilibrium is defined as follows:

\(^7\)The threshold values of \( \theta \) appearing in this paragraph will be provided in the next section.

\(^8\)In Appendix A.1, we briefly discuss the case of full information.
Definition 1. An equilibrium is a pair of prices $\hat{p}_H$ and $\hat{p}_L$ and a system of beliefs $\mu(\hat{p}_i, \hat{p}_j)$ with $i, j \in \{H, L\}$ such that:

1. $\hat{p}_L \in \arg \max \Pi_L(p_L, \hat{p}_H, \mu(p_L, \hat{p}_H))$;
2. $\hat{p}_H \in \arg \max \Pi_H(p_H, \hat{p}_L, \mu(p_H, \hat{p}_L))$;
3. if $\hat{p}_H \neq \hat{p}_L$ then $\mu(\hat{p}_H, \hat{p}_L) = 1$;
4. if $\hat{p}_H = \hat{p}_L$ then $\mu(\hat{p}_H, \hat{p}_L) = 1/2$;
5. $\mu(p_L, p_H) + \mu(p_H, p_L) = 1$.

Conditions 1 and 2 say that, at the equilibrium, the two firms maximize profits, given the strategy of the rival and the posterior beliefs of consumers. Conditions 3 and 4 are referred to the revision of consumers’ beliefs. We assume that, if both firms set equal prices, consumers do not change their initial beliefs. In contrast, if firms choose different prices, consumers learn with probability one which quality is offered by each firm. Clearly, condition 5 simply requires that the posterior beliefs over two collectively exhaustive events sum to one. Two types of equilibria may then occur: pooling and separating.

3.1.1 Pooling Equilibria

We start by characterizing the pooling equilibria. Assume that both firms set the same price so that consumers cannot distinguish between them. Accordingly, they assign to each good a probability 1/2 to be of high quality. In the analysis of pooling equilibria, the expected quality ratio equals the price ratio (equal to 1). As a result, consumers are always equally salient.

A consumer with appreciation for quality $\theta$ compares the expected utility of buying with the alternative of not buying at all. As a result, if

$$q_L + \theta \left(\frac{q_H + q_L}{2} - q_L\right) - p \geq 0 \iff \theta \geq \tilde{\theta} \equiv \frac{2(p - q_L)}{q_H - q_L},$$

the consumer randomly purchases one of the two products. The demand facing each firm is $D(p) = \frac{1}{2} \max \left\{1 - \tilde{\theta}, 1\right\}$. Notice that whenever $p < q_L$, the two firms equally split the entire market, as every consumer buys either product at price $p$.

Clearly, when playing a pooling strategy, the two firms obtain the same profits, given by:

\[9\]

\[\text{We discard the case in which the price is higher than the average quality, as no consumer would buy either product.}\]
\[ \Pi^{pool}(p, p, 1/2) = \frac{p}{2} \max \left\{ 1 - \frac{2(p - q L)}{q H - q L}, 1 \right\}. \] (3)

The identity of profits implies that both firms have the same incentive to defect from any pooling equilibrium, no matter how we define out-of-equilibrium beliefs. Therefore, when consumers observe a deviation from a putative pooling equilibrium, they assign equal probability to either firm to deviate. This is the intuition of the impartial out-of-equilibrium beliefs criterion that we adopt in order to select a unique pooling equilibrium.\(^{10}\) It follows that each firm, independently of the quality produced, has always an incentive to set a price slightly lower than \(p > 0\). Indeed, since consumers believe that this defection may come from the high- or the low-quality seller, they would buy the cheaper good and the defecting firm would serve the entire market. Hence, no pooling equilibrium with positive profits can survive this refinement. As a result, the only pooling equilibrium that resists is the one leading to a Bertrand trap, in which both firms serve half of the market at a price equal to zero.

### 3.1.2 Separating Equilibria

In a separating equilibrium, the qualities of the two firms are credibly disclosed by prices before purchase. As a consequence, it is easy to notice that any couple of prices \((p_H, p_L)\) such that \(\frac{p_H}{p_L} \neq \frac{q_H}{q_L}\) will surely make either the price or the quality the salient attribute. The following two definitions identify the two classes of separating equilibria.

**Definition 2.** A price-salient separating equilibrium is a pair of prices \(\hat{p}_H\) and \(\hat{p}_L\) and a system of beliefs \(\mu(\hat{p}_i, \hat{p}_j)\) with \(i, j \in \{H, L\}\) such that conditions 1-3 and 5 of Definition 1 hold and \(\frac{\hat{p}_H}{\hat{p}_L} > \frac{q_H}{q_L}\).

**Definition 3.** A quality-salient separating equilibrium is a pair of prices \(\hat{p}_H\) and \(\hat{p}_L\) and a system of beliefs \(\mu(\hat{p}_i, \hat{p}_j)\) with \(i, j \in \{H, L\}\) such that 1-3 and 5 of Definition 1 hold and \(\frac{\hat{p}_H}{\hat{p}_L} < \frac{q_H}{q_L}\).

In order to characterize a separating equilibrium, we proceed as follows. First, we consider a class of separating equilibria, depending on whether price or quality is the salient attribute. Second, we find the optimal reply of the low-quality firm when consumers, according to their posterior beliefs, assign probability one to firm \(L\) selling the low-quality variant. Since the low-quality firm faces the worst possible beliefs in a separating equilibrium, altering its strategy cannot negatively affect consumers’ beliefs. Hence, it can not do better than maximize its profits. Then, we find the conditions under which each type does not find it profitable to mimic the strategy played by

\(^{10}\)This criterion was introduced by Hertzendorf and Overgaard (2001), to which we refer for additional formal details.
the rival (pooling equilibria) or to deviate to a price that makes the other attribute salient. For instance, let us consider a quality-salient separating equilibrium. If firm $H$ sets price $\hat{p}_H$, firm $L$ faces three alternatives. The first is to set a price and accept to be perceived as a low-quality firm with probability one under quality salience. The second is to mimic the strategy of firm $H$ by charging the same price, thereby confusing consumers. In this case, the two firms obtain the pooling profits given in (3). The third option is to set another price and accept to be perceived as a low-quality firm under price salience. If firm $L$ finds it profitable one of the two last alternatives, the quality-salient separating equilibrium does not exist.

In a separating equilibrium, the profits that firm $L$ maximizes are:

$$\Pi_L(p_H, p_L) = \begin{cases} 
  p_L \left( \frac{p_H - p_L}{\delta(q_H - q_L)} \right) & \text{if price is salient}, \\
  p_L \left( \frac{\delta(p_H - p_L)}{q_H - q_L} \right) & \text{if quality is salient}, \\
  p_L \left( \frac{p_H - p_L}{q_H - q_L} \right) & \text{if equally salient}.
\end{cases} \tag{4}$$

One can easily notice that the best reply of firm $L$ is always given by $p_L(p_H) = p_H/2$, no matter which attribute is salient.

Let us assume a price-salient separating equilibrium as defined in Definition 1, i.e., when $q_H/q_L < 2$. In this case, firm $L$ would charge a price $p/2$ and enjoy the following profits:

$$\Pi^\text{sep}_L(p/2, p, 0) = \frac{p^2}{4\delta(q_H - q_L)} \tag{5}.$$  

For a separating equilibrium to be incentive compatible, firm $L$ must prefer the profits in (5) to those of mimicking. In the latter case, it would charge price $p$ in order to obtain the profits in (3).

From this comparison we find a minimum price $p_{\text{min}} \equiv \frac{2(\delta q_H + q_L)}{1 + 4\delta}$ above which the low-quality firm would not find it profitable to mimic the high type. Turning to firm $H$, in a separating equilibrium it would charge a price $p$ and obtain:

$$\Pi^\text{sep}_H(p, p/2, 1) = p \left[ 1 - \frac{p}{2\delta(q_H - q_L)} \right]. \tag{6}$$

In case of mimicking, it would charge $p/2$ instead, and each consumer would buy one of the two products on a random basis. The expected profits from this deviation would be $\Pi^\text{pool}_H = p/4$. Comparing the two profits, the high-quality firm prefers not to mimic if $p < p_{\text{max}} \equiv \frac{3\delta(q_H - q_L)}{2}$.

The previous analysis allows us to conclude the following:

**Lemma 1.** A necessary condition for the emergence of the price-salient separating equilibrium is that $q_H/q_L > 19/11$ and $\delta \in \left[ \tilde{\delta}, 1 \right]$ with $\tilde{\delta} \equiv \frac{q_H + q_L}{12(q_H - q_L)}$ with $p_L = p_H/2$ and $p_H \in [p_{\text{min}}, p_{\text{max}}]$.  

12
Notice that the interval \([p_{\text{min}}, p_{\text{max}}]\) is non-empty when the quality ratio is sufficiently large and the salience bias sufficiently small.

Let us turn to the case of quality salience, which holds when \(q_H/q_L > 2\). Applying the same procedure as that of price salience, we find that:

**Lemma 2.** Let \(p'_{\text{min}} \equiv \frac{2(q_H + q_L)}{4 + \delta}\) and \(p'_{\text{max}} \equiv \frac{2(q_H + q_L)}{4 + \delta}\). A necessary condition for the emergence of the quality-salient separating equilibrium is that \(q_H/q_L > 2\) with \(p_L = p_H/2\) and \(p_H \in [p'_{\text{min}}, p'_{\text{max}}]\).

**Proof.** See Appendix A.2. ■

Lemmas 1 and 2 give conditions for a price- and a quality-salient separating equilibrium to emerge. These conditions are necessary but not sufficient: a firm can in principle decide to deviate setting another price that renders the other attribute salient, taking as given the price of the rival in the candidate equilibrium. For example, assume a candidate separating equilibrium with two prices leading to separation with the price attribute salient to consumers. In this case, a firm may have incentives to deviate to a price that renders quality salient to consumers so as to mitigate price competition. Moreover, among the possible equilibria of Lemma 1 and 2, it would be important to select the most reasonable one(s).

In order to perform the deviation analysis described above and to restrict the set of equilibria, it is necessary to suitably define out-of-equilibrium beliefs. At this regard, we follow Hertzendorf and Overgaard (2001), applying the Resistance to Equilibrium Defections (REDE) criterion:

**Definition 4.** An equilibrium profile \((\hat{p}_H, \hat{p}_L)\) is resistant to equilibrium defections if beliefs satisfy \(\mu(p_i, p_j) = 1\) whenever:

1. \(p_i \in (p_{\text{min}}, p_{\text{max}})\) or \(p_i \in (p'_{\text{min}}, p'_{\text{max}})\) and
2. \(p_j = \tilde{\hat{p}}/2\) for some \(\tilde{\hat{p}}\) satisfying 1.

According to REDE, a deviation from a couple of putative-equilibrium prices does not change consumers’ beliefs whenever the resulting price profile is compatible with another separating equilibrium. Instead, we assume that the beliefs are the most pessimistic ones when this is not the case in order to span the set of separating profiles that survive REDE. Restricting our attention to out-of-equilibrium beliefs as such is very convenient for two reasons. On the one hand, whenever the deviating price might be adopted by a firm in another separating equilibrium revealing that firm \(i\) sells a high-quality product and firm \(j\) a low-quality one, consumers’ beliefs are kept unchanged. When this is the case, the gains from a deviation by firm \(H\) are the highest possible ones, so that this firm will choose a constrained best reply, i.e., the best possible price compatible with preventing mimicry. On the other hand, if the deviation leads to a couple of prices not compatible
with another separating equilibrium, these are the worst beliefs from the point of view of a firm contemplating a deviation, as consumers would infer that the deviating firm offers low quality and that the rival offers high quality. This implies that, whenever deviating, firm $H$ is required to make consumers believe that the deviation comes from a high type. Moreover, it also implies that firm $L$ is always treated as a low type out-of-equilibrium, reducing as much as possible its gains from deviations. The salience bias affects the best reply by the high type to $p_L = p_H/2$ in a different way, augmenting it when quality is salient and reducing it when price is salient. Notice that the difference between the minimum price to prevent mimicry and the optimal reply augments with $\delta$ in the former case and reduces in the latter case. This affects the set of reveal that the surviving separating equilibria and the (possible) need of price distortion as formalized by the following Proposition:

**Proposition 1.** There exist two types of separating equilibria surviving REDE:

1. If $q_H/q_L > 2$ and $\delta \geq \hat{\delta} \equiv \frac{2\sqrt{(q_H-q_L)q_L}}{q_H}$, quality is the salient attribute and the equilibrium prices are:

\[
\hat{p}^{qs}_L = \frac{\hat{p}^{qs}_H}{2} \quad \text{with} \quad \hat{p}^{qs}_H = \begin{cases} 
\hat{p}'_{\min} & \text{when} \quad \delta > \frac{2(q_H-q_L)}{q_H+2q_L} \\
\frac{2(q_H-q_L)}{3\delta} & \text{when} \quad \delta \leq \frac{2(q_H-q_L)}{q_H+2q_L}
\end{cases}
\]

2. If $q_H/q_L \in [19/11, 2)$ and $\delta \in \left[\tilde{\delta}, 1\right]$, price is the salient attribute and the equilibrium prices are:

\[
\hat{p}^{ps}_L = \frac{\hat{p}^{ps}_H}{2} \quad \text{with} \quad \hat{p}^{ps}_H = p_{\min}.
\]

**Proof.** See Appendix A.3. ■

The salience bias influences the incentives of firms to deviate from quality to price salience and vice versa, thereby affecting the regions in which a separating equilibrium can be sustained.

When quality is the salient attribute, the firm having incentives to deviate towards a situation of price salience is the low type. To do so, this firm should reduce its price in order to move consumers’ attention towards the price attribute. The higher is the salience bias (the lower is $\delta$), the more attractive becomes this deviation. In this case, candidate equilibrium prices are relatively high because of the salience bias, and the low type can deviate to price salience keeping its price relatively high. Proposition 1 shows that, when $\delta < \hat{\delta}$, this deviation makes the quality-salient separating equilibrium destabilized. In the region in which a quality-salient separating equilibrium can be sustained, the high type faces a less severe informational problem when $\delta$ is low. As a consequence, the usual upward price distortion arises only when the salience bias is moderate and
the quality ratio is relatively small. Indeed, if $\delta$ is sufficiently low, the optimal price becomes
$$\frac{2(q_H - q_L)}{3\delta}$$
which represents the best reply to $p^q_L$ and coincides with the full-information price.\footnote{Notice that no-distortion equilibria also arise in Fluet and Garella (2002) but this is due to cost asymmetry. In their model, the difference between the two full-information prices increases in the cost differential and may become so large to reveal quality without any distortion. In our set-up, no-distortion equilibria result from consumer salience. Clearly, adding cost asymmetry in our setup would eliminate the informational problem for a larger parametric region.}

When price is the salient attribute, the firm having incentives to deviate towards a situation of quality salience is the high type. Also in this case, this firm should reduce its price in order to move consumers’ attention towards the quality attribute. Differently from the previous case, candidate equilibrium prices are relatively low, and the high type faces the additional problem of making consumers believe that the deviation comes effectively from the high type. However, the objective of reducing the price is conflicting with the need to convince consumers out of equilibrium, making this deviation unprofitable. Proposition 1 shows that a price-salient separating equilibrium always resists to such a deviation. In the region in which a price-salient separating equilibrium can be sustained, the best reply of the high type is never sufficient to prevent mimicking. Therefore, its optimal price is distorted upwards and equal to $p_{min}$.

### 3.2 Signalling through prices and advertising

In the previous analysis, we only considered the possibility of using price as a signaling device. However, separation is not always feasible, as it is shown in Proposition 1. Consequently, we now allow firms to adopt advertising as a complementary tool to reveal their types. As in Hertzendorf and Overgaard (2001) and Fluet and Garella (2002), advertising is purely dissipative and requires a fixed cost that does not affect revenues. The profit function of firm $i \in \{H, L\}$ net of advertising expenditure is given by $\Pi^i(p_i) - A_i$, where $A_i$ is the advertising level.

Advertising can be an effective additional tool to separate only when price is the salient attribute. Indeed, when quality is salient, the incentives of the low type to deviate to a price salient scenario do not depend on the level of advertising expenditure of the high type. As a result, the threshold $\hat{\delta}$ compatible with a quality-salient separating equilibrium will be not affected by the use of advertising. Notice that, if price alone is sufficient to separate, advertising would never be used by the high type. Therefore, in the following, let us focus on the price-salience scenario. The following Lemma provides the necessary condition for the emergence of a price-salient separating equilibrium with advertising:

**Lemma 3.** Let $A_{min} = \frac{25(p_H - q_L) - p^2}{48(q_H - q_L)}$. A necessary condition for the emergence of a price-salient separating equilibrium with advertising is that $q_H/q_L < 19/11$ or $q_H/q_L \in (19/11, 2)$ with $\delta < \tilde{\delta}$.
The equilibrium profile strategies must satisfy $(A_L, p_L) = (0, p_H/2)$ and $(A_H, p_H) = (A_{\text{min}}, p)$ with $p \leq \delta(q_H - q_L)$.

**Proof.** See Appendix A.4.

The following Proposition characterizes the only separating equilibrium that survives REDE:

**Proposition 2.** There exist three types of separating equilibria surviving REDE:

1. If $\frac{q_H}{q_L} > 2$ and $\delta \geq \delta \equiv \frac{2\sqrt{(q_H - q_L)q_L}}{q_H}$, quality is the salient attribute and the equilibrium strategy profiles are:

   $$(\hat{A}_{\text{adv}}^L, \hat{p}_{\text{adv}}^L) = (0, \hat{p}_{qs}^L) \quad \text{and} \quad (\hat{A}_{\text{adv}}^H, \hat{p}_{\text{adv}}^H) = (0, \hat{p}_{qs}^H).$$

2. If $\frac{q_H}{q_L} \in [19/11, 2)$ and $\delta \in \left[\tilde{\delta}, 1\right]$, price is the salient attribute and the equilibrium strategy profiles are:

   $$(\hat{A}_{\text{adv}}^L, \hat{p}_{\text{adv}}^L) = (0, \hat{p}_{ps}^L) \quad \text{and} \quad (\hat{A}_{\text{adv}}^H, \hat{p}_{\text{adv}}^H) = (0, \hat{p}_{ps}^H).$$

3. If $q_H/q_L < 19/11$ or $q_H/q_L \in (19/11, 2)$ with $\delta < \tilde{\delta}$, price is the salient attribute and the equilibrium strategy profiles are:

   $$(\hat{A}_{\text{adv}}^L, \hat{p}_{\text{adv}}^L) = \left(0, \frac{\delta(q_H - q_L)}{2}\right) \quad \text{and} \quad (\hat{A}_{\text{adv}}^H, \hat{p}_{\text{adv}}^H) = \left(\frac{\delta(q_H - q_L)}{4}, \delta(q_H - q_L)\right).$$

**Proof.** See Appendix A.5.

Recall that advertising has no direct effect on demand. Hence, the aim of the high-quality firm is just to change consumers’ beliefs by “burning money”. In order to reach this goal, the amount “burned” must be at least equal to the gain of being perceived as the high- rather than the low-quality type. This gain corresponds to the difference between the gross profits of the high-quality firm and that of the rival. If the advertising expenditure were lower, the low-quality firm would always opt for mimicking, and a separating equilibrium would never appear.

### 4 Quality signaling and consumer salience

We now discuss how the equilibrium outcomes of the signaling game are affected by consumer salience. We provide the most relevant results in a non-technical way and draw the main implications of our analysis. In particular, we highlight the relationship between quality signaling and consumer salience. To ease the exposition, we represent all the possible equilibria resulting from Proposition 2 in Figure 1. There are five areas depending on the interplay between the quality ratio and the intensity of the salience bias. Recall that price is the salient attribute when $q_H/q_L < 2$, whereas quality is the salient attribute when $q_H/q_L > 2$. 


When the quality ratio is small (area $A$ with $q_H/q_L \leq 19/11$), a separating equilibrium can be obtained only through the combination of price and dissipative advertising adopted by the high-quality firm. When the quality ratio is intermediate (i.e., $q_H/q_L \in (19/11, 2)$), two different scenarios appear, depending on the level of salience. In particular, if the salience bias is relatively small (area $B$), a separating equilibrium can be supported by using prices only. The quality ratio is not as small as in the previous region and distorting the price upwards is sufficient to signal quality. Yet, if the salience bias is higher (area $A$), upward price distortion does not suffice to support separation and advertising is required.

When the quality ratio is relatively high ($q_H/q_L > 2$), price alone can be used as a signaling device, but the intensity of the price distortion crucially depends on the salience bias. If consumers are moderately salient (area $C$), upward price distortion still emerges. Instead, if the salience bias is strong and the quality ratio is sufficiently high (area $D$), separation occurs without any price distortion. The high-quality firm can charge the full-information price without facing the risk of being imitated by the low-quality firm.

The following Corollary draws attention to the impact of salience on emergence of separating outcomes:
Corollary 1. The set of separating equilibria with the only use of price shrinks when the salience bias increases.

Corollary 1 highlights the fact that salience makes separation more difficult to achieve. When price is the salient attribute, salience makes mimicking by the low type more likely to occur. Instead, when quality is the salient attribute, salience makes the deviation of the low type from quality to price salience more profitable. In both cases, a large salience bias renders price alone not sufficient to signal quality. In terms of separation, this becomes particularly relevant when the quality ratio is high (quality salience). One may think that this is the most favourable situation for a high-quality firm as salience adds an additional quality premium to the advantage of being a high type. However, this creates too strong incentives for the low type to deviate towards price salience with the consequence of destabilizing the separating equilibria under quality salience. Somewhat at odds with what one could have expected, this brings to a pooling equilibrium in which salience becomes irrelevant.

5 Conclusions

This paper has analyzed quality signaling when consumers are salient thinkers. In particular, our aim was to investigate a scenario in which consumers are uninformed about quality and whose attention can be directed to specific attributes of a product. In order to do so, our model has considered different ingredients. First, we have introduced the mechanics of salience developed by Bordalo et al. (2012, 2013, 2016) into a duopoly model in which firms produce a predetermined variant (of high or low quality) of a vertically differentiated product. Second, we have assumed that consumers were not only uninformed about firms’ qualities, but also heterogeneous in the appreciation of the quality difference between the two varieties of the product they want to buy. In addition, qualities were initially supposed as exogenously given, and firms then competed for consumer attention only by choosing prices. Compatible with earlier studies on quality signaling, we have also allowed the high-quality firm to resort to dissipative advertising as an additional tool to signal its quality.

Our analysis has revealed that salient thinking has a contrasting impact on the signaling game. When price is the salient attribute, it exacerbates the asymmetric information problem by intensifying price competition. The high-quality firm distorts its price above the full-information level, but this may not suffice to signal its quality. Indeed, if the salience bias is relatively intense, it should adopt a combination of price and advertising expenditure because a high price alone does not serve the purpose of supporting a separating equilibrium. On the contrary, when quality is the
salient attribute, the asymmetric information problem is mitigated by salient thinking. In particular, if the salience bias is high enough, the need of signaling is fully eliminated and there is no price distortion. This last result contributes to explain the presence of particularly high prices in markets for those products whose relative quality is unknown to consumers prior to purchasing. Our analysis has revealed that such high prices might not be due to a signaling motive, but simply depend on the fact that firms exploit consumers’ saliency-augmented appreciation for quality.

Furthermore, we have analyzed the effect of salience on equilibrium profits, and compared asymmetric information with full information. We have shown that the low-quality firm is never worse off under asymmetric information, whereas the high-quality firm may obtain lower profits than the full-information ones when consumers are price salient and the salience bias is high enough. The result is driven by the trade-off faced by the high-quality firm when it distorts the price upwards in order to signal quality, given that its market share inevitably shrinks. This does not occur to the low-quality firm, which responds by increasing its price as well, although proportionally less than the rival, thereby increasing its market share. In the last part of the paper we have endogenized quality choice and shown that firms choose maximum quality differentiation. As a consequence, quality becomes the salient attribute and quality levels tend to increase with the salience bias. We have also briefly discussed what could happen if we cast our analysis in the conventional framework of vertical product differentiation à la Mussa and Rosen (1978).

An interesting development of our model would be to enable consumers to gather information about the quality of a product prior to purchasing. Online reviews aggregators, for instance, provide different sources of information, depending on whether they rely on consumer reviews only or on a combination of both the aggregator itself and peer reviews. This may represent a promising, yet different approach that we leave for future research.
Appendix A

A.1 Full information

We briefly describe the equilibrium outcome in the case of full information. Assume therefore that consumers are informed about firms’ qualities. For a salient thinker, the relative ratios of prices and qualities will determine which attribute is salient. According to Eqs. (1)-(2), the low-quality product is purchased when price is salient if
\[ \delta q_L - p_L \geq \delta q_L + \theta(q_H - q_L) - p_H, \]
and when quality is salient if
\[ q_L - \delta p_L \geq q_L + \theta(q_H - q_L) - \delta p_H. \]
Therefore, firm L’s profits are given by:
\[
\Pi_L(p_H, p_L) = \begin{cases} 
  p_L \left[ \frac{p_H - p_L}{\delta(q_H - q_L)} \right] & \text{if price is salient,} \\
  p_L \left[ \frac{\delta(p_H - p_L)}{q_H - q_L} \right] & \text{if quality is salient,} \\
  p_L \left[ \frac{p_H - p_L}{q_H - q_L} \right] & \text{if equally salient.}
\end{cases}
\]

(A1)

It can be shown that, when a pure-strategy equilibrium exists, the optimal response of firm L to any \( p_H \) is given by \( p_L(p_H) = p_H/2 \), regardless of which attribute is salient. It follows that, for each price set by firm H, quality is salient when \( q_H/q_L > 2 \), and price is salient when \( q_H/q_L < 2 \). In the former case, firm H maximizes \( \Pi_H(p_H, p_L) = p_H \left[ 1 - \frac{\delta(p_H - p_L)}{q_H - q_L} \right] \), whereas in the latter case, it maximizes \( \Pi_H(p_H, p_L) = p_H \left[ 1 - \frac{p_H - p_L}{\delta(q_H - q_L)} \right] \). Then, we get:

(i) If \( q_H/q_L < 2 \) and \( \delta \in (0, 1) \), price is salient and equilibrium prices are:
\[ p_{ps}^H = \frac{2\delta(q_H - q_L)}{3} \text{ and } p_{ps}^L = \frac{\delta(q_H - q_L)}{3}. \]

(ii) If \( q_H/q_L > 2 \) and \( \delta \in (0, 1) \), quality is salient and equilibrium prices are:
\[ p_{qs}^H = \frac{2(q_H - q_L)}{3\delta} \text{ and } p_{qs}^L = \frac{q_H - q_L}{3\delta}. \]

(iii) If \( q_H/q_L = 2 \) and \( \delta \in (0, 1) \), or if \( \delta = 1 \) for any \( q_H/q_L \neq 2 \), price and quality are equally salient and equilibrium prices are:
\[ p_{es}^H = \frac{2(q_H - q_L)}{3} \text{ and } p_{es}^L = \frac{q_H - q_L}{3}. \]

Regardless of which attribute is salient, the demand of the high-quality firm is equal to \( 2/3 \), whereas that of the low-quality firm amounts to \( 1/3 \).
A.2 Proof of Lemma 2

Consider \( q_H/q_L > 2 \). When firm \( H \) sets price \( p \), the profit accruing to firm \( L \) in a quality-salient separating equilibrium is:

\[
\Pi_L(p/2, p, 0) = \frac{\delta p^2}{4(q_H - q_L)}, \tag{A2}
\]

In order for a separating equilibrium to be incentive compatible, firm \( L \) must prefer the profits in (A2) to \( \Pi_{pool}(p, p, 1/2) \), which occurs when \( p > p'_{min} = \frac{2(q_H + q_L)}{4+s} \). From the standpoint of firm \( H \), setting a price \( p \) guarantees the following profits:

\[
\Pi_H(p, p/2, 1) = p \left[ 1 - \frac{\delta p}{2(q_H - q_L)} \right],
\]

whereas mimicking firm \( L \) would yield \( \Pi_{pool}(p/2, p/2, 1/2) = p/4 \). Thus, incentive compatibility requires \( p < p'_{max} = \frac{3(q_H - q_L)}{2s} \). Therefore, a separating equilibrium profile must be \( \{\hat{p}_H, \hat{p}_L\} = \{p, p/2\} \), with \( p \in [p'_{min}, p'_{max}] \). Since \( p'_{max} > p'_{min} \) when \( q_H/q_L > 2 \), a quality-salient separating equilibrium always exists.

A.3 Proof of Proposition 1

Consider a quality-salient candidate equilibrium. Given our specification of out-of-equilibrium beliefs, the low-quality firm will be perceived as the low type when it deviates. Therefore, there will be no profitable deviation in which quality is salient. Let us consider a possible deviation of the low quality firm to a situation in which price is salient. Formally, given a price \( p \) charged by firm \( H \) in a putative separating equilibrium, firm \( L \) maximizes \( p_{dev}^{L} = p_{\hat{q}_L}^{q_L} - \epsilon \) with \( \epsilon > 0 \) arbitrarily small and the maximal deviation profits amount to \( \Pi_{dev}^{L}(p_{dev}^{L}, p, 0) = (p_{\hat{q}_L}^{q_L})/(q_H^2\delta) \). For firm \( L \) not to deviate it must be that \( \Pi_L(p/2, p, 0) > \Pi_{dev}^{L}(p_{dev}^{L}, p, 0) \). This requires that \( \delta > \hat{\delta} = \frac{2\sqrt{q_H-q_L}q_L}{q_H} \).

Let us now consider a possible deviation of firm \( H \) towards a price-salient configuration, given the price \( p_L = p/2 \) with \( p \in (p'_{min}, p'_{max}) \). The high quality firm will be perceived as the high type if the deviation price \( p_{dev}^{H} \) is compatible with a price-salient separating equilibrium, i.e., \( p_{dev}^{H} \in (p_{min}, p_{max}) \). Formally, firm \( H \) maximizes \( p_{dev}^{H} = p_{\hat{q}_L}^{q_L} \left( 1 - \frac{p_{dev}^{H} q_L}{s(q_H - q_L)} \right) \) under the constraint \( p_{dev}^{H} > \frac{p q_H}{2 q_L} \). The optimal price is \( p_{dev}^{H} = \max \left\{ \frac{p q_H}{2 q_L} + \epsilon, \frac{p + 2 \delta (q_H - q_L)}{4} \right\} \) with \( \epsilon > 0 \) arbitrarily small. It is possible to show that, when \( p \in (p'_{min}, p'_{max}) \) and \( p_{dev}^{H} = \frac{p + 2 \delta (q_H - q_L)}{4}, p_{dev}^{L} < p_{min} \), so that the price couple \( (p_{dev}^{H}, p/2) \) cannot lead to any price-salient separating equilibrium. Instead, when \( p_{dev}^{H} = \frac{p q_H}{2 q_L} + \epsilon \), deviation profits are always lower than \( \Pi_H(p, p/2, 1) \). Consequently, firm \( H \) will never find it profitable to deviate to a price-salient equilibrium.
Applying REDE, firm $H$’s price is required to be a best reply to firm $L$’s price. If firm $H$ does not choose this constrained best reply, the separating strategy profile is destabilized. Since this refinement has no impact on firm $L$’s behaviour, we can focus only on firm $H$. Notice that the unique price $p$ surviving REDE is $\max\{p_{\min}, p_{H}^{qs}\}$. We finally get that the unconstrained best reply of firm $H$, $p_{H}^{qs}$, is below $p_{\min}$ if $\delta > \frac{2(q_{H} - q_{L})}{q_{H} + 2q_{L}}$.

Let us now turn to a price-salient candidate equilibrium and a possible deviation to quality salience. Firm $L$ would maximize $\frac{\delta q_{H}^{L}(p - p_{L}^{dev})}{q_{H} - q_{L}}$ under the constraint $p_{L}^{dev} > p_{H}^{\frac{q_{L}}{q_{H}}}$. The optimal price is $p_{L}^{dev} = \frac{q_{L}}{q_{H}} + \epsilon$ with $\epsilon > 0$ arbitrarily small and the maximal deviation profits amount to $\Pi_{L}^{dev}(p_{L}^{dev}, p, 0) = (\delta p_{L}^{2}q_{L})/q_{H}^{2}$. For firm $L$ not to deviate it must be that $\Pi_{L}(p/2, p, 0) > \Pi_{L}^{dev}(p_{L}^{dev}, p, 0)$, which always occurs. Therefore, firm $L$ will never deviate from a price-salient separating equilibrium. If firm $H$ deviates to quality salience, it maximizes

$$
\Pi_{H}^{dev} = p_{H}^{p} \left[1 - \frac{p_{H}^{p}/p - 2}{q_{H} - q_{L}}\right], \text{ under the constraint } p_{H}^{p} < \frac{p/2}{q_{H}/q_{L}}.
$$

The optimal deviation price is $p_{H}^{dev} = \frac{p_{H}}{2} q_{L} - \epsilon$ which is compatible with a separating equilibrium if $p > \frac{4q_{H}q_{L} + 4\delta^{2}}{q_{H}(4+\delta)}$. This implies that the set of prices $p$ leading to a price-salient equilibria restricts to $p \in [p_{\min}, p_{\max}']$ with $p_{\max}' = \max\left\{p_{\max}, \frac{4q_{H}q_{L} + 4\delta^{2}}{q_{H}(4+\delta)}\right\}$. We conclude that the unique price surviving REDE is $p_{H}^{qs} = p_{\min}$.

### A.4 Proof of Lemma 3

Let us consider the case of price salience, i.e., when $q_{H}/q_{L} < 2$. In a separating equilibrium, firm $H$ receives $p_{H} \left[1 - \frac{p_{H} - p_{L}}{\delta(q_{H} - q_{L})}\right] - A_{H}$ and firm $L$ obtains $p_{L} \left[\frac{p_{H} - p_{L}}{\delta(q_{H} - q_{L})}\right] - A_{L}$. Dissipative advertising does not directly affect firms’ revenues. Therefore, the only reason justifying a positive advertising expenditure is that of changing consumers’ beliefs. As a consequence, in a separating equilibrium, only firm $H$ would bear such a cost, as consumers would identify firm $L$ as the low type anyway. The best reply of the low-quality firm remains $p_{L}(p_{H}) = p_{H}/2$. Thus, let us focus on firm $H$’s strategy of setting a price $p$ together with an advertising level $A$. In a separating equilibrium, the low type receives profits (5).

Mimicking the behaviour of the high type would entail deviation profits which depend on the level of $p$. Two cases have to be considered. First, if $p > q_{L}$, the market is not fully covered in a pooling equilibrium with price $p$ because all agents with $\theta < \frac{q_{H} + q_{L} - 2p}{q_{H} - q_{L}}$ are not willing to buy either product. In this case, the deviation profits for the low type amount to:

$$
\Pi_{L}(p, p, 1/2) - A = \frac{p(q_{H} + q_{L} - 2p)}{2(q_{H} - q_{L})} - A. \quad (A3)
$$
Comparing (A3) with (5), the minimum amount of advertising that the high type has to provide in order to avoid mimicking is \( A_{min} = \max \left\{ \frac{2p\delta(q_H+q_L)-p^2(1+4\delta)}{4p(q_H-q_L)}, 0 \right\} \). Notice that if \( p = \hat{p}_H^*, A_{min} = 0 \). Therefore, in the region in which a separating equilibrium can be sustained with the sole use of price, advertising will never be used as it would require to decrease the price and bear the additional cost of advertising. However, the maximum amount of advertising that the high type is willing to provide is never higher than that required to avoid mimicking. Indeed, if the high type mimics the low type, the profits of the high type will be \( \frac{p}{p_0} \) the low type, the profits of the high type will be \( \frac{p}{p_0} \). Indeed, if the high type mimics the low type, the profits of the high type will be \( \frac{p}{p_0} \).

Comparing these profits with the separating ones (6), the high type is not willing to spend more than \( A_{max} = \frac{3p\delta(q_H-q_L)-2p^2}{4p(q_H-q_L)} \). Notice that \( A_{max} < A_{min} \) if \( \delta < \delta \). Hence, a separating equilibrium would never emerge when \( p > q_L \).

Second, if \( p < q_L \), the demand of each firm is equal to 1/2 in a pooling equilibrium. Therefore, the profits of the low type amount to \( p/2 - A \), which are lower than the profits in (5) if \( A > A_{min} = \max \left\{ \frac{2p\delta(q_H-q_L)-p^2}{4p(q_H-q_L)}, 0 \right\} \). The incentives of the high type are the same as in the case of \( p > q_L \). For this reason, advertising expenditure cannot exceed \( A_{max} \). Notice that \( A_{max} \) is higher than \( A_{min} \) only if \( p < \delta(q_H-q_L) \). Since advertising is just dissipative, it follows that \( \hat{A}_H = A_{min} \) with \( p \leq \delta(q_H-q_L) \).

### A.5 Proof of Proposition 2

As before, firm \( L \) will never deviate from a price-salient separating equilibrium. If firm \( H \) deviates to quality salience, it chooses \((A_{dev}^H, p_{dev}^H)\) to maximize:

\[
\Pi_{H}^{dev} - A_{H}^{dev} = \hat{p}_{H}^{dev} \left[ 1 - \frac{\delta(p_{H}^{dev} - p^{2}/2)}{q_H - q_L} \right] - A_{H}^{dev}, \text{ under the constraint } p_{H}^{dev} < \frac{pq_H}{2q_L}.
\]

The optimal deviation strategy \((A_{H}^{dev}, p_{H}^{dev})\) is \( \left( 0, \frac{pq_H}{2q_L} - \epsilon \right) \) which is compatible with a quality-salient separating equilibrium if \( p > \frac{4\mu q_L + 4q_L^2}{q_H(1+\delta)} \). Comparing this minimal price with the maximal price compatible with a separating equilibrium with advertising, i.e., \( \delta(q_h - q_L) \), we find that \( \frac{4\mu q_L + 4q^2_L}{q_H(1+\delta)} > \delta(q_h - q_L) \). Therefore, there is no possibility for the high type to deviate to quality salience, making consumers believe it is the high type to deviate.

Given the equilibrium strategy profile of the high type \((A_H, p_H) = (A_{min}, p)\), the equilibrium profits of firm \( H \) net of advertising expenditure are equal to \( \frac{p}{4} \left[ 2 - \frac{p}{\delta(q_H-q_L)} \right] \), which are maximized when \( p = \delta(q_H-q_L) \). Therefore, the only \( p \) that resists REDE is \( \hat{p}_{H}^{dev} = \delta(q_H-q_L) \) which implies \( \hat{A}_H = \delta(q_H-q_L) \) and \( \hat{p}_{L}^{adv} = \frac{\delta(q_H-q_L)}{2} \).
References


