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ABSTRACT

We present a model of market competition and product differentiation in which consumers' attention is drawn to the products' most salient attributes. Firms compete for consumer attention via their choices of quality and price. With salience, strategic positioning of each product affects how all other products are perceived. With this attention externality, depending on the cost of producing quality some markets exhibit "commoditized" price salient equilibria, while others exhibit "de-commoditized" quality salient equilibria. When the cost of producing quality changes, innovation can lead to a radical change in markets. In the context of financial innovation, the model generates the well documented phenomenon of "reaching for yield".

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1 Introduction

In many markets, consumers' attention to particular attributes of a product seems critical. In fashion goods, business class airline seats, and financial products, consumers focus on quality rather than price. Firms advertise quality, and rarely mention prices. In fast food, regular air travel, or standard home goods, consumers seem much more attentive to prices. In these markets, firms often advertise low prices to draw consumers' attention.

Scholars of strategy and marketing are keenly aware of these distinct modes of market competition, and tirelessly emphasize the importance of having differentiated attributes and drawing consumer attention to them (Levitt 1983, Rangan and Bowman 1992, Mauborgne and Kim 2005). Southwest wants to be known as "the low cost airline;" Singapore as the winner of prizes for luxury and comfort. Walmart touts its everyday low prices, Nordstrom's its service. Yet the salience of one attribute relative to others is not a natural feature of economic models of product differentiation, in which all attributes matter symmetrically. There is a bit of a gap between how economists and business strategists think about competition.

We seek to bridge this gap by introducing the idea of salience into a standard model of market competition in which firms choose qualities and prices. This idea, developed in our earlier work (BGS 2012a,2012b), holds that the attention of consumers or decision makers more generally is drawn to the most unusual, surprising, or salient attributes of the options they face, leading them to overweight these attributes in their decisions. We have shown in previous work that salience can naturally account for a range of puzzles in the theory of individual choice, from Allais paradoxes to preference reversals to decoy effects, but also helps think in a new way about market phenomena such as products being put on sale immediately after their introduction, or the demand for insurance with small deductibles. In many of these situations, the context of the decision influences consumer attention and choice, even when this context should be irrelevant to a rational consumer.

In this paper, we show that salience allows us to describe product differentiation and market competition in a way more congruent with business strategists' views, but also yielding new empirical predictions. We examine markets in which firms compete on both quality and price. When salience matters, part of product market competition is that for consumer attention via the choice of quality and price. Strategic positioning of one product affects how all other products are perceived, by influencing the salience of either quality or price of each product. A very high quality good draws attention not only to its own quality, but also to the fact that the competitor product has lower quality, reducing the competitor's relative valuation. A good with a very low price draws attention to the competitor's higher price, reducing the competitor's relative valuation. This attention externality is at the heart of our model.

Depending on the cost of producing quality, some markets exhibit price salient equilibria, in which consumers are attentive to prices rather than quality and become relatively less sensitive to quality differences than price differences. Firms compete on prices, and quality could be under-provided relative to the efficient level. Because consumers neglect quality, escaping such "commodity magnets" is difficult. We suggest that markets such as fast food or air travel are well described in this way.

In other markets, equilibria are quality salient in that consumers are attentive to quality and are to some extent insensitive to price differences. Firms compete on quality, which can be over-supplied relative to the efficient level. In these markets, it is again difficult to escape the high quality equilibrium, because consumers neglect price cuts. We think of financial services or fashion as well described by such equilibria.

We show that although equilibria in this model are fairly stable, there is a possibility of radical change in markets when the cost of producing quality changes dramatically. This can take the form of de-commoditization, whereby a firm acquires access to a technology of producing quality at a much lower cost than its competitor, and is able to change the market from a price-salient to a quality-salient equilibrium. In such markets, prices can rise dramatically, but quality as perceived by consumers rises more. We think of the introduction of Starbucks coffee into a market of tasteless drip, or the introduction of fashion men's briefs by Calvin Klein in the early 1980's as examples of this phenomenon. Market transformation can also take the form of commoditization, and reductions in quality, as happened in airlines after deregulation. Companies such as Southwest and Ryan Air were able to change the equilibrium in that market from quality salient to price salient because they enjoyed an enormous advantage relative to the incumbents with high legacy costs. Our model enables us to analyze these situations.

We also consider in detail the case of financial innovation, as exemplified by the creation of new products with higher expected return and risk. We show that such innovation is particularly attractive in low interest rate environments, and when the innovation allows to create higher returns at a moderately higher risk. Indeed, higher returns are salient to investors when alternative yields are extremely low and the (small) extra risk of the new product is underweighted. The model generates the well documented phenomenon of "reaching for yield" in an intuitive psychological way, based on the properties of salience.

Our paper is related to recent work on "behavioral industrial organization" (Ellison 2006, Spiegler 2011). One strand of this research studies settings in which consumers restrict their attention to a subset of available options, the consideration set, which can be manipulated by firms by expending a marketing cost (Spiegler and Eliaz 2011a,b and Hefti 2012) or by setting a salient low price on some products (Ellison and Ellison 2009). Our paper provides a formal model of salience, in which firms draw consumers' attention to different product attributes by suitably differentiating their products. Our model thus features an attention externality within a *given* consideration set and provides insight into quality provision even in standard competitive environments.

Another strand of the literature considers the working of market competition in settings in which some product attributes are "shrouded", namely sufficiently obscured that consumers find it difficult to compare them across products (Gabaix and Laibson 2006, Ellison and Ellison 2009, Spiegler and Piccione 2012). This literature takes as given the attributes that consumers pay attention to. In our analysis, consumers may pay differential attention to quality or price, but the neglect of one attribute or the other is endogenously determined by product design and market competition.

Azar (2008), Cunningham (2012), and Dahremöller and Fels (2012) explore models in which the relative weight that consumers put on different attributes depends on the choice context, and can thus be manipulated by firms. These papers model consumer attention by using approaches different from salience (technically, they do not combine the diminishing sensitivity and ordering properties) and explore a different set of issues, such as properties of markups or the monopolist problem. Finally, our analysis builds on recent work studying how different forms of inattention affect consumer demand. As in our salience approach, Koszegi and Szeidl (2013) propose that consumer attention to different product features is determined ex-post, depending on which product attribute stands out. Other approaches – such as Gabaix (2012), Mateijka and McKay (2012), and Persson (2012) – are grounded in the rational inattention framework, in which attention to different product features is efficiently allocated ex-ante.[1]

The paper is organized as follows. In section 2, we describe our basic model of competition and show how salience would influence product valuations by consumers. In section 3, we take qualities as fixed and examine the basic analytics of price competition and of price and quality salient equilibria. Section 4 focuses on the full model of quality competition, and derives our main results for markets for products where attribute salience matters. In section 5, we apply the model to discuss innovation. Section 6 concludes.

2 The Model

There are two firms, 1 and 2. Firm $k = 1, 2$ produces a good having quality q_k under a firm-specific cost function $c_k(q_k)$. From the viewpoint of consumers, the good of firm k is identified by its quality q_k and price p_k. Qualities and prices are competitively set by firms. Following Shaked and Sutton (1982), we assume that firms play a two stage game. In the first stage, each firm k makes a costless commitment to produce quality $q_k \in [0, +\infty)$. In the second stage, firms set optimal prices given the quality-cost attributes they committed to (q_k, c_k), for $k = 1, 2$, where $c_k \equiv c_k(q_k)$. In light of these quality and price offerings, consumers choose which product to buy. In what follows, we consider only pure strategy Nash equilibria of this game.

There is a measure one of identical consumers, each of whom chooses one unit of one good from the choice set $C \equiv \{(q_2, -p_2), (q_1, -p_1)\}$.[2] Absent salience distortions, each consumer

[1] For explorations of the role of inattention in financial markets, see Barber and Odean (2008), DellaVigna and Pollet (2009), and Bordalo, Gennaioli and Shleifer (2013).

[2] For simplicity, we assume the consumer does not consider the possibility of not buying either good (e.g., the outside option of not buying is not considered because it has a large negative utility relative to the two goods). We show in Appendix C that our results are robust to the inclusion of an outside option when the costs of quality are not so high that they preclude the existence of a market.

values good $k = 1, 2$ at:

$$u(q_k, -p_k) = q_k - p_k. \tag{1}$$

Both qualities and prices are measured in utils and assumed to be known to the consumer. A salient thinker departs from (1) by inflating the weight attached to the attribute that he perceives to be more salient in the choice set $C \equiv \{(q_2, -p_2), (q_1, -p_1)\}$.[3]

Following BGS (2012b), we assume that there is a salience function $\sigma(x, y)$ that satisfies two properties: ordering and homogeneity of degree zero. According to ordering, if an interval $[x, y]$ is contained in a larger interval $[x', y']$, then $\sigma(x, y) < \sigma(x', y')$. According to homogeneity of degree zero, $\sigma(\alpha x, \alpha y) = \sigma(x, y)$ for any $\alpha > 0$, with $\sigma(0, 0) = 0$. In the choice set C, the salience of price for good k is equal to $\sigma(p_k, \overline{p})$ while the salience of quality for good k is equal to $\sigma(q_k, \overline{q})$, where $\overline{p} = (p_1 + p_2)/2$ and $\overline{q} = (q_1 + q_2)/2$ are the average price and quality in the market. Good k's quality is more salient than its price – or, for short, quality is salient – if and only if $\sigma(q_k, \overline{q}) > \sigma(p_k, \overline{p})$. Ordering and homogeneity of degree zero imply that the salience of a good's quality is an increasing function of the percentage difference between the good's quality and the average quality in the choice set, and similarly for price. In particular, consumers have diminishing sensitivity to attribute differences: increasing the prices of both goods by a uniform amount ϵ makes prices less salient, $\sigma(p_k + \epsilon, \overline{p} + \epsilon) < \sigma(p_k, \overline{p})$ for $k = 1, 2$.[4]

Given a salience ranking, the salient thinker's perceived utility from good $(q_k, -p_k)$ is given by:

$$u^{ST}(q_k, -p_k) = \begin{cases} q_k - \delta p_k & \text{if} \quad \text{quality is salient} \\ \delta q_k - p_k & \text{if} \quad \text{price is salient} \\ q_k - p_k & \text{if} \quad \text{equal salience} \end{cases}, \tag{2}$$

where $\delta \in [0, 1]$ captures the extent to which valuation is distorted by salience.[5] When

[3] We are thus assuming that firms do not strategically manipulate the set of goods considered by consumers, for example by offering decoys (see BGS 2012b). This distinguishes our approach from Spiegler and Eliaz (2011a,b), who study the incentive for firms to alter consideration sets.

[4] Interpreting salience as a perceptual difference between attribute levels, this property is consistent with Weber's law of sensorial perception. See BGS (2012b) for more details on the properties of the salience function and their psychological foundations.

[5] Relative to BGS 2012b, we omit for simplicity the normalisation factor $\frac{2}{1+\delta}$.

$\delta = 1$ valuation is rational, as it coincides with (1). When $\delta < 1$, the consumer overweights the salient attribute. The competitive equilibrium then depends on δ, allowing us to study how salience affects market competition.

The assumptions of consumer homogeneity and rank-based salience weighting allow us to characterize the basic implications of our framework. In Appendix B we show that our main results also hold in a more continuous specification in which the salience of different attributes, and therefore of preferences over the two goods, has a stochastic component and varies in the population of otherwise identical consumers.

We solve this model in two steps. In Section 3, we take each firm's quality and cost (q_k, c_k) as given and study price competition among firms. This price setting stage is of independent interest from endogenous quality choice because in the short run firms often take quality as given, and react to cost shocks only by adjusting their prices.[6] Section 4 investigates how firms choose quality in the first stage so as to influence price competition in the second stage.

3 Price Competition

We begin with an analysis of price competition between firms 1 and 2, assuming that qualities q_1, q_2 and costs c_1, c_2 are fixed, and only prices are set by firms. We assume that firm 1 has a weakly higher quality and cost than firm 2, namely $q_1 \geq q_2$ and $c_1 \geq c_2$ (in Sections 3 and 4 the ranking of quality and costs is determined endogenously). Before characterizing the outcome under salience, consider the rational benchmark that obtains when $\delta = 1$.

Lemma 1 *When $\delta = 1$, the equilibrium under price competition is as follows:*
i) If $q_1 - c_1 > q_2 - c_2$, the consumer buys the high quality good 1. Prices are $p_1 = c_2 + (q_1 - q_2)$ and $p_2 = c_2$. The profit of firm 1 is equal to $\pi_1 = (q_1 - q_2) - (c_1 - c_2)$.
ii) If $q_1 - c_1 < q_2 - c_2$, the consumer buys the low quality good 2. Prices are $p_1 = c_1$ and $p_2 = c_1 - (q_1 - q_2)$. The profit of firm 2 is equal to $\pi_2 = (c_1 - c_2) - (q_1 - q_2)$.
iii) If $q_1 - c_1 = q_2 - c_2$, the consumer is indifferent between the high and the low quality good. Prices are $p_1 = c_1$ and $p_2 = c_2$. Firms make zero profits.

[6] In some settings firms may be unable to adjust quality, due to regulatory or technological constraints.

The firm creating greater surplus $q_k - c_k$ captures the entire market and makes a profit equal to the differential surplus created.[7] When, as in case *iii*), the two goods yield the same surplus, firms share the market and make zero profits, as in standard Bertrand competition. The benchmark of fully homogeneous goods and zero profits corresponds to the special case $q_1 = q_2 = q$, and $c_1 = c_2 = c$.

To see how salience affects price competition, suppose that the firm producing the low quality product 2 sets price $p_2 \leq p_1$. The next section shows that this always holds in equilibrium. Homogeneity of degree zero of the salience function then implies that the same attribute – either quality or price – is salient for both goods. Moreover, quality is salient (that is, quality is more salient than price for both goods) provided:

$$\frac{q_1}{q_2} > \frac{p_1}{p_2}. \tag{3}$$

Price is salient if and only if the reverse holds. Inequality (3) says that quality is salient if and only if the proportional difference between qualities is higher than that between prices. Equivalently, quality is salient when the high quality good has a better quality to price ratio than the low quality good, namely $q_1/p_1 > q_2/p_2$. Price is salient when the low quality good has a better quality to price ratio than the high quality good, namely $q_1/p_1 < q_2/p_2$. Because by Equation (2) the good that fares better along the salient attribute is overvalued relative to the other good, salience tilts preferences in favor of the good that has the highest ratio of quality to price (BGS 2012b).

According to Equation (2), the valuation of a good depends not just on the good's characteristics but also on the entire competitive context. If qualities vary more than prices across all choice options, the consumer pays more attention to (overweights) quality differences when making his choice. If prices vary more than qualities, the reverse is true. This implies that, by changing its price, a firm exerts an "attention externality" on the competing good. To see this, recall that $q_1 > q_2$ and $p_1 > p_2$, and suppose the high quality firm reduces its price p_1. This change does not simply improve the consumer's valuation of good

[7] In principle, the price competition game has multiple equilibria, corresponding to different price levels the losing firm may set leading to zero demand for its good. We refine the set of equilibria by assuming that the firm that loses the market sets price equal to production cost (as setting price below cost might entail negative profits). See Appendix A, footnote 17 for details.

1: by making prices less salient, it also draws the consumer's attention to the low quality of good 2. Suppose, alternatively, that the low quality firm reduces its price p_2. This does not only improve the consumer's valuation of good 2: by making prices more salient, it also draws his attention to the high price of good 1. In other words, by cutting its price a firm draws the consumer's attention to the attribute along which it fares better. As this attention externality makes price cuts more effective in attracting consumers, it seems that it should strengthen competitive forces. As we will see, however, this is not always the case.

3.1 Salience and Competitive Pricing

When a firm sells to salient thinkers, it sets its price to render salient the advantage of its product relative to its competitor. To explore how salience affects competitive pricing, we examine price setting in two opposite situations, one in which quality is salient and firm 1 wins the market, another in which price is salient and firm 2 wins the market.

Consider first the optimal price set by the high quality firm 1 in order to win a quality-salient market. Suppose that firm 2 has set a price p_2 for q_2. The maximal price p_1 at which firm 1 lures the consumer into buying its product while keeping quality salient solves:

$$\begin{aligned} &\max_{p_1 \geq p_2} \quad p_1 - c_1 \\ &s.t. \quad q_1 - \delta p_1 \geq q_2 - \delta p_2, \qquad (4) \\ &\qquad\quad q_1/p_1 \geq q_2/p_2. \qquad (5) \end{aligned}$$

Constraint (4) ensures that the consumer prefers good 1 when quality is salient, while constraint (5) ensures that quality is indeed salient. There are two departures from the rational case. On the one hand, firm 1 now has an additional reason to cut its price: by setting p_1 low enough, it makes quality salient in (5), inducing the consumer to buy its high quality product. On the other hand, when quality is salient the high quality good is over-valued, which may allow firm 1 to hike its price p_1 above the rational equilibrium level. This effect of salience is captured by Equation (4).

Consider next the optimal price set by the low cost firm 2 to win a price salient market. The maximal price p_2 at which firm 2 lures the consumer into buying its product while keeping prices salient solves:

$$\max_{p_2 \leq p_1} \quad p_2 - c_2$$
$$s.t. \quad \delta q_2 - p_2 \geq \delta q_1 - p_1, \tag{6}$$
$$q_2/p_2 \geq q_1/p_1. \tag{7}$$

Once again, price setting is constrained by consumer participation and salience. One the one hand, salience provides firm 2 with an additional incentive to cut its price. By lowering p_2, firm 2 does not just make its product more attractive, it also makes its lower price salient, inducing the consumer to buy the cheap good. This effect is captured by (7). On the other hand, by causing an over-valuation of the cheap good, salience can allow firm 2 to charge a higher price than in the rational case. This effect is captured by (6).

This preliminary analysis suggests that, depending on the balance between the salience and participation constraints, salient thinking may boost or dampen prices relative to a rational world. To see which force dominates, we now characterise equilibrium prices under salience. To do so, we make the simplifying parametric restriction:

A.1: $\quad \delta(c_1 - c_2) < q_1 - q_2 < \frac{1}{\delta}(c_1 - c_2)$.

Assumption A.1 ensures that salience fully determines the preference of consumers among goods when goods' prices equal their production costs. If quality is salient, consumers prefer the high quality good 1; if price is salient they prefer the cheap good 2. As evident from A.1, this is akin to assuming that the two firms produce sufficiently similar surpluses $q_k - c_k$ that changes in salience change the consumer's preference ranking. Under A.1, we can characterise which firm wins the market. Appendix A contains all the proofs.

Proposition 1 *Under A.1, pure strategy subgame perfect equilibria under price competition satisfy:*
i) if $\frac{q_1}{c_1} > \frac{q_2}{c_2}$, quality is salient, the consumer buys the high quality good, and prices are

$$p_1 = \min\{q_1 \cdot \frac{c_2}{q_2}, c_2 + \frac{1}{\delta}(q_1 - q_2)\} \quad \textit{and} \quad p_2 = c_2.$$

ii) if $\frac{q_1}{c_1} < \frac{q_2}{c_2}$*, price is salient, the consumer buys the low quality good, and prices are*

$$p_1 = c_1 \text{ and } p_2 = \min\{q_2 \cdot \frac{c_1}{q_1}, c_1 - \delta(q_1 - q_2)\}.$$

iii) if $\frac{q_1}{c_1} = \frac{q_2}{c_2}$*, quality and price are equally salient, the consumer buys the good delivering the highest (rational) surplus* $q_k - c_k$*, and prices are*

$$p_1 = c_1 \text{ and } p_2 = c_2.$$

Under salience, the market outcome critically depends on the quality to cost ratios q_k/c_k of different products. A firm with a higher ratio q_k/c_k monopolizes the market and makes positive profits. When the two firms have identical quality to cost ratios, they earn zero profits in the competitive outcome.

Proposition 1 holds because the firm having the highest quality to cost ratio can always engineer a price cut turning salience in its favor. When $q_1/c_1 > q_2/c_2$, the high quality firm can set a sufficiently low price that quality becomes salient, monopolizing the market. The low quality firm is unable to reverse this outcome: in fact, doing so would require it to cut price below cost. When instead $q_1/c_1 < q_2/c_2$, the low quality firm can set price sufficiently low so that price is salient, and it monopolizes the market. The high quality firm is unable to reverse this outcome: once again, doing so would require it to cut price below cost. Finally, consider the case in which $q_1/c_1 = q_2/c_2$. In this case, salience changes as soon as a firm tries to set its price above cost. In particular, a firm that hikes prices is immediately perceived as having a lower quality to price ratio than its competitor. As a consequence, the firm's disadvantage becomes salient and the price hike becomes self defeating. The only equilibrium outcome is zero profits for both firms.

The central role of the quality to cost ratio is economically appealing because it pins down salience distortions in terms of average costs of quality c_k/q_k. As we show when we endogenize quality, this feature allows our model to make tight predictions about how changes in cost structure affect salience and market outcomes. Before turning to that analysis, it is useful to look more closely at some implications of Proposition 1.

3.2 Price salient vs. Quality salient equilibria

Depending on the quality and cost parameters, salience leads to two types of equilibria: price salient and quality salient. In quality salient equilibria (case *i* of Proposition 1), consumers' attention is drawn to quality and they pay less attention to prices. This resembles de-commoditized markets described in the marketing literature, such as fashion or financial services. In contrast, in price salient equilibria (case *ii*), consumers' attention is drawn to prices and they neglect quality differences among goods. This resembles the canonical description of commoditised markets, where consumers buy the cheapest goods.

According to Proposition 1, in both types of equilibria the profits of the winning firm can be either lower or higher than in the rational benchmark. To see this, note that - due to the salience constraint - the equilibrium profits of the winning firm k (the one with lowest average cost) must satisfy:

$$\pi_k^S \leq q_k \cdot \frac{c_{-k}}{q_{-k}} - c_k = q_k \left[\frac{c_{-k}}{q_{-k}} - \frac{c_k}{q_k} \right], \tag{8}$$

where equality holds when the salience constraint binds. Equation (8) shows that equilibrium profits increase in the difference between the firms' average cost of quality. Consider the following special cases:

- The two goods yield different surpluses $q_1 - c_1 \neq q_2 - c_2$ but exhibit identical (similar) average costs of quality. Under rationality, the high surplus firm would make positive profits. Under salient thinking, in contrast, industry profits are zero (negligible). Intuitively, when average costs of quality are identical (similar), a firm can always undercut its competitor and render its advantage salient. Price cuts are thus very effective and profits are lower than under rationality.

- The two goods yield the same surplus $q_1 - c_1 = q_2 - c_2$, but differ in their average costs of quality. Here, profits are zero under rationality, but positive under salient thinking. The reason is that the firm with the lower average cost of quality can set a price above cost and still be perceived as offering a better deal than its competitor. Price cuts by the losing firm are ineffective, and salience dampens competitive forces.

Salience can create abnormal profits in both quality and price salient equilibria. In quality salient equilibria, consumers overvalue the high quality good. The high quality firm is then able to hike prices and earn high profits. Financial services and fashion may be examples of this type of competition. In price salient equilibria, consumers are attentive to prices and under-appreciate quality differences among products. This grants an extra advantage to the cheap (and low quality) firm, allowing it to raise the price above cost.[8] Fast-food industry and low-cost airlines may be examples of this type of competition.

4 Optimal Quality Choice

We now examine endogenous quality choice in the two-stage game introduced in Section 1. In the first stage, each firm $k = 1, 2$ makes a costless commitment to produce quality $q_k \in [0, +\infty)$. In the second stage, firms compete in prices given the quality-cost attributes each firm committed to $(q_k, c_k(q_k))$, for $k = 1, 2$. We denote by $c_k(q)$ the increasing and convex cost of firm k in producing the quality q it committed to, where $k = 1, 2$.[9] Cost functions are common knowledge.

We assume that firm 1 is the low cost firm, in the sense that it has weakly lower total and marginal costs of quality than firm 2. Formally, $c_1(q) \leq c_2(q)$ and $c_1'(q) \leq c_2'(q)$ for all qualities q. We think of this cost function as consisting of a fixed and a variable component. Formally, $c_k(q) = F_k + v_k(q)$, where $v_k(q)$ is an increasing and convex function satisfying $v_k(0) = 0$. To obtain intuitive closed form solutions, we sometimes use the quadratic form:

$$c_k(q) = F_k + \frac{c_k}{2} \cdot q^2, \text{ for } k = 1, 2, \text{ where } c_1 \leq c_2 \text{ and } F_1 \leq F_2. \tag{9}$$

The critical question is whether the low cost of quality firm 1 will choose to produce higher or lower quality than the high cost of quality firm 2, and what this implies for the equilibrium market outcome.

[8] This result extends to *industry* profits as a whole, namely the sum of the profits of both firms.

[9] This implies, plausibly, that a firm's marginal cost of quality increases with the quality it produces. Results would change under the alternative assumption that the marginal cost of producing the good does not depend on q but firms must incur a variable cost $H(q)$ at $t = 0$ to produce quality q at $t = 1$. Abstracting from the issue of firm entry or exit (thus taking as given the presence of the two firms in the market), in that case quality will always be salient at $t = 1$ and only quality-salient equilibria would exist.

To fix ideas, consider the rational benchmark. In stage 2, the market is monopolized by firm k producing the highest surplus $q_k - c_k(q_k)$. Anticipating this, at $t = 1$ the two firms set their qualities as follows.

Lemma 2 *Under rationality, it is (weakly) optimal for firm $k = 1, 2$ to set q_k^* such that:*

$$c_k'(q_k^*) = 1. \tag{10}$$

a) If firms have the same marginal cost of quality $v_1'(q) = v_2'(q) = v'(q)$, they set identical quality levels $q_1^* = q_2^* = q^*$. Firm 1 sets price $p_1^* = c_2(q^*)$ and monopolizes the market (making positive profits) if and only if $F_1 < F_2$. If $F_1 = F_2$, equilibrium profits are zero.
b) If firm 1 has a lower marginal cost of quality than 2, namely $v_1'(q) < v_2'(q)$, then it commits to higher quality $q_1^* > q_2^*$ and monopolizes the market (making positive profits) by setting $p_1^* = c_2(q_2^*) + (q_1^* - q_2^*)$.

By choosing the surplus-maximizing quality in (10), each firm maximizes its chance to win the market.[10] If firms have identical costs $c_1(q) = c_2(q)$, they produce homogeneous goods, split the market, and make no profits. If instead firm 1 has strictly lower costs than firm 2, it captures the entire market and makes positive profits. Firm 1 then provides higher quality if and only its marginal cost of quality is lower than that of firm 2.

Under the quadratic cost function of Equation (9), firm k sets its quality at the level:

$$q_k^* = \frac{1}{c_k},$$

which intuitively increases as the marginal cost falls (as c_k becomes smaller), but is independent of F. In the rational model, a drop in the marginal cost of quality for all firms increases equilibrium quality, while a drop in the fixed cost of quality F leaves quality unaffected.

[10]If firm 1 has strictly lower costs than firm 2, then in equilibrium firm 2 loses the market. Firm 2 is then indifferent to deviating to a different quality than the one entailed by (10). In principle, there may be multiple equilibria, each corresponding to a different quality level chosen by firm 2. We refine the set of Nash equilibria by assuming that firm 2 chooses the surplus maximizing quality, which is a weakly dominant strategy.

4.1 Salience and Quality Choice

Consider now how salience affects quality choice. To develop an intuition for the main results, suppose that the two firms have identical costs of quality $c_1(q) = c_2(q) = c(q)$. Suppose that firms are at the "rational" quality level q^*, which is pinned down by the optimality condition $c'(q^*) = 1$. If consumers are salient thinkers, would firm 1 have an incentive to change its quality?

Consider the incentive of firm 1 to choose a lower quality, cheaper, product. The new product has quality $q' = q^* - \Delta q$ and cost $c(q') = c(q^*) - \Delta c$. Whether this new product is successful or not against q^* critically relies on salience. If the lower quality q' is salient, the new product fails. If instead the lower price is salient, the new product may be successful. By Proposition 1, price is salient if and only if the quality to cost ratio of q' is higher than that of product q^*:

$$\frac{q^* - \Delta q}{c(q^*) - \Delta c} > \frac{q^*}{c(q^*)} \Leftrightarrow \frac{\Delta c}{\Delta q} > \frac{c(q^*)}{q^*}. \tag{11}$$

A cost cutting deviation works if the marginal cost of quality $\Delta c/\Delta q$ is higher than the average cost $c(q^*)/q^*$ at the rational equilibrium. This is intuitive: when the marginal cost is high, a small quality reduction greatly reduces the cost of firm 1. This allows firm 1 to set a salient low price, and to win the market.

The attention externality plays a key role here. As prices become salient, consumers pay less attention to quality, which reduces consumer valuation of the quality q' offered by the deviating firm. This effect may undermine the profitability of the new product. However, because price becomes salient for *both* firms, the valuation by consumers of the competing product q^* drops even more! Thus, it is precisely the attention externality that allows the quality cut to be profitable for firm 1 by causing a large *relative* undervaluation of its competitor's product.

Consider the alternative move whereby firm 1 deviates to a higher quality product $q' = q^* + \Delta q$, which entails a higher cost $c(q') = c(q^*) + \Delta c$. If the higher price of q' is salient, the deviation fails. If instead its higher quality is salient, the new product may be successful.

This scenario occurs provided:

$$\frac{q^* + \Delta q}{c(q^*) + \Delta c} > \frac{q^*}{c(q^*)} \;\Leftrightarrow\; \frac{\Delta c}{\Delta q} < \frac{c(q^*)}{q^*}. \tag{12}$$

A quality improving deviation can work provided the marginal cost of quality is below the average cost at the rational equilibrium. Intuitively, if the marginal cost is low, a large quality improvement entails only a small price hike, making quality salient. Once again, the attention externality is at work. The salience of quality boosts consumer valuation of the new product, but it also draws the consumer's attention to the low quality q^* of the competing product. These effects cause a relative over-valuation of the high quality product q', allowing the deviating firm to make profits.

This discussion delivers two messages. First, salience creates incentives to deviate away from the rational equilibrium. Second, the deviation can be toward higher or lower quality depending on the relationship between marginal and average costs of quality. In equilibrium, quality is generally provided at inefficient levels. Firms engaged in competition for attention find it beneficial to exploit the ordering property of salience by deviating from the efficient quality level.

To further explore these forces, let us consider the general case in which firms have different cost of quality functions, $c_k(q) \neq c_j(q)$. Suppose that firm j has set the quality level q_j. The best response of firm k is then as follows.

Lemma 3 *The best response q_k^{br} of firm k to its opponent's quality q_j satisfies:*
i) weakly higher quality $q_k^{br} \geq q_j$ provided $c_k'(q_j) < c_j(q_j)/q_j$,
ii) weakly lower quality $q_k^{br} \leq q_j$ provided $c_k'(q_j) > c_j(q_j)/q_j$.
Both inequalities above are strict provided $c_j(q_j)/q_j \in (\delta, 1/\delta)$.

According to the salience constraint in (5) and (7), the maximum price per unit of quality at which firm k renders its advantage salient is equal to the average cost of quality of its competitor j. As a consequence, firm k optimally raises quality when the marginal cost $c_k'(q_j)$ of producing this extra quality is below the benefit $c_j(q_j)/q_j$ of doing so, while it optimally lowers quality when the reverse is true.

This mechanism has interesting implications. When the average cost of quality is high, the consumer is willing to pay a high price and still perceive quality as salient. Firm k then has a strong incentive to boost quality, because the associated increase in price is relatively neglected. In particular, when $c_j(q_j)/q_j > 1$, consumers overpay for quality and firm k has an incentive to over-provide it (relative to the rational benchmark $c'_k(q^*_k) = 1$). In contrast, when the average cost of quality is low, even a slight price increase is very salient. In this case, firm k has a strong incentive to cut quality and price. In particular, when $c_j(q_j)/q_j < 1$ firm k under-provides quality relative to the rational benchmark.

To describe the market equilibrium, we focus on the symmetric case in which the two firms have the same cost function $c_1(q) = c_2(q) = c(q)$. This case captures the long run outcome arising when all firms, through imitation or entry, end up adopting the best available technology.

Proposition 2 *When $\delta < 1$ and firms have identical cost functions, the unique pure strategy equilibrium is symmetric. Denote by $\overline{q}$ and $\underline{q}$ the quality levels such that $c'(\overline{q}) = 1/\delta$ and $c'(\underline{q}) = \delta$, and by $\widehat{q}(F)$ the quality level minimizing average cost, namely $\widehat{q}(F) \equiv$* $\arg\min c(q)/q$. *Then, in equilibrium price and quality are equally salient, firms make no profits, and quality provision is given by:*

$$q_2^S = q_1^S = q^S \equiv \begin{cases} \overline{q} & if \quad F > \overline{F} \equiv \overline{q}/\delta - v(\overline{q}) \\ \widehat{q}(F) & if \quad F \in \left[\underline{F}, \overline{F}\right] \\ \underline{q} & if \quad F < \underline{F} \equiv \underline{q}\delta - v(\underline{q}) \end{cases} . \tag{13}$$

This equilibrium exhibits three main features. First, because costs are identical, firms produce the same quality and face the same production costs. Price and quality are equally salient in equilibrium: consumers correctly value the products that are offered (as in the case where $\delta = 1$), and firms make zero profits.

Second, although *in equilibrium* consumers correctly value the goods produced, there is inefficient provision of quality (and therefore lower consumer surplus) relative to the rational case. The reason is that salience makes the firms unwilling to deviate towards the socially efficient quality q^*. When quality is over-provided ($q^S > q^*$), reducing quality and price backfires because consumers' attention is drawn to the quality reduction, rather than to the price cut. This sustains an equilibrium with high quality and high prices. Similarly, when quality is under-provided ($q^S < q^*$), increases in quality and price backfire because consumers focus on the price rather than the quality hike. This sustains an equilibrium with low quality and low prices. Although in equilibrium both attributes are equally salient, we refer to the equilibrium with quality over-provision as quality-salient and to the equilibrium with under-provision as price-salient. This terminology underscores which salience ranking constrains firms from deviating towards the efficient quality level.

The third key feature of the equilibrium is that - unlike in the rational case - quality provision increases in the fixed cost of quality F.[11] Intuitively, F affects average costs and thus, by Lemma 3, the firms' best responses. When F is high, costs and thus prices are high. By the diminishing sensitivity property, the salience of prices is low. The firm has an incentive to boost quality because any extra cost can be "hidden" behind the already high price. As a consequence, the extra price is not salient and quality is over-provided. When in contrast F is low, costs and thus prices are low. By diminishing sensitivity, prices are now very salient. In this case, any price cut is immediately noticed, encouraging firms to cut costs to an extent that quality is under-provided.

To see these effects clearly, consider the case of the quadratic cost function.

Corollary 1 *When $\delta < 1$ and firms have identical quadratic costs $c(q) = F + c \cdot q^2/2$, quality provision in the symmetric equilibrium is given by:*

$$q_2^S = q_1^S = q^S \equiv \begin{cases} \frac{1}{\delta c} & if \quad F \cdot c > \frac{1}{2\delta^2} \\ \sqrt{\frac{2F}{c}} & if \quad \frac{1}{2\delta^2} \leq F \cdot c \leq \frac{\delta^2}{2} \\ \frac{\delta}{c} & if \quad F \cdot c < \frac{\delta^2}{2} \end{cases} . \tag{14}$$

Figure 1 below plots q^S as a function of the unit cost F, and compares it to the surplus maximizing quality, given by $q^* = 1/c$. As evident from the figure, salience causes quality to be over-provided when the fixed cost F is sufficiently high and under-provided otherwise. Recall that for $\delta = 1$, we have $q^* = 1/c$ and quality provision does not depend on the fixed

[11]The reason is that $\widehat{q}(F)$ satisfies $v'(\widehat{q}) \cdot \widehat{q} - v(\widehat{q}) = F$ and the left hand side is increasing in quality because v is convex.

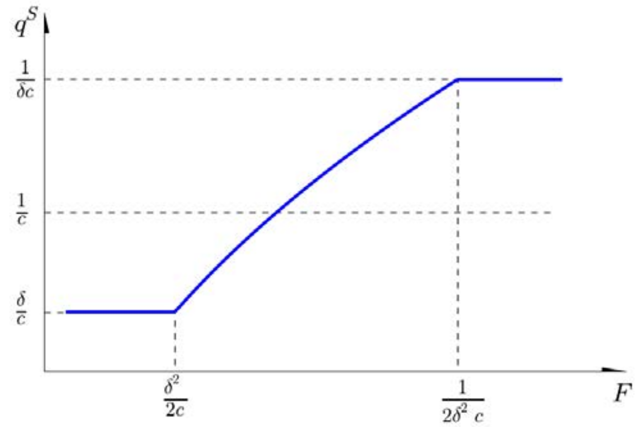

Figure 1: Quality provision in the symmetric equilibrium (quadratic cost).

cost F.

This analysis may help explain why sellers of expensive goods such as fancy hotel rooms or business class airplane seats compete mostly on the quality dimension, often providing customers with visible quality add-ons such as champagne, airport lounges, or treats. These visible quality add-ons help make overall product quality salient, and the profit margin associated with them can be hidden behind the high cost of the baseline good. In contrast, sellers of cheap goods such as low quality clothes or fast food compete on the price dimension, and cut product quality if that allows them to offer substantially lower prices. These cuts are proportionally larger in the price dimension, draw consumers' attention to prices, and thus enable firms that supply these cheap goods to make abnormal profits. In both cases, equilibrium profits disappear as competing firms adopt the same add-on or quality cutting strategies, despite the fact that they are providing inefficient levels of quality.[12]

Similar intuitions may help shed light on the technological and competitive forces leading product attributes to be "shrouded" (e.g. Gabaix and Laibson 2006) or to the introduction

[12] The intuition that diminishing sensitivity (to prices) favors the provision of quality add-ons is present also in Prospect Theory (Tversky and Kahneman, 1981). However, the central ingredient of our approach – which is absent in other models of choice – is the attention externality, namely the fact that changing attributes of one product alter the valuation of the competing product. This ingredient is important to pin down equilibrium quantities and to generate strong reactions to price or quality changes. The benefit for a firm of increasing quality (and price) is particularly large when it induces the consumer to focus more on the full quality provided. Our model thus features a complementarity between the add-on quality and the baseline quality.

of "irrelevant" attributes (e.g. Carpenter, Glazer and Nakamoto, 1994). For instance, in a world where all hotels charge high prices for phone usage, it may be difficult for one hotel to cut phone charges and make that advantage salient to consumers (as opposed to other more important dimensions of hotel quality). On the other hand, being the unique hotel that introduces a charge for pillows is a competitive disadvantage that is likely to draw consumers' attention. Such trade-offs can be analysed in a setting with horizontal differentiation. We leave this important topic to future work.

So far we considered only the symmetric equilibrium in which the two firms share the same cost functions. The next section considers the effects of changes to cost structures, and in particular the case where firms have asymmetric costs.

4.2 Innovation as a Cost Shock

We now use our model to explore the implications of salience for product innovation. Suppose a market is in the long run symmetric equilibrium of Proposition 2. We view innovation as a change in product characteristics and market equilibrium triggered by a cost shock. We distinguish industry-wide cost shocks, such as those caused by deregulation or changes input prices, and firm-specific shocks such as those stemming from the development of a new technology by an individual firm. This taxonomy allows us to separately consider the two key forces driving salience: diminishing sensitivity and ordering. Industry-wide shocks in fact work mainly through diminishing sensitivity because they alter the average value of different attributes in the market. Firm-specific shocks instead work mostly through ordering: they allow one firm's product to stand out against those of its competitors. The analysis of firm specific shocks allows us to describe the equilibrium in our model when firms have different cost functions.

Real world innovation episodes often combine firm-specific and industry-wide factors. Initially only some firms discover new technologies or change their strategies in response to common shocks, so that the initial phase is effectively firm-specific. Subsequently, the new technologies or strategies spread to other firms, becoming industry-wide phenomena. One could view our analysis as providing snapshots of short and long-run market adjustments to shocks. We leave the modelling of industry dynamics under salience to future research.

In what follows, we restrict our attention to the case of quadratic costs, in which $c_k(q_k) = F_k + \frac{c_k}{2} \cdot q_k^2$, for $k = 1, 2$. We begin our analysis by considering industry-wide shocks to an industry in symmetric equilibrium.

Proposition 3 *Suppose that the market is in the equilibrium described by Equation (14). We then have:*

i) A marginal increase (decrease) in the fixed cost F of all firms weakly increases (decreases) equilibrium quality provision under salient thinking ($\delta < 1$) while it leaves quality unaffected under rationality ($\delta = 1$).

ii) A marginal increase (decrease) in the marginal cost of producing quality c of all firms strictly decreases (increases) equilibrium quality provision. Under salient thinking, the change in quality is larger than under rationality ($\delta = 1$) if and only if in the original equilibrium quality is sufficiently over-provided.

With rational consumers, changes in the fixed cost F do not affect quality provision. With salient thinkers, they do. This follows from the fact that a symmetric shock to the general level of costs shifts competition from quality to prices or vice-versa. A drastic increase in F reduces, by diminishing sensitivity, the salience of price differences. This makes it very attractive for firms to upgrade their quality. Conversely, a drastic reduction in F increases the salience of price differences. This makes it very attractive for firms to cut their prices. Somewhat paradoxically, a drop in costs translates into lower quality provision.

As an example, the transportation costs involved in exporting German cars to the United States (akin to a rise in F relative to the home market) may cause the car manufacturers to compete on quality provision in the US market, more than in the domestic market, by adding quality add-ons to their cars. Conversely, a reduction in the tariffs on textile imports from China (akin to a drop in F) may induce clothing manufacturers in Europe to intensify price competition relative to the situation with higher tariffs.

The effect of a drop in the marginal cost of producing quality c is more standard. As in the rational case, this shock increases quality provision. However, salience modulates the strength of this effect. The boost in quality provision is amplified at very high cost levels, when there is over-provision of quality, while it is dampened in all other cases. This effect is again due to diminishing sensitivity: by reducing the level of prices, reductions in c render consumers more attentive to price differences, reducing firms' incentive to increase quality.

Consider next the effect of a firm-specific shock. Suppose that, starting from a symmetric equilibrium, firm 1 acquires a cost advantage over its competitor. This enables firm 1 to monopolize the market (see proofs in Appendix A). To analyze the new equilibrium, we allow firm 1 to freely adjust its quality but keep the quality of firm 2 fixed.[13] For brevity, we report only the effects of reductions in the variable cost of providing quality.

Proposition 4 *Suppose that, starting from the symmetric equilibrium of Equation (14), the variable cost of firm* 1 *drops to* $c_1 < c_2 = c$ *and firm* 1 *can optimally reset its quality and price. There are two cases:*
i) The cost shock is large, $c_1 < c/2$*. Then, firm* 1 *monopolizes the market by boosting both its quality and its price.*
ii) The cost shock is small, $c_1 > c/2$*. Then, there is a threshold* $\widehat{F} > 0$ *such that firm* 1 *boosts its quality and price if and only if* $F \geq \widehat{F}$*. If* $F < \widehat{F}$*, firm* 1 *keeps its quality constant at the competitor's level* δ/c*, and monopolizes the market by slightly cutting its price.*

The size of the cost shock plays a critical role. If the variable cost reduction is drastic, or if the fixed cost of quality is high (i.e. $F \geq \widehat{F}$), firm 1 can win the market by boosting quality provision. In this case, prices tend not to be salient, because average costs are high, and therefore quality differences can be large. Thus, it is very beneficial for the low marginal cost firm 1 to provide extra quality: by doing so, the firm draws the consumers' attention to quality and raises their willingness to pay even for infra-marginal quality units. The quality added by the innovating firm acts as a complement to its baseline quality, greatly increasing the price that firm 1 can charge for its product. This logic implies that large quality upgradings can alter market outcomes, changing the equilibrium from price- to

[13] Forcing firm 2 to keep the initial quality is not a significant restriction. Having a dominated technology, firm 2 is in fact certain of losing the market. As a consequence, it is weakly optimal for it not to alter its quality provision. In general, in a game in which firm 2 can freely choose its quality in response to the cost shock, there are several quality levels consistent with equilibrium. To make predictions one needs an equilibrium refinement criterion. Assuming that firm 2 does not adjust to the cost shock is one possible refinement criterion, based on the idea that firms face some inertia in adjusting their quality level, and so they keep quality constant unless it is strictly beneficial for them to do otherwise. See Appendix D for a more detailed characterization of asymmetric equilibria.

quality- salient. It further provides a testable prediction of the model, namely that quality add-ons are prevalent particularly for higher quality (and more expensive) goods, and that the level of add-ons provided should respond positively to increases to the fixed cost of quality, and to reductions of the marginal cost of quality.

Matters are different when the cost shock is small, $c_1 > c/2$, and the fixed cost is low (i.e., $F < \widehat{F}$). Now, not only prices tend to be salient because of low average cost of quality, but the small cost advantage also makes it very costly for firm 1 to engineer a drastic increase in quality. This implies that quality upgrades make the associated price hikes salient, and thus backfire. As a consequence, it is optimal for firm 1 to keep its quality constant at the symmetric equilibrium level, and to capture the market by lowering its price below the competitor's. This outcome, which is puzzling in a rational model, looks natural from the perspective of salience: in a price-salient equilibrium quality upgradings are neglected, and firms exploit lower costs to cut prices.

An important implication of this analysis is that price-salient equilibria are very stable, particularly for low cost industries. To escape a commoditized market, an individual firm must develop a drastic innovation that allows it to provide sufficiently higher quality than its competitors, and at such reasonable prices that quality can become salient. Small cost reducing innovations neither beat the "commodity magnet"nor lead to marginal quality improvements. They just translate into lower prices.

This result more generally illustrates the working of our model when costs are asymmetric. The low cost firm wins the market, but whether it does so by setting higher quality or lower price depends on the extent of its cost advantage. If it has a large cost advantage, the low cost firm captures the market by setting a salient high quality. If the cost advantage is small, the low cost firm captures the market by setting a salient low price. In Proposition 4, the strategy of the losing firm 2 is held at the quality it would set in a symmetric equilibrium where both firms have cost $\mathbf{c}_2(q)$. This is a plausible refinement to study the effect of an innovation shock, but may be less appealing to study the equilibrium arising under permanently different cost functions. In Appendix D, we describe asymmetric equilibria more generally, where the high cost firm 2 is not constrained to the quality level given by (14). Although the results focus on the case where $F = 0$, they closely mirror Proposition 4. The only difference is that when the cost advantage of firm 1 is low, equilibria may arise in which – instead of producing the same quality – the low cost firm wins the market by providing *less* quality than the high cost firm. This is a further departure from the rational benchmark: the low cost firm may deliberately provide lower quality precisely to make its lower price salient to the consumer.

5 Applications

5.1 Southwest and Starbucks

In our previous analysis, we portrayed innovation as a shock to the costs of quality provision of competing firms initially locked in a symmetric equilibrium. We distinguished between market-wide and firm-specific shocks. We now suggest how our results might shed light on two noteworthy innovations: the rise of low cost airlines and quality upgrades in the coffee shop market.

The rise of low cost airlines in the U.S. is directly linked to deregulation that started in the late seventies. Deregulation enabled carriers to freely set routes and prices, but also freed entry into the industry. Aside from the removal of price controls, these developments can be conceptualized in our model as a major reduction in the costs F of operating an airline. Proposition 3 then predicts that such a cost reduction should lead to prices and quality to fall together. This seems consistent with the observed trends in the U.S. airline industry. Prices have declined steadily since deregulation, and some aspects of the quality of airline service have also declined.

Our model explains this phenomenon as the outcome of a transition from a quality salient to a price salient equilibrium. In the pre-deregulation era, high operating costs rendered small differences in airfares non salient. As a consequence, the most effective way for airlines to compete was to offer visible extra services to consumers. The market was in a quality salient equilibrium, where high quality and high prices went hand in hand. Deregulation created the opportunity for new entrants, such as Southwest and Ryan Air, to implement large, and thus salient, price cuts. Traditional carriers, burdened with legacy costs, were unable to respond. The salience of low prices characterizing the new regime placed the incumbents at a competitive disadvantage, forcing many of them into bankruptcy. Our model accounts neither for the progressive restructuring of existing airlines nor for the entry of new low cost carriers, but it predicts the key feature of the new long run equilibrium: a commoditized airline market characterized by fierce price competition, low prices, and low quality.[14]

A different phenomenon has occurred in the coffee shop market. In the 1970's, the low operating costs associated with selling drip coffee at neighbourhood coffee-shops and fast food restaurants ensured that the market was commoditized: coffee sellers were locked in a price-salient equilibrium, providing low quality coffee at low prices. In this initial regime, innovations, such as free refills, effectively translated into price cuts instead of quality increases. In the 1980's, firms such as Starbucks and Pete's Coffee & Tea figured out how to deliver a much higher quality coffee at only a reasonable extra cost. This included serving expresso drinks but also training baristas to ensure consistency of the product, and providing a "cafe" experience through a comfortable in-shop environment. Starbucks thus invented a way to drastically reduce the costs of producing quality. In line with Proposition 4, Starbucks boosted the quality of its coffee as well as its prices, but quality increased more than prices, making salient the quality of its product. By focusing consumers' attention on quality, Starbucks could charge higher prices. Starbucks' well-documented growth trajectory, while extreme, reflects the growth of the premium coffee market, which was successfully de-commoditized. This example illustrates the important point that de-commoditization of a market is not (only) a composition effect of demand, where an increase in quality attracts a wealthier consumer base (although such effects are probably at work for goods that are more expensive than coffee). Instead, de-commoditization works through a salient increase in quality, shifting the attention of infra-marginal consumers from price to quality.

[14]When considering the role of price controls, two points should be noted. First, in the pre-deregulation era price controls merely specified a standard of "reasonableness" for prices. In principle, this rule did not prevent airlines to engage in small scale price competition (potentially affecting the standard price level itself). Of course, salience could be a reason why competition did not ignite a succession of "reasonable" price cuts: being small, such price cuts would not be noticed by consumers. In this sense, price controls and salience may be complementary forces.

A second observation concerns the asymmetric response to deregulation in business class vs. coach. The fact that a large price and quality adjustment occurred in coach but not business class is not easily explained whithin a rational version of our model by the removal of price controls. Salience can instead explain why the business class market may remain quality salient even after deregulation: being characterized by larger fixed costs F of space, it is comparatively more likely to experience high quality and high prices.

5.2 Financial Innovation

We now show that our model can shed light on the working of financial innovation and in the phenomenon of "reaching for yield." Assume that a financial security i is characterized by the expected return R_i it yields to investors (net of intermediation fees), and its risk (variance) v_i. The investor's "rational" valuation of asset (R_i, v_i) is mean-variance, namely:

$$u_i(R_i, v_i) = R_i - v_i. \tag{15}$$

Under salient thinking, the investor overweights the more salient attribute, which can be either risk or return. Suppose that the investor chooses between two securities $i = 1, 2$ and the salience function is $\sigma(\cdot, \cdot)$. The following cases can then occur. If $\sigma(R_1, R_2) > \sigma(v_1, v_2)$, returns are salient and the investor values asset i at $R_i - \delta \cdot v_i$. If $\sigma(R_1, R_2) < \sigma(v_1, v_2)$, risk is salient and the investor values asset i at $\delta \cdot R_i - v_i$. Finally, if $\sigma(R_1, R_2) = \sigma(v_1, v_2)$, risk and return are equally salient and the investor's valuation is rational.

There are two financial intermediaries $i = 1, 2$, each producing an identical security delivering a gross expected return $\overline{R}$ with risk v. This is the no-innovation benchmark, in which both intermediaries produce an identical "standard" asset (perhaps because it is prohibitively costly to innovate).

In this setting, intermediaries compete by offering a net return $R_i \leq \overline{R}$ to investors, who must decide with which intermediary to invest. If $R_i < \overline{R}$, the net return offered by firm i entails a positive intermediation fee. If $R_i = \overline{R}$, this fee is zero. Competition then works as in Section 2, where quality and cost are fixed.[15] Each intermediary offers a net of fee return R_i, which is analogous to product quality, at the cost to the investor of bearing risk v, which is analogous to price. As a consequence, the upside of the asset with the highest ratio of return to risk R_i/v_i is salient, causing that asset to be overvalued relative to its competitor's. Because firms are identical and returns are given exogenously, the following equilibrium benchmark holds both in the rational case and with salient thinkers.

Lemma 4 *With no innovation, firms pledge their net returns to the investor,* $R_1 = R_2 = \overline{R}$*,*

[15]The only difference is that in the setting of Section 2, firms' pricing strategies determine the cost for consumers to buy the good, while here the firms' pricing strategies determine the "quality" of the asset for the investor (namely the investor's return), while cost is exogenously given by the asset's risk.

the investor is indifferent between the two firms, and firms make zero profits.

As in standard Bertrand competition, the two firms selling the same asset make zero profits, offering the totality of the return $\overline{R}$ to the investor. Under salient thinking, this result is reinforced by the logic of Proposition 1: because the two assets have the same ratio of return to risk $\overline{R}/v$, as soon as one firm offers to the investor less than $\overline{R}$, the firm's disadvantage becomes salient and the investor switches to the competing firm.

Against this benchmark, we model financial innovation as the invention by one of the two firms of a technology to create excess return at only a moderate extra risk. In particular, we allow the innovating firm, say 1, to increase the return of its asset to:

$$\overline{R} + \alpha,$$

where α is the new asset's excess return. Excess return comes at the cost of increasing the asset's risk to:

$$v + \frac{c}{2} \cdot \alpha^2,$$

where c captures the (low) marginal cost - in terms of added risk - of creating excess return α. Firm 2 continues to produce the standard asset $(\overline{R}, v)$. The no-innovation benchmark can be viewed as the extreme case where c is prohibitively high for both firms.

Two questions then arise. Does this financial innovation allow firm 1 to capture the market and make profits? What pins down excess return and risk taking in equilibrium? When the investor is fully rational, the answers to these questions are straightforward. In the spirit of Lemma 2, firm 1: i) captures the entire market by offering the investor a net return of $\overline{R} + (c/2) \cdot \alpha^2$ (which compensates the investor for bearing the extra risk), and ii) sets α to maximize its profit:

$$\max_{\alpha} \ \alpha - (c/2) \cdot \alpha^2 \tag{16}$$

which implies $\alpha^* = 1/c$. The lower is the extra risk c, the greater is the excess return promised by the new asset. Financial innovation enables firm 1 to manufacture an asset with higher excess return and risk. This process increases social welfare by attracting demand and thus earning profits for firm 1 (the investor is left indifferent).

In the case of salient thinking, the critical question is whether, compared to the standard security, the new security is salient in terms of return or risk, since salience affects the incentive of firm 1 to create a particular return vs. risk profile. Additionally, in this case the investor's risk appetite depends endogenously, through salience, on the characteristics of the new asset. The new equilibrium is as follows.

Proposition 5 *The innovating firm* 1 *captures the market and makes positive profits. The optimal excess return satisfies:*

$$\alpha^* = \begin{cases} \frac{1}{\delta \cdot c} & for \quad \overline{R} < \delta \cdot v \\ \frac{v}{\overline{R}} \cdot \frac{1}{c} & for \quad \overline{R} \geq \delta \cdot v \end{cases} . \tag{17}$$

Relative to the rational benchmark, under salient thinking there is excessive risk taking if $\overline{R} < v$ *and too little risk taking if* $\overline{R} > v$.

A financial innovation creating a higher return is particularly successful when investors focus on the extra return and neglect the risk associated with the new securities. To make this possible, firm 1 must keep the extra risk of the new asset sufficiently low. By doing so, the firm can charge the investor for the excess return created, which in turn generates high profits, while still maintaining higher risk non-salient. Precisely for this reason, the new asset may encourage excess risk taking by the investor, who underweights the risks he is effectively taking.

Proposition 5 illustrates the conditions under which such excess risk taking occurs. Financial innovation generates excessive risk taking when the net return $\overline{R}$ of the standard asset is sufficiently low. By diminishing sensitivity, a low net return causes any excess return to be very salient. The investor then underweights the extra risk of the new asset and pursues excessive risk taking. This reasoning may help explain why - for a given level of risk - investors "reach for yield" in low interest rate environments: the idea is that at low levels of interest rates any excess return draws investors' attention. An excess return of, say, 0.5% is much more salient when the baseline return is 1% than when the baseline return is 6%.[16]

[16] If one views the baseline return $\overline{R}$ as a net return generated after defraying the intermediary's operating

Proposition 5 also shows that financial innovations geared at creating excess returns are much less successful when net returns are already high. In this case, the investor is much less sensitive to a given increase in return, and the innovating firm must keep the risks of the new asset very low, lest the investors focus on them. In this case, there is too little risk taking, in the sense that the intermediary selects an excess return in (17) below its rational counterpart in (16). Although for simplicity we have not allowed for this possibility, here the intermediary may find it profitable to reduce excess returns and risks relative to the standard asset.

6 Conclusion

We have shown how salience changes some of the basic predictions of a standard model of competition with vertical product differentiation. Yet the paper has only begun to explore the consequences of salience for market competition. Rather than sumarizing our results, in conclusion we mention some issues we have not addressed, but which may be interesting to investigate. These include dynamics of competition, welfare, horizontal product differentiation, and advertising. We have not solved any of these problems, so the discussion here is strictly conjectural.

The dynamics of entry and imitation with salience may be very different depending on whether the innovation ultimately leads to quality-salient or price-salient long run equilibrium. If an innovator finds a way to escape the commodity magnet and produce a higher quality at a higher price, the pace at which this change is implemented, and imitated, might be relatively slow. The reason is that firms need to keep quality rather than price salient, and keep consumers from getting focused on price increases. This slows down innovation. As an extreme example, if consumers are used to free education, as they are in Europe, charging for education might be extremely difficult even with significant quality improvements be-

costs, the same intuition may explain why banks take more risk when their operating costs are higher. If intermediaries react to higher operating costs (i.e. a lower $\overline{R}$) by cutting the net return paid to investors (as the rational model would predict), consumers would find this an unattractive deal, reducing their demand, and the intermediary's profit. If instead the intermediary takes more risk, investors focus on its excess return. Because the investors underweight the asset's risk, the intermediary can increase fees. These fees allow the intermediary not only to cover its higher operating costs, but also generate profits.

cause the focus will be entirely on prices. (Of course, once prices are high enough, the pace of innovation and price increases will accelerate.) In contrast, precisely because consumers are focused on prices and neglect quality, innovation that reduces price and quality will be adopted extremely fast. The slide to the commodity magnet will be faster than in a rational model.

We have shown that – under the natural assumption that consumer welfare is measured by the undistorted utility – quality provision is generally inefficient in a duopoly, as a consequence of competition for attention between the two firms. An assessment of the welfare consequences of competition when consumers are salient thinkers would require a deeper understanding of the model with heterogeneous consumers, and in particular of monopoly and free entry.

Our approach might also be used to study horizontal differentiation, and to investigate the marketing dictum of "differentiate in any way you can" (Levitt 1983). If a firm differentiates its product from competitors, then differences along that attribute become salient, and will attract consumers' attention. In fact, firms might differentiate their products precisely to segment the market between consumers attracted to different attributes, and thus earn higher profits. This approach might provide a psychological foundation for the shrouded attributes model of Gabaix and Laibson (2006). It might also shed light on political competition, and reverse the median voter result in a plausible way. It would suggest that politicians might perhaps converge to the median voter viewpoint on some positions, but also seek to differentiate their views on dimensions that voters might find salient (and attractive). The two parties in the United States might converge on their views on Social Security, for example, making sure that voters do not pay attention to that issue, but then seek to differentiate on the issues they choose, such as immigration or gay marriage.

Finally, salience may have significant implications for how we think about advertising, which deals precisely with drawing consumer attention to products and their attributes. Economists distinguish two broad approaches to advertising: informative and persuasive. The former focuses on provision of hard information about the product; the latter deals with its more emotional appeal. Salience suggests that in fact the two approaches are intimately related, and usually integrated: a key purpose of advertising is to inform about and thus draw attention to the attributes of the product that the seller wants the consumer to think about, but not others. Advertising of attributes is simultaneously informative (sometimes about prices, sometimes about quality, rarely both) and persuasive in that the salience of the attributes being advertised is enhanced. The purpose of advertising is precisely to let some desirable attributes of the product stand out for the potential customers.

In all these situations, firms compete to attract attention to the attributes they want consumers to attend to, and to distract attention away from the attributes that are less attractive.

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A Proofs

Lemma 1 (price competition under rationality). When $\delta = 1$ there are no salience distortions and utility is given by Equation (1). We also assume that firms do not price below cost (as that might imply negative profits)[17], so we restrict $p_k \geq c_k$ for $k = 1, 2$.

If $q_1 - c_1 > q_2 - c_2$ then firm 1 sets price $p_1 = c_2 + (q_1 - q_2)$ and firm 2 sets price $p_2 = c_2$. Firm 2 has no incentive to deviate to another price, since it cannot satisfy the participation constraint while making non-negative profits, (and). Firm 1 has no incentive to deviate from p_1, since it cannot increase price without violating the participation constraint, and it cannot decrease price without reducing profits. If $q_1 - c_1 < q_2 - c_2$, the argument carries through switching firms 1 and 2. Finally, if $q_1 - c_1 = q_2 - c_2$, then both firms price at cost and share the market. We assume that having market share has some value to the firm, so that each firm strictly prefers to share the market while making zero profits to having zero market share. In this case, neither firm has an incentive to deviate: increasing price would violate the participation constraint, decreasing the price would imply making negative profits. ■

Proposition 1 (price competition under salient thinking). When $\delta < 1$, utility is given by Equation (2), where salience determines the relative weight of quality and price. We proceed under assumption A.1. As we show below, this assumption further implies that, in equilibrium, the good that wins the price competition sets the price so that its relative advantage is salient (i.e. the salience constraint weakly binds).

If $q_1/c_1 > q_2/c_2$, then assumption A.1 implies that firm 1 gains the market by setting p_1 sufficiently close to c_1. This ensures that quality is salient for both goods, and as a consequence consumers choose good 1. Since firm 2 loses the market, it sets price at $p_2 = c_2$. Firm 1 then hikes up price subject to the constraint that quality is salient

[17] Formally, if firm k loses the market in equilibrium, setting $p_k = c_k$ is a weakly dominant strategy for firm k. If $q_1 - c_1 > q_2 - c_2$ then firm 1 sets price $p_1 = p_2 + (q_1 - q_2)$ and firm 2 sets price p_2 in the range $p_2 \in [c_1 - (q_1 - q_2), c_2]$. In equilibrium, $p_2 > c_2$ cannot obtain since by reducing its price firm 2 could then profitably capture the market. Moreover, $p_2 < c_1 - (q_1 - q_2)$ can also not obtain in equilibrium since it would imply that both firms price below cost, making it beneficial for either firm to raise prices. Within the range $[c_1 - (q_1 - q_2), c_2]$, setting $p_2 = c_2$ is weakly dominant since a tremble play by firm 1 results in zero, instead of negative, profits.

and to the participation constraint (conditional on quality being salient), namely $p_1 = \min\left\{c_2 \cdot q_1/q_2, c_2 + \frac{1}{\delta}(q_1 - q_2)\right\}$, see constraints (4,5). Firm 1 has no incentive to deviate from this price. To see why, suppose the salience constraint is binding, $c_2 \cdot q_1/q_2 < c_2 + \frac{1}{\delta}(q_1 - q_2)$. Then raising the price p_1 above the salience constraint makes price salient, and the participation constraint becomes $p_1 < c_2 + \delta(q_1 - q_2)$. However, A.1 requires $c_2 + \delta(q_1 - q_2) < c_1$, which together with $\frac{q_1}{c_1} > \frac{q_2}{c_2}$ implies that the participation constraint is violated. By increasing price to the point where it becomes salient, firm 1 shifts the consumer's attention to its downside, and lowers the consumer's valuation to the point where it loses the market. Suppose instead that the participation constraint is binding. Then, by construction, any deviation in price leads to a decrease in profits.[18]

When $q_2/c_2 > q_1/c_1$, and as a result firm 1 sets price $p_1 = c_1$ and firm 2 sets price $p_2 = \min\{c_1 \cdot q_2/q_1, c_1 + \delta(q_2 - q_1)\}$, see constraints (6,7). Now price is salient, because firm 2 has lower price, lower quality but higher quality price ratio than firm 1. To see why this is an equilibrium, an argument similar to the above carries through. For instance, suppose that salience is binding for firm 2, namely, $c_1 \cdot q_2/q_1 < c_1 + \delta(q_2 - q_1)$. Then reducing p_2 decreases profits, while increasing p_2 takes firm 2 into a quality salient equilibrium, where the participation constraint reads $p_2 \leq c_1 + \frac{1}{\delta}(q_2 - q_1)$. Because the consumer now overvalues the quality differences across goods, his relative valuation of good 2 decreases drastically. Assumption A.1 then ensures the participation constraint is violated. Firm 1 has no incentive to change price, since increasing the price does not win the market, and decreasing the price might lead to negative profits if it does sell the good (notice the asymmetry in the firms' best responses, which comes from the fact that firm 2 can explore asymmetries in salience ranking when it is dominated, but firm 1 cannot). ■

Lemma 2 (quality competition under rationality).

[18] Firm 2 might hike up its price to the point where the price of good 1 is salient. That would require setting $p_2 > p_1$, making good 2 a dominated good. When one good dominates the other, their salience rankings may be different, potentially allowing good 2 to be quality salient while good 1 is price salient. In fact, diminishing sensitivity implies that: i) the salience of quality is larger for the lower quality firm 2 than for firm 1, and ii) as firm 2 raises p_2 over p_1, price salience increases for firm 1 faster than for firm 2. So there is a range of prices where good 2 may be quality salient while the dominating good 1 is price salient, in which case good 2 is overvalued relative to good 1. This feature of the model occurs because salience distortions depend only on salience ranking. As we show in BGS (2012b), under continuous salience weighting valuation is monotonic. To avoid this problem, we restrict optimisation in the price competition stage to $p_2 \leq p_1$.

We are interested in pure strategy, sub-game perfect Nash equilibria. Consider first the case where firms have the same cost structure. In the price competition stage, the firm that generates the highest surplus wins the market or shares it. As a consequence, in the first stage of the game each firm $i = k, -k$ sets quality q^* to maximize its own surplus $q_i - c_i(q_i)$. Since firms are identical, both set the same quality q^* that satisfies $c_1'(q^*) = c_2'(q^*) = 1$.

Suppose now firm 1 has lower costs than firm 2. In the price competition stage, firm 1 wins the market, sets price $p_1 = c_2(q_2)+(q_1-q_2)$ and generates profits $c_2(q_2)-c_1(q_1)+(q_1-q_2)$. Consider now the choice of quality. As explained in footnote 10, we assume that the firm that loses the market chooses a surplus maximizing quality (this corresponds to a trembling hand perfect equilibrium). Profits are maximised when quality q_1^* satisfies $c_1'(q_1^*) = v_1'(q_1^*) = 1$. In particular, if firm 1 has the same marginal cost function but a lower fixed cost than firm 2, then in the first stage both firms set quality q^* satisfying $v_1'(q^*) = v_2'(q^*) = 1$. In this case, firm 1 sets price $p_1 = F_2 - F_1$. If firm 1 has lower marginal costs, then it commits to a higher quality, $q_1^* > q_2^*$ since $v_1'(q_1^*) = v_2'(q_2^*) = 1$ but $v_1'(q) \leq v_2'(q)$. ■

Lemma 3 (best response under salient thinking). Consider two firms, k and $-k$ with cost functions $c_k(\cdot)$, $c_{-k}(\cdot)$. Denote firm $-k$'s average costs by $A_{-k} = c_{-k}(q_{-k})/q_{-k}$. In deriving firm k's best response on quality, we consider prices $p_k^*(q_k, q_{-k})$ and $p_{-k}^*(q_k, q_{-k})$ to be set competitively at the price competition stage as a function of qualities q_k^*, q_{-k}^*. When quality is salient ex post (at the price competition stage), firm k's best response features $q_k^* \geq q_{-k}^*$ and $p_k = c_{-k}(q_{-k}) + \min\left\{A_{-k}, \frac{1}{\delta}\right\}(q_k - q_{-k})$. To see this, note that when $A_{-k} < \frac{1}{\delta}$ the price condition becomes the (binding) salience constraint, $p_k/q_k = A_{-k}$, while for $A_{-k} > \frac{1}{\delta}$ it becomes the (binding) participation constraint conditional on quality being salient. In particular, the price condition above ensures that firm k provides a weakly higher quality to price ratio than firm $-k$.

In contrast, when price is salient ex post, firm k's best response features $q_k^* \leq q_{-k}^*$ and $p_k = c_{-k}(q_{-k}) + \max\{A_{-k}, \delta\}(q_k - q_{-k})$. Again, this ensures firm k has a weakly higher quality to price ratio than firm $-k$.

We now consider firm k's best response case by case: if $A_{-k} \in \left[\delta, \frac{1}{\delta}\right]$, firm k sets quality $c_k'(q_k^*) = A_{-k}$. Since costs are convex, the marginal cost $c_k'(q)$ is increasing in quality q.

Thus, if $c'_k(q^*_{-k}) < A_{-k} = c'_k(q^*_k)$ it follows that $q^*_k > q^*_{-k}$ and quality is salient. Similarly, if $c'_k(q^*_{-k}) > A_{-k} = c'_k(q^*_k)$ it follows that $q^*_k < q^*_{-k}$ and price is salient.

If $A_{-k} > 1/\delta$, two possibilities arise. If $c'_k(q^*_{-k}) > A_{-k}$ then firm k sets quality so that $c'_k(q^*_k) = A_{-k}$ leading to a price salient outcome, in which $q^*_k < q^*_{-k}$. If instead $c'_k(q^*_{-k}) < A_{-k}$, then firm k maximizes profits by setting quality such that $c'_k(q^*_k) = 1/\delta$, as long as quality is salient and in particular $q^*_k > q^*_{-k}$. As q^*_{-k} increases, firm k can no longer maintain a salient advantage, either by increasing quality or by cutting quality. Therefore, its best response is to set $q^*_k = q^*_{-k}$.

If $A_{-k} < \delta$, again two possibilities arise. If $c'_k(q^*_{-k}) < A_{-k}$ then firm k sets quality so that $c'_k(q^*_k) = A_{-k}$ leading to a quality salient outcome, in which $q^*_k > q^*_{-k}$. If instead $c'_k(q^*_{-k}) < A_{-k}$, then firm k maximizes profits by setting quality such that $c'_k(q^*_k) = \delta$, as long as price is salient and in particular $q^*_k < q^*_{-k}$. As q^*_{-k} decreases, firm k can no longer maintain a salient advantage and its best response is to set $q^*_k = q^*_{-k}$. ■

Proposition 2 (symmetric equilibrium under salient thinking).

We first show that any pure strategy subgame perfect equilibrium is symmetric. In equilibrium consumers must be indifferent between the two products and firms share the market (this is because, as is standard, we assume that each firm prefers to share the market while making zero profits to being driven out of the market). In particular, no firm's advantage can be salient. As a consequence, the two following conditions must hold: $q_1/c_1(q_1) = q_2/c_2(q_2)$ and $q_1 - c_1(q_1) = q_2 - c_2(q_2)$. Together, these conditions imply $q_1 = q_2$ and necessarily $c(q_1) = c(q_2)$.

We now show that in (symmetric) equilibrium, both firms provide equilibrium quality q^S given in equation (13). In fact, if firms provide any other quality, Lemma 3 shows that it is optimal to deviate. We begin by examining firm 1's incentives to deviate from this configuration. Consider the case where firm 2's average cost $c(q^S)/q^S$ lie in the interval $[\delta, 1/\delta]$. This translates into the restriction that $F \in [\delta \underline{q} - v(\underline{q}), \overline{q}/\delta - v(\overline{q})]$. Then, according to Lemma 3, firm 1's best response is to set quality q^* such that $c'(q^*) = c(\hat{q})/\hat{q}$ which precisely implies $q^* = \hat{q}$ (recall that, because costs are convex, the average-cost-minimizing quality satisfies $c'(\hat{q}) = c(\hat{q})/\hat{q}$).

Consider now the case where $c(q^S)/q^S > 1/\delta$, or equivalently $F > \overline{q}/\delta - v(\overline{q})$. Now firm 1's best response is to set $c'(q^*) = \frac{1}{\delta}$, provided $q^* \geq q^S$. But in fact, q^* and q^S satisfy the same condition, $c'(q^*) = c'(q^S) = c'(\overline{q}) = 1/\delta$, and therefore the best response coincides again with the equilibrium quality $\overline{q}$. Finally, when $c(q^S)/q^S < \delta$ or equivalently $F < \delta\underline{q} - v(\underline{q})$, firm 1's best response is to set $c'(q^*) = \delta$, provided $q^* \leq q^S$. An analogous argument then shows that $q^* = \underline{q}$, concluding the argument that this configuration is an equilibrium.

■

Corollary 1 (symmetric equilibrium for quadratic costs). Consider quadratic costs, where $v(q) = \frac{c}{2}q^2$. Then $c'(q) = c \cdot q$ so that $\overline{q} = \frac{1}{\delta c}$, and $\underline{q} = \frac{\delta}{c}$. Moreover, $\overline{F} = \frac{1}{2\delta^2 c}$ and $\underline{F} = \frac{\delta^2}{2c}$. Finally, $\hat{q}$ satisfies $c'(\hat{q}) = c(\hat{q})/\hat{q}$, which yields $\hat{q} = \sqrt{2F/c}$. ■

Proposition 3 (industry wide cost shocks). Under the symmetric equilibrium of Equation (14), consider an increase in the fixed cost of all firms, from F_0 to $F_1 > F_0$. If the interval $[F_0, F_1]$ has a non-empty overlap with the interval $[\underline{F}, \overline{F}]$, then equilibrium quality strictly increases from $\max\{\delta/c, \sqrt{2F_0/c}\}$ to $\min\{\sqrt{2F_1/c}, 1/(\delta c)\}$. Otherwise, equilibrium quality provision does not change, staying at δ/c if $F_1 < \underline{F}$ or at $1/(\delta c)$ if $F_0 > \overline{F}$.

Note that, when $\delta < 1$, the equilibrium quality can be written as $\frac{1}{c} \cdot A(c, F)$, where $A(c, F) = \max\{\delta, \min\{\sqrt{2Fc}, 1/\delta\}\}$. As a consequence, following an increase in the marginal cost of producing quality for all firms, quality provision strictly decreases. Consider a marginal increase in c. When is the change in quality provision in reaction to the cost shock larger than in the rational case? When $\delta = 1$, quality provision equals $1/c$. Therefore, the change in quality provision increases when $\delta < 1$ if and only if $A(c, F) > 1$, namely when quality is over provided to begin with (i.e. if $F > \frac{1}{2c}$). ■

Proposition 4 (firm specific cost shocks). Starting from the symmetric equilibrium of Equation (14), let the marginal cost of firm 1 drop to $c_1 < c_2 = c$. This implies that, at the symmetric quality level, firm 1's marginal costs are below firm 2's average costs. From Lemma 3 we know that firm 1 responds to the cost shock by weakly increasing quality. We first compute firm 1's best response from the equilibrium quality provision, and then show that firm 2 has no incentive to deviate.

When the fixed costs are sufficiently high, $F > \frac{\delta^2}{2c}$, the average costs of firm 2 satisfy $c(q^S)/q^S > \delta$. It then follows from Lemma 3 that firm 1's best response is to engineer a salient quality increase. When $c(q^S)/q^S < 1/\delta$, firm 1 sets $q_1^* = q^S \cdot \frac{c}{c_1} > q^S$. Firm 2 has no incentive to deviate because it is already minimizing average cost, so it cannot engineer a quality innovation that gives it a salient advantage which, together with the fact that it has higher costs, precludes any profitable deviation. When the average costs of firm 2 exceed $1/\delta$, firm 1 boosts quality to $1/\delta c_1$, which is above firm 2's quality provision of $1/\delta c$. Firm 2 again has no incentive to deviate, since increasing quality (thereby diminishing average costs below that of its competitor, if possible) is never profitable: if firm 2 engineers a salient quality advantage then it decreases perceived surplus, while if it creates a salient price advantage it cannot price above cost.

Consider now the case where $F < \frac{\delta^2}{2c}$. While firm 2 sets $q^S = \delta/c$, firm 1's best response is to set $q_1^* = \frac{c(q^S)/q^S}{c_1}$, provided $q_1^* > q^S$. This requires $F > \frac{\delta^2}{c}\left(\frac{c_1}{c} - \frac{1}{2}\right)$. Thus, if firm 1's cost advantage is sufficiently large, namely $c_1 < c/2$, then firm 1 strictly increases quality provision. If instead firm 1's cost advantage is small, $c_1 > c/2$, then for low enough levels of the fixed cost F, it is optimal for firm 1 to keep quality provision at the equilibrium level prior to the shock, $q_1^* = \delta/c$, and translate its cost advantage into profits by setting price $p_1 = c(\delta/c)$. Finally, firm 2 has no incentive to deviate because decreasing quality (thereby diminishing average costs) also decreases perceived surplus. ■

Lemma 4 (returns competition under rationality). This setting is similar to the price competition game of Lemma 1. While the costs facing investors are fixed at v (the security's risk), intermediaries compete in terms of the return they provide investors. Since intermediaries provide identical securities, this competition game only admits symmetric equilibria. In particular, both firms offer the maximum return to investors, $R_i - F = \overline{R} - F$, and share the market. No intermediary has an incentive to deviate from this configuration: increasing the returns offered to investors would lead to negative profits, while decreasing the returns would lead to the loss of the market share. ■

Proposition 5 (financial innovation under salient thinking). Suppose firm 2 creates a security of fixed total return and cost, $(\overline{R}-F,-v)$. Firm 1 develops a financial innovation and can create a family of securities $(\overline{R}+\alpha-F,-v-\frac{c}{2}\cdot\alpha^2)$, indexed by α, the increase in returns relative to the competition. The firms play a two stage game: in the first stage firm 1 chooses α, and in the second stage both firms choose how big a return to pledge to investors. Firm 1 pledges return $R_\alpha-F$ where $R_\alpha\in[\overline{R},\overline{R}+\alpha]$ so that in the return competition stage it sells security $(R_\alpha-F,-v-\frac{c}{2}\cdot\alpha^2)$ and maximizes profits $\overline{R}+\alpha-R_\alpha$.

To determine the optimal choice of α, we begin by noticing that, for α sufficiently small, the marginal cost of quality for firm 1 is lower than its average cost. This is because returns increase linearly in α, while risk increases quadratically. As a result, firm 1 finds it optimal to provide a salient increase in returns. The pledged returns R_α must satisfy both the constraint that returns are salient, and the participation constraint. The salience constraint reads $R_\alpha-F>(\overline{R}-F)\cdot\frac{v+\frac{c}{2}\alpha^2}{v}$ (recall that firm 1 provides higher returns at a higher risk), while the valuation constraint reads $R_\alpha>\overline{R}+\delta\frac{c}{2}\alpha^2$. The valuation constraint is binding when $\overline{R}>F+\delta v$. In this case, firm 1 must provide at least $R_\alpha=\overline{R}+(\overline{R}-F)\frac{\delta c}{2}\alpha^2$. To maximize profits $\overline{R}+\alpha-R_\alpha$, firm 1 sets $\alpha=\frac{1}{\delta c}$.

The salience constraint is binding when $\overline{R}\geq F+\delta v$. In this case, firm 1 must provide at least $R_\alpha=F+(\overline{R}-F)\left(1+\frac{c}{2v}\alpha^2\right)$. To maximize profits $\overline{R}+\alpha-R_\alpha$, firm 1 sets $\alpha=\frac{1}{\overline{R}-F}\cdot\frac{1}{c}$.
■

B Heterogeneity in Salience

We now introduce consumer heterogeneity in individual perceptions of salience. Formally, for given qualities $q_1\geq q_2$, we assume that the salience of quality is a stochastic function $\sigma(q_k,\overline{q}\,|\Delta\epsilon)$, where $\Delta\epsilon$ is a random shock that varies across consumers. This captures the idea that – holding the quality of different goods constant – some consumers may focus on quality differences more than others, due for instance to their habits.

Introducing heterogeneity generates "smooth" demand functions, and allows both firms to earn some profits in equilibrium. These features render the model more suitable to systematic empirical analysis. Heterogeneous salience also allows us for smoothen the effect of product attributes on the overall salience ranking, providing a way to assess the robustness of our findings to the case in which the salience weighting is continuous (rather than rank-based). An alternative approach would be to model consumer heterogeneity as affecting utility. This formulation yields similar results but the analysis becomes less tractable.

As in Section 2, we assume that the objective utility provided by goods 1 and 2 is sufficiently similar and non-salient dimensions are sufficiently discounted (δ is sufficiently low) that each consumer chooses the good whose advantage he perceives to be more salient. That is, a consumer receiving a perceptual shock $\Delta\epsilon$ inducing him to view quality as salient chooses the high quality good 1, while a consumer receiving a perceptual shock $\Delta\epsilon$ inducing him to view price as salient chooses the low quality good 2. Formally, denoting by (p_1^*, p_2^*) equilibrium prices, we assume that δ is sufficiently small that $q_1 - q_2 > \delta(p_1^* - p_2^*)$ and $\delta(q_1 - q_2) < p_1^* - p_2^*$. As we will see, optimal prices (p_1^*, p_2^*) are independent of δ, so it is always possible to find values of δ such that the above conditions hold at equilibrium.

To attain tractability, we model the shock $\Delta\epsilon$ as affecting salience through the consumer's focus on the ratio q_1/q_2 among the quality of the goods. Technically, this ensures that - as in our main analysis - the two goods have the same salience ranking (i.e., quality or price is salient for both good). In particular, we assume that the perceptual shock transforms the ratio q_1/q_2 into $\frac{q_1/q_2\cdot(2+\Delta\epsilon)+\Delta\epsilon}{2-\Delta\epsilon(q_1/q_2+1)}$, where $\Delta\epsilon = \epsilon_1 - \epsilon_2$ and ϵ_1, ϵ_2 are iid from a Gumbel distribution with scale $\beta > 0$ and location $\mu = 0$. As a result of this transformation, the salience of quality for goods 1 and 2 depends on $\Delta\epsilon$. It is easy to show that quality is salient for good 1 when

$$\frac{q_1}{(q_1+q_2)/2} + \Delta\epsilon > \frac{p_1}{(p_1+p_2)/2}$$

while quality is salient for good 2 when

$$\frac{q_1+q_2}{2q_2} \cdot \frac{2q_2}{2q_2 - \Delta\epsilon(q_1+q_2)} > \frac{p_1+p_2}{2p_2}$$

(Taking $\Delta\epsilon = 0$ in either of the above equations yields condition (3)). By construction, we find that quality is salient for each good if and only if:

$$\Delta\epsilon \geq 2 \cdot \frac{(r_p - r_q)}{(r_p+1)(r_q+1)}.$$

where we denote, for simplicity, $r_q = q_1/q_2$ and $r_p = p_1/p_2$.

The assumed structure for stochastic disturbances to salience yields a simple equation for quality. Because the shock $\Delta\epsilon$ is distributed according to a logistic function, the underlying demand sturcture is akin to a simple modification of the conventional multinomial logit model:[19]

Lemma 5 *Firms $i = 1, 2$ face demand $D_i(p_1, p_2)$ given by*

$$D_1 = \frac{1}{1 + e^{\frac{1}{\beta} \cdot K \cdot [r_p - r_q]}}, \qquad D_2 = \frac{1}{1 + e^{-\frac{1}{\beta} \cdot K \cdot [r_p - r_q]}} \tag{18}$$

where $K = 2/[(r_q + 1)(r_p + 1)]$.

Proofs are collected in Appendix B.1. This demand structure has some very intutive properties. First, good 1 has a larger market share than good 2 if and only if quality is salient, namely if $r_q > r_p$, which is equivalent to the same condition $q_1/p_1 > q_2/p_2$ of Section 2. The scale parameter $1/\beta$ measures how sensitive demand is to the difference Δr between the salience of quality and price: for large $1/\beta$, demand is extremely sensitive to any deviations from equal salience, thus implying that providing a higher quality to price ratio is critical to attracting a large share of consumers. For low $1/\beta$ consumers effectively choose randomly between the two options.

Firms $i = 1, 2$ sets price p_i to maximize profits $\pi_i = D_i \cdot (p_i - c_i)$. We focus on pure strategy equilibria. We prove:

Proposition 6 *In equilibrium, firms sets prices p_1, p_2 satisfying*

$$\frac{p_1 - c_1}{p_1} = \frac{p_2 - c_2}{p_2} e^{-K\Delta_r} \tag{19}$$

[19] Consider alternatively the case where noise enters through independent shocks to the perception of (or tastes for) qualities, $u_i = q_i + \epsilon_i - p_i$ for $i = 1, 2$. Here the ϵ_i are taken (independently) from Gumbel distributions. Then good 1 is chosen iff $q_1 + \epsilon_1 > q_2 + \epsilon_2$ and $\frac{q_1+\epsilon_1}{q_2+\epsilon_2} > \frac{p_1}{p_2}$, in other words, if and only if

$$\epsilon_1 - \epsilon_2 > q_2 - q_1, \qquad \epsilon_1 - \epsilon_2 \cdot \frac{p_1}{p_2} > q_2 \cdot \left(\frac{p_1}{p_2} - \frac{q_1}{q_2}\right)$$

If either of these conditions fail, then good 2 is chosen. Good 2 has an advantage in this setting because its price is always perceived (correctly) to be lower, while the quality ranking may be affected by noise. Because there are two conditions, in this model it is difficult to compute the probability that 1 gets chosen.

As a result, firm i with the lowest average cost: i) sets the highest markup $p_i/c_i > p_{-i}/c_{-i}$, ii) captures the highest market share $D_i > D_{-i}$, and iii) makes the highest profit $\pi_i > \pi_{-i}$.

Adding heterogeneity in consumers' salience rankings preserves the key result of our basic model, namely that under salient thinking quality cost ratios are critical to determine the outcome of price competition.

Consider now the implications of Proposition 6 for the symmetric case where both firms produce the same quality $q_1 = q_2 = q$ at identical costs, $c_1 = c_2 = c$. Condition (19) then implies that firms set equal prices $p_1 = p_2 = p$. Inserting this condition into the first order conditions, we find

$$p = c \cdot \frac{1/\beta}{1/\beta - 4} \tag{20}$$

When consumers are sufficiently sensitive to salient advantages (namely $1/\beta > 4$), there exists a symmetric equilibrium with prices above costs.[20] When consumers are infinitely sensitive to differences in quality to price ratios, namely $\beta \to 0$, equilibrium prices fall to cost and the model boils down to the standard Bertrand competition case.

We can now study the exogenous quality case when firms have identical cost of quality structures, $c_1(q) = c_2(q) = c(q)$. We find:

Proposition 7 *The unique pure strategy subgame perfect equilibrium with identical firms is symmetric. Firms provide quality q^* satisfying*

$$c'(q^*) = \frac{1}{1-\beta} \cdot \frac{c(q^*)}{q^*} \tag{21}$$

Propositions 6 and 7 extend essentially all our results for discrete salience in the symmetric case. In particular, as β approaches zero and consumers are infinitely attuned to salience ranking, expression (21) states that firms choose quality that minimizes average cost.

[20] The fact that prices are above costs mirrors Anderson and de Palma (1992)'s description of imperfect competition under logit demand.

B.1 Proofs

Lemma 5 (Demand under salience heterogeneity). The probability that good 1 is chosen is

$$\begin{aligned} Pr(u_1 > u_2) &= Pr\left(\frac{q_1}{(q_1+q_2)/2} + \Delta\epsilon > \frac{p_1}{(p_1+p_2)/2}\right) \\ &= Pr\left(\Delta\epsilon > K \cdot [r_p - r_q]\right) \end{aligned} \tag{22}$$

where $r_p = \frac{p_1}{p_2}$, $r_q = \frac{q_1}{q_2}$ and $K = \frac{2}{(r_p+1)(r_q+1)}$. To compute this expression, we first integrate over ϵ_2 keeping ϵ_1 fixed, and then integrate over all ϵ_1. The first integration is written in terms of the CDF of the Gumbell distribution, which is $CDF(x) = e^{-e^{-x}}$. To integrate over ϵ_1 we use the Gumbel PDF, which is $PDF(x) = e^{-x}e^{-e^{-x}}$. Therefore, equation (22) becomes

$$Pr(u_1 > u_2) = \int \left(e^{-e^{-\epsilon_1 + K\cdot[r_p - r_q]}}\right) \cdot e^{-\epsilon_1} e^{-e^{-\epsilon_1}} d\epsilon_1 \tag{23}$$

We find $Pr(u_1 > u_2) = \frac{1}{1+e^{-K\cdot[r_q - r_p]}}$ from which the result follows. ■

Proposition 6 (Equilibrium prices under salience heterogeneity). Denote $\Delta r = r_p - r_q$. Optimal prices satisfy:

$$\begin{aligned} FOC_1: &\quad D_1 e^{K\Delta r} k \cdot \frac{r_q+1}{r_p+1} \cdot \frac{p_1 - c_1}{p_2} = 1 \\ FOC_2: &\quad D_2 e^{-K\Delta r} k \cdot \frac{r_q+1}{r_p+1} \cdot \frac{p_1(p_2 - c_2)}{p_2^2} = 1 \end{aligned}$$

Since $D_1 e^{K\Delta r} = D_2$, together these imply condition (19). This captures several properties of equilibrium prices:[21]

- In the symmetric case, $c_1 = c_2 = c$, firms price at cost, $p_1 = p_2 = c$.
- The good with the larger quality price ratio also has the larger markup. Suppose $\Delta r > 0$ so that $q_2/p_2 > q_1/p_1$ and price is salient. Then (19) implies that $(p_1 - c_1)/p_1 < (p_2 - c_2)/p_2$ so that $p_2/c_2 > p_1/c_1$. The reverse conditions hold when $\Delta r < 0$.

[21] Still need to check that $p_1 \geq p_2$ always.

- The good with the highest quality price ratio is the good with the highest quality to cost ratio (or the lowest average cost). To see that, rewrite (19) as

$$1 - \frac{c_1}{q_1} \cdot \frac{q_1}{p_1} = \left(1 - \frac{c_2}{q_2} \cdot \frac{q_2}{p_2}\right) e^{-K \frac{q_1}{p_2}\left[\frac{p_1}{q_1} - \frac{p_2}{q_2}\right]} \tag{24}$$

  This implies that $q_1/p_1 > q_2/p_2$ if and only if $q_1/c_1 > q_2/c_2$. In particular, if firms have equal average costs, they both price at cost and make zero profits.

- Finallly, this implies that the firm with lower average cost makes higher profits (equivalently, it extracts higher total surplus). It is clear that if quality is salient the higher quality firm makes higher profits. It is also straightforward to see that if the low quality firm has sufficiently lower average costs, it makes higher profits. By continuity, and by the fact that both firms make zero profits when average costs are equal, the result follows.

■

Proposition 7 (Symmetric equilibrium under salience heterogeneity). At the quality selection stage, firms take into account the outcome of the price competition stage, where they implement a price schedule given by $p(q) = c(q)/(1 - 4\beta)$. At the first stage, firm 1's optimisation problem is then

$$\max_{q_1} \frac{1}{1 + e^{\frac{1}{\beta} K \Delta r}} \cdot [p(q_1) - c(q_1)]$$

Notice that $r_p = c(q_1)/c(q_2)$ and $r_q = q_1/q_2$. The first order condition then reads

$$c'(q_1) = \frac{c(q_1)}{1 + e^{\frac{1}{\beta} K \Delta r}} e^{\frac{1}{\beta} K \Delta r} \frac{2}{\beta} \partial_{q_1} \left[\frac{c(q_1)/c(q_2) - q_1/q_2}{(c(q_1)/c(q_2) + 1)(q_1/q_2 + 1)}\right]$$

This is evaluated at the symmetric equilibrium condition $q_1 = q_2$, so that $\Delta r = 0$. The factor multiplying the derivative term then simplifies to $\frac{c(q_1)}{\beta}$. Developing and simplifying the expression above gives the result (21). ■

C Competition with an outside option

We extend the analysis of the paper to the case where each consumer chooses one unit of one good from the choice set $C_O \equiv \{(q_2, -p_2), (q_1, -p_1), (0, 0)\}$, where $(0, 0)$ represents the outside option of buying neither good 1 nor good 2. Including an outside option has two effects on market competition: first, as in standard models, it makes the participation constraint weakly stronger; second, by shaping the reference good, the outside option also influences the attention externality each good exerts on the other. We now show, however, that the fundamental role of the quality cost ratio in determining who wins the market survives in this setting as well.

Consider first the price competition stage, where qualities q_1, q_2 and costs c_1, c_2 are given. As in section 3, assume that $q_1 > q_2$ and $c_1 > c_2$. In the choice set C_O, the reference good has $\overline{q} = (q_1 + q_2)/3$ and $\overline{p} = (p_1 + p_2)/3$. For good 1, its advantage – namely, quality – is salient when $q_1/\overline{q} > p_1/\overline{p}$, and it is easy to see this condition is equivalent to

$$q_1/p_1 > q_2/p_2 \tag{25}$$

Thus, assumption A.1 implies that good 1 is preferred to good 2 if and only if the salience constraint (25) holds, independently of the salience ranking of good 2. The preference ranking between the goods, under assumption A.1, is thus invariant to the inclusion of the outside option $(0, 0)$.[22]

We now consider the impact of the outside option on the participation constraint. When (25) holds, the consumer buys good 1 provided the participation constraint $q_1 - \delta p_1 > 0$ is satisfied. When (25) does not hold, the consumer buys good 2 provided its valuation is positive. To determine good 2's valuation, we now characterise its salience ranking. To do so, note that $q_2 > \overline{q}$ iff $q_2 > q_1/2$, and $p_2 > \overline{p}$ iff $p_2 > p_1/2$. As a consequence, there are four cases to consider, depending on whether good 2's quality and price are above or below the reference good's quality and price. Here we focus on the cases where good 2 is preferred to

[22] This is not generally the case with an arbitrary outside option, so the reasoning may have to be adjusted in situations where there is a clear default option. However, in a choice context defined only by goods 1 and 2, it is natural to represent the alternative of not buying a good as $(0, 0)$, which can be thought of as narrow framing.

good 1, namely $q_2/p_2 > q_1/p_1$. Consider first the case where good 2 is close to good 1 along both dimensions, namely $q_2 > q_1/2, p_2 > p_1/2$. In this case, the two goods have opposite salience ranking: good 2's quality is salient and good 1's price is salient. When good 2 is distant from good 1, namely $q_2 < q_1/2, p_2 < p_1/2$, the two goods have the same salience ranking (as in the absence of the outside option), so price is salient for both goods. Finally, when $q_2 > \overline{q}$ and $p_2 < \overline{p}$ good 2 has a high quality-price ratio, so good 1 is price salient, while good 2 is quality salient provided $q_2 p_2 > \overline{qp}$.

At the price competition stage, we show that the good with the highest quality price ratio captures the market, provided the costs of quality are not too high.

Lemma 6 *Under A.1, pure strategy equilibria under price competition in the choice set C_O satisfy:*

i) if $\frac{q_1}{c_1} > \frac{q_2}{c_2}$, the consumer buys good 1 provided costs are not too high, $c_1 < q_1 \frac{1}{\delta}$.

ii) if $\frac{q_2}{c_2} > \frac{q_1}{c_1}$, the consumer buys good 2 provided the costs are not too high. A sufficient condition for that is $c_2 < \delta q_2$.

iii) if $\frac{q_1}{c_1} = \frac{q_2}{c_2}$, quality and price are equally salient, the consumer buys the good yielding the highest (rational) surplus $q_k - c_k$, if the latter is positive. Prices are $p_1 = c_1, p_2 = c_2$.

We now turn to the endogenous quality case when firms have identical costs. For simplicity, we consider the case of quadratic costs, $c(q) = \frac{c}{2}q^2 + F$. As before, pure strategy equilibria entail symmetric quality production, where price and quality are equally salient (we assume that firms strictly prefer to share the market with zero profits than being out of the market). Analogously to proposition 2, we derive the equilibrium quality provision q^S as a function of the fixed cost F. Because the quality price ratio is a necessary statistic for winning the market, proposition 2 carries through in the range of intermediate $F \in [\underline{F}, \overline{F}]$ where the salience constraint binds. In this range, firms set $q^S = \sqrt{2F/c}$. Participation in the market requires that $q^S - c(q^S) \leq 0$, namely $F < 1/2c$. So the outside option truncates the symmetric equilibria for F larger than $1/2c$, excluding equilibria where quality is over provided relative to the efficient level. Consider now the range $F < \underline{F}$, where in the absence of the outside option the equilibrium quality provision is $q^S = \delta/c$. With an outside option, there might in principle be profitable deviations from this solution because a firm that cuts quality slightly in order to minimise its average cost renders its good quality salient, while rendering its competitor price salient. This stronger salience advantage would push firms to always minimise average costs. We find:

Lemma 7 *When firms have identical cost functions, the unique pure strategy subgame perfect equilibrium in the choice set C_O is symmetric. Equilibria exists provided costs are not too high, $F \leq \frac{1}{2c}$. In equilibrium price and quality are equally salient, firms make no profits, and quality provision is given by: $q_2^S = q_1^S = q^S \equiv \widehat{q}(F)$.*

Finally, we turn to innovation, where firm 1 has a positive shock to the marginal cost of quality. Recall that in this case firm 1 always weakly increases quality provision, so that quality is (weakly) salient. As a consequence, firm 1 captures the market, provided good 1 satisfies the participation constraint $q_1 > \delta c_1(q_1)$. Because the participation constraint is strictly weaker than in the symmetric case, such innovation equilibria exist for all $F \leq \frac{1}{2c}$. In fact, for the same reason, such equilibria exist even for higher levels of F where quality is over provided relative to the efficient level. However, such equilibria do not preserve the interpretation as an innovation relative to the symmetric case.

C.1 Proofs

Proof of Lemma 6.

From the analysis in the text, we know that the high quality good 1 is quality salient, and thus is preferred to good 2, if and only if $q_1/p_1 > q_2/p_2$. As in the case without the outside option, then, in a market equilibrium (where firm 1 sells the good) this condition is satisfied if and only if $q_1/c_1 > q_2/c_2$. In this case, firm 2 sets price $p_2 = c_2$ and firm 1 sets price satisfying $p_1 \leq \min\left\{q_2 \cdot \frac{c_2}{q_2}, \frac{1}{\delta}(q_1 - q_2) + c_2\right\}$. The market equilibrium exists (namely, firm 1 sells its good) if and only if good 1 is preferred to the outside option, namely it has positive valuation, $q_1 - \delta p_1 > 0$. Firm 1 can set a price satisfying this condition whenever $c_1 < \delta q_1$. Consider now the case where $c_1 > \delta q_1$. Firm 1 cannot sell its good and, as before, we assume it sets price at $p_1 = c_1$. In this case, no good is sold. In particular, under assumption A.1, firm 2 is also unable to sell its good, regardless of its salience ranking, since $q_2 - \delta c_2 < q_1 - \delta c_1 < 0$.

A similar analysis carries through if $q_2/c_2 > q_1/c_1$. In this case, in any market equilibrium firm 1 sets price $p_1 = c_1$ while firm 2 sets price $p_2 \leq q_2 \frac{c_1}{q_1}$. In order to sell its good, firm 2's good must be preferred both to good 1 and to the outside option. Both participation constraints depend on the salience ranking of good 2 (note that good 1 is always price salient). A sufficient condition for the market to exist is that good 2 is chosen when it is price salient, namely $c_2 < \delta q_2$.

■

Proof of Lemma 7.

Given the discussion in the text, it is sufficient to check that $q^S = \sqrt{2F/c}$ is the unique (symmetric) equilibrium for $F < \underline{F}$. We first show that there are profitable deviations from the two-good symmetric equilibrium quality δ/c in this range. Suppose firm 1 cuts quality slightly to $\delta/2c < q_1 < \delta/c$, while firm 2 keeps quality at $q_2 = \delta/c$. As a consequence good 1 becomes quality salient while good 2 becomes price salient. This is a profitable move when firm 1 can sell its good with a positive profit. To see that is the case, note that $q_1 - \delta c(q) > 0$ for $F < \underline{F}$ and also that $q_1 - \delta c(q) > \frac{\delta^2}{c} - c(\delta/c)$ for any $\delta < 1$. The same logic implies that $q^S = \sqrt{2F/c}$ is an equilibrium for any $F < \underline{F}$: deviating from the average-cost minimizing quality makes the deviating firm's good price salient while its competitor becomes quality salient. Therefore, such deviations are never profitable. ■

D Asymmetric Equilibria

This appendix characterizes the set of equilibria that arise when firms have different cost functions. We focus on pure strategy equilibria, and restrict our analysis to the quadratic cost structure:

$$c_1(q) = \frac{c_1}{2}q^2 + F, \qquad c_2(q) = \frac{c_2}{2}q^2 + F, \qquad 0 < c_1 < c_2$$

in which the fixed cost of quality F is the same for both firms, but firm 1 has lower marginal cost than firm 2. We begin by describing general properties of the model for arbitrary fixed cost of quality $F \geq 0$ (Lemmas 1 and 2). We then fully characterize equilibria for the special case $F = 0$, and comment on how the results extend to the case $F > 0$. All proofs are collected in section D.1.

Lemma 8 *In all pure strategy equilibria, firm* 1 *captures the market.*

Intuitively, firm 1 can always mimic firm 2's quality provision and exploit its cost advantage. To identify the equilibria of the model, it is useful to characterize what kind of deviations may be profitable for firm 2. We find:

Lemma 9 *Let firm* 1 *produce a quality level* q_1^* *that is a best response to firm* 2*'s quality* q_2^**, which can be arbitrary. Then:*

i) firm 2 *can never profitably deviate to configuration* $\widehat{q}_2$ *where it has a salient quality advantage, namely* $\widehat{q}_2 > q_1^*$ *and* $c_2(\widehat{q}_2)/\widehat{q}_2 \leq c_1(q_1^*)/q_1^*$.

ii) a price-salient and profitable deviation $\widehat{q}_2$ *(where* $\widehat{q}_2 < q_1^*$ *and* $c_2(\widehat{q}_2)/\widehat{q}_2 \leq c_1(q_1^*)/q_1^*$*) exists for firm* 2 *only if firm* 1*'s quality is sufficiently high, namely* $q_1^* > \delta/c_1$.

Intuitively, if the high cost firm 2 tries to provide more quality than firm 1, it will face much higher costs. Prices will be salient, and quality improvements will backfire. As a consequence, optimal deviations by firm 2 consist of salient price cuts. This suggests that equilibria in the model occur when quality levels (q_1^*, q_2^*) are optimal for both firms and firm 2 is unable to undercut firm 1.

In light of these results, we describe the equilibria arising when $F = 0$. In this case, pure strategy equilibria can be characterized in the following intuitive way:

Lemma 10 *Let* $F = 0$*. For any* $c_1 < c_2$*, there exist equilibria* (q_1^*, q_2^*)*. Pure strategy equilibria fall into three cases:*

i) the cost advantage of firm 1 *is large,* $\frac{c_1}{c_2} < \frac{1}{2}$*, equilibria are quality-salient with* $q_1^* > q_2^*$.

ii) the cost advantage of firm 1 *is small,* $\frac{c_1}{c_2} \geq \frac{1}{2}$*, equilibria are price-salient with* $q_1^* < q_2^*$.

iii) the cost advantage of firm 1 *is small,* $\frac{c_1}{c_2} \geq \frac{1}{2}$*, equilibria feature homogeneous qualities,* $q_1^* = q_2^* < \delta/c_1$*. Firm* 1 *prices at* $c_2(q_2^*)$ *and price is salient.*

As in our characterization of equilibria under unilateral cost shocks (Proposition 4), the low cost firm 1 wins the market by providing salient high quality if its marginal cost advantage is sufficiently large, namely when $c_1 < c_2/2$. If the cost advantage is small, the low cost firm 1 wins a price-salient market by undercutting quality relative to its competitor. This includes case iii) where both firms provide the same quality level, effectively offering homogeneous goods.[23,24]

We conclude this Appendix by briefly discussing how the analysis might extend to a positive (and common across firms) fixed cost of quality F. Although the analysis is more complicated, some effects are intuitive. Now the average cost of firm k to produce quality q becomes $A_k(q) = c_k \cdot q/2 + F/q$. A positive F has two effects: i) it increases the average costs for both firms and for any quality level, but ii) this effect is particularly large for low quality levels, so that $A_k(q)$ is U-shaped. The quality minimizing average cost for firm k is now $\sqrt{2F/c_k}$, which increases with F. This has two implications. First, since cost levels are higher, it is more likely that a quality salient equilibrium obtains for a given level of c_1, c_2. Second, it is harder for firm 2 to profitably undercut a given quality provision of firm 1. This last feature expands the set of possible equilibria, particularly quality salient equilibria. In particular, price salient equilibria now require not only that firm 1's cost advantage is small, $c_1/c_2 < 1/2$, but also that fixed costs are small. In contrast, quality salient equilibria arise when either firm 1's cost advantage is large, or when F – and thus cost levels – is high.

D.1 Proofs

Notation. In this section, we denote the equilibrium quality provided by firm k by q_k^*. When we examine quality deviations by firm k, we denote them by $\widehat{q}_k$. We let $A_k = c_k(q_k)/q_k$ denote the average cost of quality q_k to firm k. We write $A_k^* = A_k(q_k^*)$ and $\widehat{A}_k = A_k(\widehat{q}_k)$.

Proof of Lemma 8. Suppose, by contradiction, that for some quality choice (q_1^*, q_2^*) firm 2 would capture the market with non-negative profits, $p_2 \geq c_2(q_2^*)$. Then firm 1 can shift quality to mimic firm 2 and lower its price to capture the market: $q_1' = q_2^*$ and $p_1' = c_2(q_2^*)$.

[23] In Lemma 10, we consider only equilibria that arise for any $\delta \in [0, 1)$. More details can be found in the proof.

[24] One unappealing aspect of this model is that it features many equilibria. This is because: i) firm 2 is certain to lose and so it is indifferent between setting several quality levels, and ii) the equilibrium quality that firm 1 optimally provides sometimes depends on the quality chosen by firm 2. One way to tackle equilibrium multiplicity would be to provide a refinement criterion. This is beyond the scope of our current analysis, which simply seeks to characterize the broad properties of asymmetric equilibria as stated in Lemma 10.

Since the good $(q_1', -p_1')$ offered by firm 1 dominates any good offered by firm 2 at quality q_2^*, and since it is priced above cost $(c_1(q_2^*) > c_2(q_2^*))$, this deviation is profitable for firm 1. Thus, there is no pure strategy equilibrium where firm 2 captures the market. The same logic shows that there is no pure strategy equilibrium where both firms share the market. ■

Proof of Lemma 9. To prove point $i)$ of the Lemma, note that all deviations by firm 2 to a profitable quality salient configuration $\widehat{q}_2$ require the competing conditions of providing high quality $\widehat{q}_2 > q_1^*$ at relatively low average cost $A_2(\widehat{q}_2) < A_1(q_1^*)$. We first show, case by case, that these conditions cannot be simultaneously satisfied. Among deviations to configurations where firm 2 might have a salient quality advantage, we distinguish between cases where the participation constraint is binding (denoted QP) or where the salience constraint is binding (denoted by QS).

To simplify notation, write $A_k^* = A_k(q_k^*)$ for $k = 1, 2$. Also, a configuration where quality is salient and the participation constraint is binding is referred to as a QP configuration, whereas QS refers to a quality salient configuration where the salience constraint is binding. Similarly, we use the terms PP and PS to refer to price salient configurations where the participation constraint, or the salience constraint, is binding.

- Consider a configuration where firm 1 has a salient quality advantage, and the participation constraint is binding. Then $q_1^* = \frac{1}{\delta c_1}$ and $p_1^* = \frac{1}{\delta}(q_1^* - q_2^*) + c_2(q_2^*)$, for some q_2^* satisfying $A_2^* > 1/\delta$.
  - If $A_1^* > 1/\delta$, firm 2 deviates to a QP configuration, $\widehat{p}_2 = \frac{1}{\delta}(\widehat{q}_2 - q_1^*) + c_1(q_1^*)$ so $\widehat{q}_2 = \frac{1}{\delta c_2}$. Then $\widehat{q}_2 < q_1^*$ (since $c_2 > c_1$), so the quality ranking condition is violated.
  - If $A_1^* < 1/\delta$, firm 2 deviates to a QS configuration, $\widehat{p}_2 = \widehat{q}_2 A_1^*$ so $\widehat{q}_2 = \frac{1}{c_2} A_1^*$. Then the quality constraint $\widehat{q}_2 > q_1^*$ is $F > q_1^{*2}\left[c_2 - \frac{1}{2}c_1\right]$, while the salience constraint $A_1^* < \frac{1}{\delta}$ reads $F < \frac{1}{2\delta^2 c_1}$. Inserting $q_1^* = 1/\delta c_1$, and using $c_2 > c_1$ we find that these conditions are incompatible.

- Consider a configuration where firm 1 has a salient quality advantage and the salience constraint is binding. Then $q_1^* = \frac{1}{c_1} A_2^*$ and $p_1^* = \frac{1}{c_1} A_2^{*2}$ for some q_2^* satisfying $A_2^* < 1/\delta$.

– We have $A_1^* < A_2^* < 1/\delta$, so firm 2 deviates to a QS configuration, where $\widehat{p}_2 = \widehat{q}_2 A_1^*$ so $\widehat{q}_2 = \frac{1}{c_2} A_1^*$. Then $\widehat{q}_2 > q_1^*$ if and only if $\frac{1}{c_2} A_1^* > \frac{1}{c_1} A_2^*$ which again is incompatible with $A_1^* < A_2^*$, and $c_2 > c_1$.

- Consider a configuration where firm 1 has a salient price advantage and the salience constraint is binding. Then $q_1^* = \frac{1}{c_1} A_2^*$ and $p_1^* = \frac{1}{c_1} A_2^{*2}$, where $A_2^* > \max\{A_1^*, \delta\}$.

  – If $A_1^* > 1/\delta$ firm 2 deviates to a QP configuration, and we have $\widehat{p}_2 = \frac{1}{\delta}(\widehat{q}_2 - q_1^*) + c_1(q_1^*)$ and $\widehat{q}_2 = \frac{1}{\delta c_2}$. Then $\widehat{q}_2 > q_1^*$ if and only if $A_2^* < \frac{c_1}{\delta c_2}$, which is inconsistent with the requirement that $A_2^* > A_1^* > \frac{1}{\delta}$.

  – If $A_1^* < 1/\delta$, firm 2 tries deviates to a QS configuration. This is not profitable, for identical reasons to the case above where the ex ante regime was quality salient (only difference was ex ante ranking of qualities q_1^* and q_2^* which does not matter for the deviation).

- Consider a configuration where firm 1 has a salient price advantage and the participation constraint is binding. Then $q_1^* = \frac{\delta}{c_1}$ and $p_1^* = \delta(q_1^* - q_1^*) + c_2(q_2^*)$. Moreover, $A_2^* < \delta$.

  – We have $A_1^* < A_2^* < \delta < 1/\delta$, so firm 2 deviates to a QS configuration. We have $\widehat{p}_2 = \widehat{q}_2 A_1^*$ and $\widehat{q}_2 = \frac{1}{c_2} A_1^*$. However, the salience constraint on A_1^* implies $\widehat{q}_2 < \frac{\delta}{c_2} < q_1^*$ so the quality ranking is violated.

We now turn to point *ii*) of the lemma. Since q_1^* is a best response to some q_2, we can distinguish two cases: either $q_1^* = \delta/c_1$ and $A_2 \leq \delta$, or $q_1^* = A_2/c_1$ and $A_2 > \delta$. To prove point *ii*), therefore, it is sufficient to show that a price-salient and profitable deviation $\widehat{q}_2$ does not exist for firm 2 if firm 1 sets quality $q_1^* = \delta/c_1$. (As we show below, for higher values of q_1 such profitable deviations do exist for firm 2).

In this case, since firm 1's quality setting is optimal, we have $A_1^* < A_2^* < \delta$. As a consequence, only deviations to price salient configurations where the participation constraint binds are available to firm 2. Firm 2 thus sets $\widehat{q}_2 = \frac{\delta}{c_2}$ which satisfies $\widehat{q}_2 < q_1^*$. However, this move does not satisfy the salience constraint, since $\widehat{A}_2 = \delta/2 + Fc_2/\delta$ and $A_1^* = \delta/2 + Fc_1/\delta$ so

$\widehat{A}_2 > A_1^*$ for any positive F. Even for $F = 0$ the cost structure implies that this move cannot be profitable. In fact, the participation constraint on firm 2's price is $\widehat{p}_2 = \delta(\widehat{q}_2 - q_1^*) + c_1(q_1^*)$. Inserting the values for $\widehat{q}_2$ and q_1^* it is easy to show that $\widehat{p}_2 < c_2(\widehat{q}_2)$. ■

Proof of Lemma 10. We proceed in two steps: in the first step, we show that the conditions on the cost advantage c_1/c_2 are necessary for the equilibria. In the second step, we derive the full equilibrium conditions, including all constraints on qualities and costs.

- Step 1: necessity of constraints on c_1/c_2.

  I. In equilibrium, firm 1 chooses a high quality strategy only if it satisfies the competing constraints of higher quality, $q_1^* > q_2^*$, and lower average cost, $p_1^*/q_1^* < A_2^*$ when the participation constraint is binding. The two constraints are compatible if and only if the cost advantage c_1/c_2 is sufficiently large, as we now show.

  - Consider equilibria where quality is salient and the participation constraint is binding (QP). Then $p_1^* = \frac{1}{\delta}(q_1^* - q_2^*) + c_2(q_2^*)$ and $q_1^* = \frac{1}{\delta c_1}$. The higher quality constraint implies $q_2^* < \frac{1}{\delta c_1}$. In turn, the participation constraint is binding if and only if $A_2^* > \frac{1}{\delta}$, which reads $q_2^* > \frac{2}{\delta c_2}$, which requires $c_1/c_2 < 1/2$.
  - Consider now a configuration where quality is salient and the salience constraint is binding (QS). In this case, $p_1^* = q_1^* A_2^*$ and $q_1^* = \frac{1}{c_1} A_2^*$. The higher quality constraint reads $\frac{1}{c_1} A_2^* > q_2^*$, or equivalently $q_2^{*2} \left(\frac{c_2}{2c_1} - 1\right) > 0$, which again requires $c_2 > 2c_1$.

  II. Firm 1 chooses a low price strategy only if it provides weakly lower quality, $q_1^* \leq q_2^*$ and lower average cost.

  - In a configuration where price is salient and the salience constraint is binding (PS), we have $p_1^* = q_1^* A_2^*$ and again $q_1^* = \frac{1}{c_1} A_2^*$. The lower quality constraint reads $\frac{1}{c_1} A_2^* < q_2^*$, or equivalently $q_2^{*2} \left(\frac{c_2}{2c_1} - 1\right) < 0$, which now requires $c_2 < 2c_1$.
  - Finally, in a configuration where price is salient and the participation constraint is binding (PS), we have $p_1^* = \delta(q_1^* - q_2^*) + c_2(q_2^*)$ and $q_1^* = \frac{\delta}{c_1}$. The lower quality constraint implies $q_2^* > \frac{\delta}{c_1}$. In turn, the participation constraint is binding if and

only if $A_2^* < \delta$, which reads $q_2^* < \frac{2\delta}{c_2}$. Compatibility of the two conditions again requires $c_2 < 2c_1$.

- Step 2a: equilibrium conditions when $c_1/c_2 < 1/2$. From the previous step, we know that any equilibrium must be quality salient. Under what conditions does firm 2 have no incentive to deviate? We now show that firm 2 can profitably deviate whenever the quality offered by firm 1 (and hence its average cost) is high. However, the equilibrium is sustained for lower quality levels, namely when $q_1^* < 2\delta/c_1$ and $A_1^* < \delta$, since then firm 2's deviation to a price salient, salience constrained configuration is not profitable.

  Note first that the condition $c_1/c_2 < 1/2$ implies (in fact is equivalent to) the condition $q_2^* < A_2^*/c_1$. This means that firm 1 can set quality at the salience constraint, $q_1^* = A_2^*/c_1$ so that $q_2^* < q_1^*$ and a quality salient configuration ensues. Whether the salience constraint or the participation constraint binds, and thus the type of equilibrium that arises, then depend on the ranking of $1/\delta c_1$ relative to q_2^* and A_2^*/c_1. We now examine all three possible cases:

  - When $q_2^* < 1/\delta c_1 < A_2^*/c_1$, the participation constraint binds (QP configuration). The participation constraint binds because $A_2^* > 1/\delta$, so firm 1 sets $q_1^* = 1/\delta c_1$. Moreover, the inequalities above restrict q_2^* to the interval $q_2^* \in [2/\delta c_2, 1/\delta c_1]$. We now show that these configurations are equilibria if and only if firm 1's average cost is low, $A_1^* < \delta$ (namely, $\delta^2 > 1/2$), *and* its cost advantage is sufficiently large, $\frac{c_1}{c_2} < \frac{2}{\delta^2}\left(1 - \frac{1}{2\delta^2}\right)$. To start, note that $A_1^* = 1/2\delta$, so there are two cases for firm 2's deviations:

    * if $A_1^* > \delta$, namely if the average cost of q_1^* is large (i.e. iff $\delta^2 < 1/2$), firm 2 can always deviate to a PS configuration. In this case, firm 2 sets $\widehat{q}_2 = \frac{A_1^*}{c_2}$ which satisfies $\widehat{q}_2 < q_1$. Moreover, it is easy to check that $\widehat{A}_2 = A_1^*/2$ and $\widehat{p}_2 = \delta(\widehat{q}_2 - q_1^*) + c_1(q_1^*)$ satisfies $\widehat{p}_2 = 1/4\delta^2 c_2 > c_2(\widehat{q}_2)$. By construction, the good $(\widehat{q}_2, -\widehat{p}_2)$ is chosen (satisfies the participation constraint) when compared to $(q_1^*, -c_1(q_1^*))$.
    * if $A_1^* < \delta$ (namely, $\delta^2 > 1/2$) firm 2 may deviate to a PP configuration, setting $\widehat{q}_2 = \delta/c_2$. This satisfies $\widehat{q}_2 < q_1^*$, as well as $\widehat{A}_2 = \delta/2 < A_1^*$. The

profitability condition $\widehat{p}_2 > c_2(\widehat{q}_2)$ reads $\frac{c_1}{c_2} > \frac{2}{\delta^2}\left(1 - \frac{1}{2\delta^2}\right)$. The constraint on A_1^* ensures the right hand side is always positive, and ranges from 0 to 1. So this configuration is an equilibrium only if c_1/c_2 is sufficiently low, $\frac{c_1}{c_2} < \frac{2}{\delta^2}\left(1 - \frac{1}{2\delta^2}\right)$. This condition requires $\delta^2 > 1/2$, which – as noted above – is satisfied exactly when the relevant constraint $A_1^* < \delta$ holds.

* because of Lemma 2 we need not check deviations to quality salient equilibria. We need also not check for deviations to homogeneous quality goods, since in the price setting stage the low cost firm would always win the competition.

- When $q_2^* < A_2^*/c_1 < 1/\delta c_1$, the salience constraint binds (QS configuration), because $A_2^* < 1/\delta$, so firm 1 sets $q_1^* = A_2^*/c_1 = \frac{c_2}{2c_1} q_2^*$. We now show that such equilibria always exist, and are indexed by q_2^* in the interval $\left[\frac{2\delta}{c_2}, \frac{2\delta}{c_1}\left(1 + \sqrt{1 - \frac{c_1}{c_2}}\right)\right]$. To see this, note that $A_1^* = A_2^*/2 < 1/2\delta$, so there are again two cases for firm 2's deviations:

  * if $A_1^* > \delta$, firm 2 can again always deviate to a PS configuration. It sets $\widehat{q}_2 = \frac{A_1^*}{c_2}$ which satisfies $\widehat{q}_2 < q_1$ as well as $\widehat{A}_2 = A_1^*/2$ and $\widehat{p}_2 = 2c_2(\widehat{q}_2)$. We also check that $\widehat{p}_2 = \frac{A_2^{*2}}{4c_2} < \frac{A_2^{*2}}{2c_1} < c_1(q_1^*)$:
  * $A_1^* < \delta$ if and only if $A_2^* < 2\delta$. Firm 2 may deviate to a PP configuration, setting $\widehat{q}_2 = \delta/c_2$. This satisfies $\widehat{A}_2 < A_1^*$ if and only if $A_2^* > \delta$ (this condition also guarantees $\widehat{q}_2 < q_1^*$). The profitability condition $\widehat{p}_2 > c_2(\widehat{q}_2)$ then reads $\frac{c_1}{c_2} > \frac{2A_2^*}{\delta^2}\left(\delta - \frac{A_2^*}{2}\right)$. The constraint on A_1^* ensures the right hand side is always positive, and in fact it ranges from 0 to 1. Replacing the $A_2^* = c_2 q_2^*/2$ we find that the pricing constraint is satisfied if and only if q_2^* lies outside the interval $\left[q_2^{*-}, q_2^{*+}\right]$, where $q_2^{*\pm} = \frac{2\delta}{c_1}\left(1 \pm \sqrt{1 - \frac{c_1}{c_2}}\right)$. Recall, however, that the salience constraint requires $A_2^* > \delta$ namely $q_2^* > \frac{2\delta}{c_2}$. Since $\frac{2\delta}{c_2} > q_2^{*-}$, we get the result.

- Finally, consider the case where $1/\delta c_1 < q_2^* < A_2^*/c_1$. Then, the best response of firm 1 featuring a salient quality advantage (namely $q_1^* = 1/\delta c_1$) pushes firm 1 to a lower quality, while the best response featuring a salient price advantage (namely $q_1^* = A_2^*/c_1$) pushes firm 1 to a higher quality: firm 1 cannot optimise the first order conditions within a strict salience ranking. Instead, it can set $q_1^* = q_2^*$

and $p_1^* = c_2(q_2^*)$. Because in this case the goods are homogeneous, quality and price are equally salient. When is this an equilibrium? If $A_1^* > \delta$, firm 2 can deviate, as in the cases above. Consider the case $A_1^* < \delta$, which requires $\delta^2 > 1/2$. Then firm 2 deviates to a PP configuration, $\widehat{q}_2 = \delta/c_2$, which trivially satisfies $\widehat{q}_2 < q_1^*$ and $\widehat{A}_2 = \delta/2 <$. Profitability of this deviation requires $\widehat{p}_2 > c_2(\widehat{q}_2)$, which reads $\frac{\delta^2}{2c_2} > q_1^*\left(\delta - \frac{c_1 q_1^*}{2}\right)$. The right hand side is maximised at q_1^*'s lower bound $1/\delta c_1$. Then the condition reads $\frac{c_1}{c_2} > \frac{2}{\delta^2}\left(1 - \frac{1}{2\delta^2}\right)$. By continuity with the QP case above, if this condition holds there exist equilibria with homogeneous goods. Such equilibria exist only under some ranges of the model's parameters: it requires both $\delta^2 > 1/2$ and $\frac{c_1}{c_2} < \frac{2}{\delta^2}\left(1 - \frac{1}{2\delta^2}\right)$.

- Step 2b: equilibrium conditions when $c_1/c_2 > 1/2$. According to step 1 above, any equilibrium must be price salient. Under what conditions does firm 2 have no incentive to deviate? Similar to the above, we now show that firm 2 can profitably deviate whenever the quality provision of firm 1 (and hence its average cost) is large. However, the equilibrium is sustained for lower quality levels, when firm 2's deviation to price salient, salience constrained configuration is not profitable.

  Note that the condition $c_1/c_2 > 1/2$ implies (in fact it is equivalent to) the condition $q_2^* > A_2^*/c_1$. Therefore, firm 1 can set quality at the salience constraint, $q_1^* = A_2^*/c_1$ so that $q_1^* < q_2^*$ and a price salient configuration ensues. Whether the salience constraint or the participation constraint binds then depends on the ranking of δ/c_1 relative to A_2^*/c_1 and q_2^*. We now examine all three possible cases:

  The condition $c_1/c_2 > 1/2$ holds if and only if $q_2^* > A_2^*/c_1$, so that if salience binds firm 1's best response, then $q_2^* > q_1^*$. The binding constraints, and thus the type of equilibrium that arises, then depend on the ranking of δ/c_1 relative to q_2^* and A_2^*/c_1.

  – When $\delta/c_1 < A_2^*/c_1 < q_2^*$, the salience constraint binds (PS configuration), because $A_2^* > \delta$, so firm 1 sets $q_1^* = A_2^*/c_1$. As before, there are two cases for firm 2's deviations:

    ∗ if $A_1^* > \delta$, firm 2 can always deviate to a PS configuration. In fact, firm 2 sets $\widehat{q}_2 = \frac{A_1^*}{c_2}$ which satisfies $\widehat{q}_2 < q_1$ provided $c_1/c_2 < 1/2$. Moreover, it is easy to check that $\widehat{A}_2 = A_1^*/2$ and $\widehat{p}_2 = 2c_2(\widehat{q}_2)$. Finally, we check that $\widehat{p}_2 = \frac{A_2^{*2}}{4c_2} < \frac{A_2^{*2}}{2c_1} = c_1(q_1^*)$.

  * if $A_1^* < \delta$, firm 2 can never deviate to a PP configuration. Setting $\widehat{q}_2 = \delta/c_2$ satisfies $\widehat{q}_2 < q_1^*$ provided $q_2^* > \frac{\delta}{c_2} \cdot \frac{2c_1}{c_2}$. The profitability condition $\widehat{p}_2 > c_2(\widehat{q}_2)$ reads, as above, $\frac{c_1}{c_2} > \frac{2A_2^*}{\delta^2}\left(\delta - \frac{A_2^*}{2}\right)$. However, given the lower bound on q_2^* and thus on the average cost $A_2^* > \delta c_1/c_2$, the deviation is never profitable while $c_1 < c_2$.

- When $A_2^*/c_1 < \delta/c_1 < q_2^*$, the participation constraint binds (PP configuration), because $A_2^* < \delta$, so firm 1 sets $q_1^* = \delta/c_1$. Lemma 9 shows that in this case no profitable deviations exist for firm 2. As a consequence, such equilibria always exist.

- Finally, consider the case where $A_2^*/c_1 < q_2^* < \delta/c_1$. In this case, firm 1 cannot optimise the first order conditions within a strict salience ranking. Instead, it can opt for homogeneous goods, $q_1^* = q_2^*$ and $p_1^* = c_2(q_2^*)$, such that quality and price are equally salient. To see that firm 2 has no incentive to deviate, note that $A_1^* < \delta/2$. This means that firm 2 tries to deviate to a PP configuration with $\widehat{q}_2 = \delta/c_2$. Even assuming that $\widehat{q}_2 < q_2^*$ (which is not guaranteed), we find that $\widehat{A}_2 = \delta/2 > A_1^*$ so this move backfires. As a consequence, such equilibria always exist.

■