Signals Sell: Product Lines when Consumers Differ Both in Taste for Quality and Image Concern

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Signals sell: Product lines when consumers differ both in taste for quality and image concern*

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Abstract

This paper analyzes optimal product lines when consumers differ both in their taste for quality and in their desire for social image. The market outcome features partial pooling and product differentiation that is not driven by heterogeneous valuations for quality but by image concerns. A typical monopoly outcome is a two-tier product line resembling a "masstige" strategy as observed in luxury goods markets. Products can have identical quality and differ only in price and image, thereby rationalizing quality-equivalent line extensions. Under competition, both average quality and market coverage are (weakly) higher but monopoly can yield higher welfare than competition.

JEL classification: L12, L15, D11, D21, D82

Keywords: image concern, conspicuous consumption, two-dimensional screening, nonlinear pricing

"People buy things not only for what they can do, but also for what they mean."
-Levy (1959)-

1 Introduction

Consumption is about the satisfaction of needs. These needs are partly addressed by the physical nature of products, their *quality*, but consumption also satisfies the consumer's desire for social recognition (e.g., Campbell, 1995, pp. 111ff). It is well-documented empirically that consumers indeed pay for their social image by demonstrating their wealth or status through their purchases (e.g. Charles et al., 2009; Heffetz, 2011).[1] Apart from wealth, consumers increasingly seek to advertise virtue or taste (Griskevicius et al., 2010; Miller, 2009; Puska et al., 2016, and also

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[1] Field experiments show that social image concerns influence behavior in a variety of domains including consumption (Bursztyn and Jensen, 2017). Consumers may also use their consumption to influence production (The Economist, 2006) or to realize expressive utility (Hillman, 2010).

The Economist, 2010).[2] Indeed, signaling to be rich, of high status, or pro-social is shown to be valuable in future interactions (e.g. Nelissen and Meijers, 2011; Lee et al., 2015; Fehrler and Przepiorka, 2016).

Anecdotal evidence suggests that firms strategically tailor their products to the consumers' signaling desires. For instance, "Toyota's Prius hybrid car is not only green; it is also instantly recognisable as such" (The Economist, 2010); it sold very well because consumers felt it was making a statement about them (The New York Times, 2007). Moreover, consumers were willing to pay a considerable price premium to signal their environmental bona fides by choosing a Prius over other hybrid cars (Sexton and Sexton, 2014; Delgado et al., 2015). The soft drinks "ChariTea" and "LemonAid" appeal to non-consumption values by linking the name of the drink with charitable acts and sell particularly well for more visible out-of-home consumption. See example 1 in Section 5 for details. The fashion industry, wine producers, technology companies, health clubs, and hotel groups segment their markets by offering products that appeal to different groups of people and their signaling desires.[3] As discussed below, economic research on supply side reactions to image concerns is scarce and typically makes strong assumptions about how image concerns relate to wealth or intrinsic preferences. The empirical evidence, however, indicates that image concerns are heterogeneous in nontrivial ways,[4] implying that we need models that can deal with various correlation structures.

This paper contributes to filling this gap by studying the effects of image concerns on market outcomes in both monopoly and competition with two-dimensional heterogeneity. Specifically, I set up a tractable model where consumers differ both in their intrinsic valuations of quality and their desire for the social image that is associated with a product, without imposing any specific correlation structure. The social image of a product is the expected taste for quality of someone purchasing the respective product and emerges endogenously from the consumption decisions of individual consumers. The notion of quality is general here, such that quality can, e.g., also refer to the extent to which production is environmentally friendly. In this case, a product's image is informative about a consumer's attitude toward the environment as in the Prius example. An individual's intrinsic taste for quality may be driven by differences in wealth or in preferences. Motivated by models of pro-social signaling (Bénabou and Tirole, 2006) and conspicuous conservation (Sexton and Sexton, 2014), I use the preference interpretation throughout the paper, which best fits the context of environmental or ethical purchases as well as fashion, and return to the wealth interpretation in Section 4. The model abstracts from the reasons why consumers care about their social image. In line with this reduced form approach, the evidence shows that social image provides hedonic utility (Bursztyn et al., 2017)

[2] Following Bourdieu (1984), tastes can be understood as markers of social class because they constitute an individual's "capacity to differentiate and appreciate these practices and products" (Bourdieu, 1984, p.166), which is itself influenced not only by an individual's economic position but also by her education, family background, and socialization. See Elliott (2013) for an analysis of status differentiation through green consumption.

[3] Whereas differentiation may partially be motivated by differential tastes for quality, the resulting differentiated images are themselves valued by customers, and allow larger price differences across products than those that could be justified by the quality differential alone. More detailed examples are contained in Section 5.

[4] Individuals may differ in their net image concern because the expected return to showing off differs depending on the social context (see, e.g., Charles et al., 2009; Kaus, 2013) or because the expected cost of showing off differs (e.g., due to different rates of property crime as in Mejía and Restrepo, 2016).

and consumption of observable goods is found to correlate with higher well-being (Perez-Truglia, 2013).[5]

The first part of the paper concentrates on a monopolistic market that captures an essential aspect of status goods, namely their inimitability. In order to study how a producer with market power strategically adjusts its product line in response to consumers' image concerns, I extend a monopolistic model of quality provision (Mussa and Rosen, 1978) to allow for heterogeneity on the consumer side in both preferences for quality and in image motivation. As images cannot be chosen freely but are endogenously determined by consumer choices, the problem differs from the two-dimensional screening problem analyzed in Armstrong and Rochet (1999), and separation or even deterministic allocations are not necessarily optimal. The analysis of this two-dimensional screening problem reveals that a monopolist reacts to heterogeneous image concerns by designing a product line that induces a partial pooling of consumers. Typically, the line features product differentiation that is not justified by the differences in tastes for quality alone. The length of the product line depends on the extent of partial pooling and reacts non-monotonically to the value of image; product variety first increases and then decreases with increasing weight on image.

Specifically, for low image concerns, the firm offers the same product line as if image concerns did not exist (*standard good*), thus partially pooling along the dimension of image concerns. For intermediate image concerns, the firm offers an *image-building* product line, comprising a low-quality and a high-quality product. The high-quality product's price reflects an image premium and is attractive only to consumers who value both quality and image, and who, due to their separation, obtain a higher image than the pool of consumers buying low quality. The low-quality product allows the firm to profitably screen consumers with respect to their willingness-to-pay a premium for image. Here, partial pooling takes the following form: Consumers who value quality but who do not care about their image purchase the same low-quality product as consumers who do not care about quality but who strongly value the social image associated with their purchase. Thus, the low-quality product provides image to those who value it by pooling them with consumers who have a high taste for quality. At the same time, the externality imposed on those providing the image is minimized because these are consumers who do not value image. If image is relatively valuable, low and high quality in the image-building product line are identical but prices differ. Even though the two products are physically identical in this case, consumers who value both quality and their image self-select toward the high-price product because of the associated image. Finally, for high image concerns, the firm offers an *exclusive* high quality product that is only bought by consumers who value image in addition to quality. In this case, all other consumer types pool on the outside option, i.e., buy nothing.

Since in the long run, substitutes that also confer image may evolve, I then develop and analyze a model of image concerns in a perfectly competitive market (Section 3). Doing so allows me to disentangle the effects of consumers' image concerns from those due to the supply response of a (monopolistic) producer that can use its entire product line to screen consumers with respect to their image concerns. I show that firms operating in perfect competition cannot

[5] Social image can be of instrumental value as being perceived as "good" increases an agent's matching opportunities and future payoffs (see Pesendorfer, 1995; Rege, 2008, and the empirical evidence cited above).

exploit image concerns to make positive profits. Still if the value of image is sufficiently high, image concerns remain relevant in a market where producers are price-takers, but the predicted distortions are different than in monopoly. The reason is that competition drives prices down to marginal cost so that consumers cannot use prices to signal their interest in quality, which is what a monopolist's product line would encourage them to do. Instead, consumers who value both image and quality buy inefficiently high quality, which serves as a *functional excuse* to separate from lower valuation consumers. Such a superior quality product is too expensive for purely image-concerned consumers even if it is sold at marginal cost. Purely image-concerned consumers pool with purely quality-concerned consumers on a cheaper product, which is of the same quality as the high-quality product in monopoly.

The theoretical findings imply that firms are charging consumers not only for costly physical quality provision but also for the symbolic values of their products and that they use their entire product lines to increase the profit from these symbolic values. As a consequence, policy makers need to be aware of the potentially adverse interactions of image concerns, market structure, and policy. Whereas quality is, on average, higher in competition than in monopoly, welfare is often higher in monopoly than in competition. The reason is that consumers buy excessive quality in the competitive market in order to acquire a good image, but producing these quality levels and, therefore, this way of signaling, is inefficient. A monopolist allows for less wasteful signaling by restricting the product line. While the monopoly does not maximize welfare, a simple quality regulation does not necessarily increase consumer surplus, while often decreasing total welfare. In a competitive market, a luxury tax on the upward distorted high-quality product strictly increases welfare but does not yield, in general, a Pareto improvement. The analysis also shows that awareness raising campaigns for, e.g., sustainable products may backfire by deteriorating the provision of these products. These counterintuitive effects of policy stem from the firm strategically adjusting its product line in response to policy.

The paper furthers our understanding of several empirical phenomena. First, if those with lower tastes for quality care more about their social image than those with a higher taste for quality, as is suggested by empirical evidence,[6] the model predicts an image-building product line which rationalizes the phenomenon of "masstige" products in image goods markets (Truong et al., 2009; Heine, 2012). "Masstige" products deliver prestige to the masses by offering a compromise between luxury and non-luxury goods in terms of price, quality, and prestige.[7] Second, by showing how prices and images alone can be used to screen different consumer types, the model provides a new rationale why manufacturers have found it profitable to introduce quality-equivalent line extensions across most consumer good categories (Connor and Peterson, 1992).[8]

[6] Indirect evidence of such a negative correlation between intrinsic motives and signaling comes from Truong and McColl (2011) (luxury consumption), Vermeir and Verbeke (2006) (socially responsible consumption), Riedl and Smeets (2017) (professional financial investing), and Filippin et al. (2013); Boyer et al. (2016); Dwenger et al. (2016) (tax avoidance). In a laboratory experiment designed to test for heterogeneous image concerns, Friedrichsen and Engelmann (2018) find a strong negative relationship between preferences for Fairtrade products and the desire to signal support for Fairtrade. These findings are consistent with social image being a substitute for self-image as found and discussed also in Bursztyn et al. (2017).

[7] The introduction of "masstige" products has been documented for luxury and fashion markets (cf. Heine, 2012). Note that a negative correlation is a sufficient condition for the existence of an image-building product line but not a necessary condition.

[8] The literature offers competitive pressure (Johnson and Myatt, 2003) and discriminatory advertising (Soberman and Parker, 2006) as alternative explanations for line extensions. The first approach cannot explain the

Third, the model also offers a new explanation for the so-called attitude-behavior-gap in sustainable consumption (Vermeir and Verbeke, 2006) and for the fact that high prices are perceived as a major obstacle to further growth in organic consumption (Aschemann-Witzel and Zielke, 2015). Acknowledging that image concerns are highly relevant for sustainable consumption (Aagerup and Nilsson, 2016), both observations are jointly rationalized by the market outcome described by the exclusive good case, in which a fraction of consumers who have a high taste for sustainability decide not to purchase a highly sustainable product because they do not care about their image. Finally, the competitive model helps to understand why long-standing actors in sustainable production have introduced their own standards above the one implemented in mainstream retailing.[9] As the signaling value of sustainable consumption increased in response to increased public attention to environmental and social issues, competitive firms responded to the consumers' desire for social image by increasing their quality, thereby moving the market to a functional excuse equilibrium. Consistent with the evidence, the market share of sustainable products increases but the quality of sustainable products varies.[10]

Relation to literature While a large number of theoretical studies investigate how consumer behavior is affected by such status concerns (Veblen, 1915; Ireland, 1994; Bagwell and Bernheim, 1996; Glazer and Konrad, 1996; Corneo and Jeanne, 1997), supply responses receive much less attention. Moreover, a large body of both theoretical and empirical economic research investigates how (non-consumer) behavior is shaped by a desire to appear as a pro-social type (e.g. Harbaugh, 1998; Bénabou and Tirole, 2006; Andreoni and Bernheim, 2009; Ariely et al., 2009), but again the implications for consumer and firm behavior and strategic design are largely unexplored. To the best of my knowledge, this paper is the first to study the implications of image concerns on quality provision in a setup that allows for arbitrary correlations between image concerns and tastes for quality. It yields insights that can also be applied to the design of charitable giving schemes when potential donors differ in their intrinsic motivation to give and their desire for social recognition.

Rayo (2013) studies the optimal design of prices and signals when consumers care about status as the posterior of a consumer's type and the goods have no intrinsic value apart from the associated status. He then extends the analysis to the case where goods deliver intrinsic utility through a product's quality in addition to status under the assumption that marginal utility of quality and marginal utility of status are proportional to each other, thereby precluding not only the empirically relevant case that the desire to signal is (weakly) negatively correlated with the consumer's wealth but also the cases of a weak positive correlation and of independence. This proportionality assumption implies that image concerns affect only prices whereas the quality schedule is identical to the one in a model of quality provision without image concerns

puzzling case where a line extension has the same quality, and the second approach assumes heterogeneous preferences for advertising but identical tastes for quality, so that differentiation along the quality dimension is not to be expected.

[9] See for instance `http://fair-plus.de/`, and Guardian (2008) on Fairtrade, and `http://www.ifoam.org/sub/faq.html` for organic products.

[10] An increase in the valuations for Fairtrade and organic products would similarly predict an increase in the available quality. However, if consumers value only quality, it is puzzling that a low-quality alternative persists and possible even worsens, as has been the case with the simultaneous introduction of own-brand labeled products by discounters. In contrast, their joint occurrence exactly matches the predictions of the present model.

(e.g. Mussa and Rosen, 1978) because it effectively transforms the two-dimensional model into a one-dimensional one. As in the one-dimensional model, Rayo (2013) predicts pooling if and only if the firm's marginal revenue function is somewhere decreasing in consumer type. This corresponds to a violation of the assumption that the hazard rate of the type distribution is increasing, see, e.g., "bunching and ironing" in Bolton and Dewatripont (2004, p. 88ff) and does not relate to image concerns. Board (2009) investigates how a firm designs groups by setting a menu of access prices when agents care about peer effects and can self-select into their preferred group, assuming that an individual's utility from the peer effect and her marginal contribution to the peer effect are perfectly correlated.

The assumptions that all consumers value image to the same extent or that the valuation of quality and image are proportional or perfectly positively correlated both come with a loss of generality. Relaxing these assumptions, I find that image concerns typically affect not only prices but also the set and levels of qualities while existing work (e.g., Rayo, 2013) found effects on prices only. The intuition is as follows: The quality schedule helps to induce a certain sorting of consumers, which itself affects the prices that the firm can charge. As the consumers who are willing to pay for image are not necessarily those who are willing to pay for quality, and, therefore, are not those who contribute to a good image, the quality schedule may differ from the one in a model without this heterogeneity in image concerns. A similar effect of the sorting on firm profits that is absent from one-dimensional screening models drives also the firm's choices in Veiga and Weyl (2016), who model an insurance market where consumers differ in taste for quality and cost of being served. While the firm in their model offers one product of endogenous quality, my model solves for a product line with an endogenous menu of qualities. My model then predicts the partial pooling of opposite tastes for quality because consumers value their images differently so that the allocation of images is not a zero-sum game.

My model focuses on second-degree price discrimination when consumers desire to signal an unobservable trait like taste, wealth, or prosociality. It is complementary to existing papers on conspicuous consumption, which investigate targeted advertising to status-conscious consumers (Vikander, 2011), strategic visibility (Yoganarasimhan, 2012; Carbajal et al., 2015), brand differentiation when brands are pure status goods and the development of a new brand involves a fixed cost (Mazali and Rodrigues-Neto, 2013), and strategies of artificial scarcity (Amaldoss and Jain, 2010). In a dynamic model by Pesendorfer (1995), consumers may purchase a design that sends a signal about their type and thereby affects future matching opportunities. The producer reacts to consumers' status concerns by inducing "fashion cycles," i.e., by regularly introducing a new design after the old one has become too widespread. These models do not allow the producer to design a line of multiple quality-differentiated products.

The utility representation in my model is similar to the one used in Bernheim (1994) where intrinsic utility and image also enter utility additively. Apart from that, the models differ substantially as Bernheim (1994) imposes a homogeneous interest in status and analyzes how individuals adjust their behavior if unrestricted. My paper allows for heterogeneous interests in image and analyzes how the supply side reacts to consumers' status concerns by manipulating the signaling possibilities in the market. It thereby sheds light on a hitherto underresearched aspect of conspicuous consumption.

Finally, this paper also proposes an approach to study image concerns in perfectly competitive markets and shows that then prices equal marginal costs but quality can be distorted upward. These findings complement those of Diaz-Diaz and Rayo (2009), who analyze a duopoly model under the assumption that firms offer fully separating product lines. They find that firms use a combination of supra-normal markups and upward-distortions in quality to address consumers' image concerns. In the light of my results from monopoly and competition, these results can be understood as a combination of the effects from market power and competition, which is what we would expect in an imperfectly competitive environment.

Outline The rest of the paper is structured as follows. Section 2 introduces the monopolistic model and derives the equilibrium with heterogeneous image concerns. Section 3 then studies heterogeneous image concerns in a competitive market, and compares both market structures with respect to welfare. Section 4 discusses how the model can address both wealth and taste heterogeneity or a generalization of the type space, relates the partial pooling results to other pooling results in the literature, and discusses how the results relate to one-dimensional screening models with more than two types. Section 5 provides details for several empirical examples before Section 6 concludes. All proofs that do not appear in the main text are included in Appendix A. Additional results and robustness checks are available in the supplementary material (Appendices B to D).

2 Monopolistic product line design

Consider a monopoly firm that sells products of potentially different quality to a unit mass population of heterogeneous consumers. Monopoly captures an essential aspect of status goods, namely their inimitability, and could reflect a firm with market power when it comes to wine, luxuries, or technology. Alternatively, in the case of food items, we can think of a supermarket chain that is deciding which product qualities to slot within a certain category and what prices to charge. A product is a combination of quality and price and is in equilibrium associated with an image that reflects which consumer types buy the respective product.

The **firm** offers a product line $\mathcal{M} \subset \mathbb{R}^2_{\geq 0}$ to maximize expected profit.[11] Perfect price discrimination is impossible because consumers are privately informed about their types. The firm has a prior belief about the distribution of consumer types that is identical with the actual distribution and it designs the product line such that consumers self-select (second-degree price discrimination). The firm cannot choose image directly, but takes into account which image will be associated with each of its products in equilibrium. Quality is chosen by the firm on a continuous scale, it is perfectly observable, and it is correctly perceived by consumers; cheating on quality is prevented e.g. through third-party verification or because it is obvious from inspection. Unit costs are constant in quantity sold and convex and increasing in quality. Specifically let $c(s) = \frac{1}{2}s^2$ for simplicity, where $s \in \mathbb{R}_{\geq 0}$ is the quality of a product.

Consumers' utility depends positively on quality $s \in \mathbb{R}_{\geq 0}$ and image $R \in [0, 1]$, and negatively on price $p \in \mathbb{R}_{\geq 0}$. Consumers can differ in both their taste for quality σ and their

[11] With slight abuse of notation, I do not distinguish between the sets of offered and accepted products but denote both by $\mathcal{M}$.

image concern ρ. The two-dimensional type (σ, ρ) is drawn from $\{\sigma_L, \sigma_H\} \times \{0, 1\}$ with $\text{Prob}(\sigma = \sigma_H) = \beta$, $\text{Prob}(\rho = 1|\sigma = \sigma_H) = \alpha_s$, and $\text{Prob}(\rho = 1|\sigma = \sigma_L) = \alpha_n$. Image concerns and taste for quality are negatively correlated if and only if $\alpha_n > \alpha_s$. To simplify the exposition, I work with $\sigma_L = 0$ and $\sigma_H = 1$. The results are qualitatively unchanged when allowing for $\sigma_H > \sigma_L > 0$.[12] For a consumer of type (σ, ρ), indirect utility takes the form:

$$U_{\sigma\rho}(s, p, R) = \sigma s + \rho\lambda R - p \tag{1}$$

The parameter $\lambda > 0$ describes the value of image relative to the marginal utility from quality. The image $R(s, p, \mathcal{M})$ associated with (s, p) from product line $\mathcal{M}$ is determined by the belief function $\mu_{\mathcal{M}}$. For every product line $\mathcal{M}$, $\mu_{\mathcal{M}} : \mathcal{M} \to [0, 1]$ assigns to each product $(s, p) \in \mathcal{M}$ the probability that a consumer purchasing this product values quality (i.e., $\sigma = 1$). Beliefs are identical for all consumers. Since there is a belief function for each product line, the same product occurring in different product lines can be associated with different beliefs.

Each consumer chooses a product from the line or decides not to buy any of them. The latter case corresponds to obtaining an outside good of zero quality at a price of zero. Reservation utility is then equal to the utility derived from the image of non-buyers (= outside good buyers), which is also endogenous. For every product line $\mathcal{M} \in \mathcal{P}(\mathbb{R}^2_{\geq 0})$, the choice functions $b^{\sigma\rho}_{\mathcal{M}} : \mathcal{M} \to \Delta(\mathcal{M})$ state the probability with which product $(s, p) \in \mathcal{M}$ is chosen by consumer type (σ, ρ). For ease of notation, I will drop the parentheses and index consumers by $\sigma\rho$.

Structure The distribution of σ and ρ, the value of λ, and the setup of the market interaction are common knowledge. Consumers privately know their types. The timing is as follows:

(i) The firm offers a product line $\mathcal{M}$.

(ii) All consumers simultaneously choose a product $(s_{\sigma\rho}, p_{\sigma\rho}) \in \mathcal{M}$ that maximizes utility for their type $\sigma\rho$.

(iii) Images associated with each product and payoffs realize.

In the presence of image concerns, the utility of a consumer not only depends on her action but also on beliefs about her type. Thus, the product line offered by the firm induces a game among consumers.[13] Consumers who value image have an incentive to buy a product that they believe is bought by consumers with an intrinsic interest in quality, since this signals caring about quality and is rewarded with a higher image. Image is not directly linked to product quality or a consumer's type but is determined by the partition of consumers on products.

[12] See Appendix D.1. Supplementary material regarding this generalization is available at `https://janafriedrichsen.wordpress.com/research/`.

[13] It is a *perception game* as introduced by Gradwohl and Smorodinsky (2017). Formally, images are a consumer's perception of the beliefs that an implicit third player forms about her type after consumption decisions have been executed. This inactive third player may exists in reality or only in the consumer's imagination. The model can be rephrased such that the consumption stage contains a signaling model à la Spence (1973) by including an explicit third player who rewards the consumer based on her social image and himself is payed for accurately predicting a consumer's taste for quality.

Equilibrium In equilibrium the belief function $\mu_{\mathcal{M}}$ and, thereby, images must reflect the actual distribution of types, i.e., be consistent with Bayes' rule. If a product is chosen with positive probability, the belief $\mu_{\mathcal{M}}$ must fulfill

$$\begin{aligned} \mu_{\mathcal{M}}(s,p) &= \text{Prob}\,(\sigma = 1|(s,p) \text{ is choosen from } \mathcal{M}) \\ &= \frac{\beta\alpha_s b^{11}_{\mathcal{M}}(s,p)+\beta(1-\alpha_s)b^{10}_{\mathcal{M}}(s,p)}{\beta\alpha_s b^{11}_{\mathcal{M}}(s,p)+\beta(1-\alpha_s)b^{10}_{\mathcal{M}}(s,p)+(1-\beta)\alpha_n b^{01}_{\mathcal{M}}(s,p)+(1-\beta)(1-\alpha_n)b^{00}_{\mathcal{M}}(s,p)} \end{aligned} \tag{2}$$

Definition 1. *Given any product line $\mathcal{M}$, an equilibrium in the consumption stage is a set of functions $b^{\sigma\rho}_{\mathcal{M}} : \mathcal{M} \to \Delta(\mathcal{M})$ for $\sigma, \rho \in \{0,1\}$ and $\mu_{\mathcal{M}} : \mathcal{M} \to [0,1]$, such that*

(i) $b^{\sigma\rho}_{\mathcal{M}}(s,p) > 0 \implies (s,p) \in \arg\max_{(s',p')\in\mathcal{M}} \sigma s' + \rho\lambda R(s',p',\mathcal{M}) - p'$ *and* $\sum_{(s,p)\in\mathcal{M}} b^{\sigma\rho}_{\mathcal{M}}(s,p) = 1$ *for* $\sigma,\rho \in \{0,1\}$ *(Utility maximization).*

(ii) $R(s,p,\mathcal{M}) = \mu_{\mathcal{M}}(s,p)$ *and* $\mu_{\mathcal{M}}$ *is defined in (2) if* (s,p) *is chosen with positive probability, and* $\mu_{\mathcal{M}} \in [0,1]$ *otherwise (Bayesian Inference).*

To simplify notation in the following, the argument $\mathcal{M}$ in the image is dropped unless this creates ambiguities. Furthermore, I restrict attention to cases where the firm's product line induces deterministic purchasing decisions for expositional clarity. While mixed strategies are required to prove existence of equilibrium in every subgame, the product lines for which only mixed-strategy equilibria exist are typically not profitable to the firm. Even if they are, the results remain qualitatively unchanged. The proof of equilibrium existence and the complete analysis with mixed strategies are contained in the supplementary material (B).

Assumption 1. *Purchases are deterministic, $b^{\sigma\rho}(s,p) \in \{0,1\}$ for all (s,p).*

The firm then solves the following problem:

$$\begin{aligned} &\max_{\mathcal{M}} && \sum_{\sigma,\rho\in\{0,1\}} \sum_{(s,p)\in\mathcal{M}} \text{Prob}(\sigma,\rho) b^{\sigma\rho}_{\mathcal{M}}(s,p)(p - c(s)) \\ &\text{s.t.} && \\ &(IC_{\sigma\rho-\sigma'\rho'}) && \sigma s_{\sigma\rho} + \rho\lambda R(s_{\sigma\rho}, p_{\sigma\rho}) - p_{\sigma\rho} \geq \sigma s_{\sigma'\rho'} + \rho\lambda R(s_{\sigma'\rho'}, p_{\sigma'\rho'}) - p_{\sigma'\rho'} \\ & && \quad \text{for } \sigma,\rho,\sigma',\rho' \in \{0,1\} \text{ and } (\sigma,\rho) \neq (\sigma',\rho') \\ &(PC_{\sigma\rho}) && \sigma s_{\sigma\rho} + \rho\lambda R(s_{\sigma\rho}, p_{\sigma\rho}) - p_{\sigma\rho} \geq \rho\lambda R(0,0) \quad \text{for } \sigma,\rho \in \{0,1\} \\ &(BI) && R(s_{\sigma\rho}, p_{\sigma\rho}) = \text{Prob}\,(\sigma|(s_{\sigma\rho}, p_{\sigma\rho}) \text{ is choosen from } \mathcal{M}) \\ & && \quad \text{for all } (s_{\sigma\rho}, p_{\sigma\rho}) \in \mathcal{M}, \text{ and } \sigma,\rho \in \{0,1\} \text{ with } b^{\sigma\rho}_{\mathcal{M}}(s,p) > 0 \end{aligned} \tag{3}$$

An equilibrium of the complete game is given by a product line $\mathcal{M}$, choice functions $b^{\sigma\rho}_{\mathcal{M}}$ for $\sigma,\rho \in \{0,1\}$, and a belief function $\mu_{\mathcal{M}}$ such that among the feasible product lines, $\mathcal{M}$ gives the highest profit to the producer given that for each feasible product line consumer behavior is consistent with equilibrium as defined in Definition 1. I assume throughout that in case of multiple equilibria in the consumption stage, the preferred equilibrium of the firm is played, meaning that the firm effectively maximizes also over $\mu_{\mathcal{M}}$ in Problem 3. This assumption is not essential for the results (see Appendix D.2).

2.1 Benchmark with homogeneous image concerns

If all value their social image equally, the firm faces a one-dimensional screening problem where the allocation of image is a zero-sum game. In this case, image concerns do not influence the provision of quality but only prices.

Lemma 1. *If $\alpha_s = \alpha_n = 1$, the unique equilibrium is separating. Consumers buy $(1, 1+\lambda)$ if they value quality and $(0,0)$ otherwise. The images associated with the products in equilibrium are $R(0,0) = 0$ and $R(1, 1+\lambda) = 1$.*

The firm increases the prices charged to all consumers without changing the allocation of quality as compared to the case without image concerns. For each consumer, this **image-premium** equals the value of the image gained over the image of the next lower quality product. The consumer type who generates a better image, because he strongly values quality, values the associated image at least as much as the consumer with a lower taste for quality and, therefore, consumers are clearly ordered with respect to their willingness-to-pay for a product. Image concerns in this setting only reinforce the firm's desire to offer a separating product line. In contrast, the order of consumers with respect to their willingness-to-pay depends on the product line and the sorting of consumers if the valuations for image differ across consumers and are not perfectly aligned with tastes for quality.

2.2 Analysis with heterogeneous image concerns

Suppose now that consumers differ in both their marginal utility from quality $\sigma \in \{0, 1\}$ and their marginal utility from image $\rho \in \{0, 1\}$. Abstracting from less interesting non-generic cases, I assume that each of the four feasible consumer types is indeed present in the market.

Assumption 2. *All consumer types occur with positive probability, $\beta, \alpha_s, \alpha_n > 0$.*

The next pages will establish the equilibrium market outcome in monopoly. I begin the analysis by showing that the equilibrium needs to involve the partial pooling of consumers. To establish these results I consider the incentive compatibility constraints of consumer behavior and the firm's profit-maximizing behavior.

Lemma 2. *A fully separating equilibrium does not exist.*

Note that in a fully separating equilibrium all consumer types would be identified so that images are fixed. This implies that any product that could be offered to consumers who do not value quality gives them zero utility. In order to separate these consumer types, however, the monopolist cannot let them both choose $(0,0)$ but must offer a positive quality at a price of zero to either of the two types. This implies a loss to the monopolist, contradicts profit maximization and, therefore, cannot be part of an equilibrium. Separation with respect to image concerns is possible only with partial pooling along the quality preference.

Furthermore, it turns out that it is not profitable for the firm to offer pure image goods that would be bought by all image-concerned consumers, irrespective of their quality concern. Thus, pure image goods cannot occur in equilibrium.

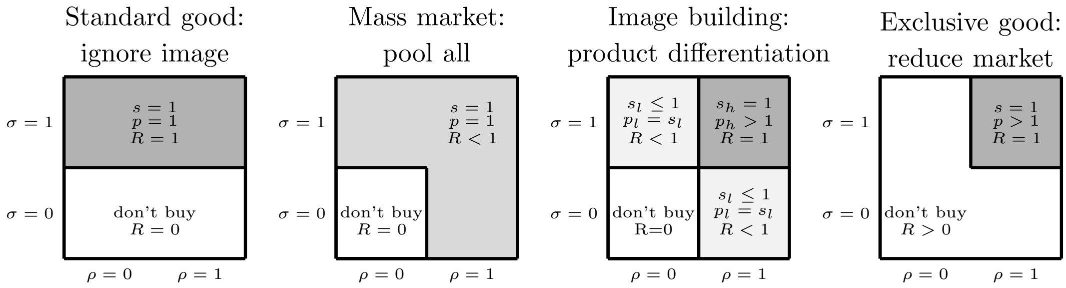

Figure 1: Possible market partitions in equilibrium.

Lemma 3. *A "pure image good" equilibrium in which image-concerned consumers, types 01 and 11, choose* $(s,p) \neq (0,0)$ *and those unconcerned with image, types 00 and 10, the outside good does not exist.*

A pure image good optimally features zero quality at a positive price because quality is costly to produce but not valued by the purely image-concerned consumer. The firm fully charges consumers for the value of their image gain without incurring any production costs. However, the purely image-concerned consumers lower the image associated with the pure image good whereas the costless outside option is also associated with a positive image because purely quality-concerned consumers choose it. The firm makes strictly higher profits by selling positive quality only to those who value image and quality (see exclusive good below). Doing so, it effectively pools the purely image-concerned with the purely quality-concerned consumers and with those who value neither quality nor image on the outside good. This not only improves the image of the good sold but also deteriorates the image on the outside good, such that the firm can extract a larger fraction of the image value, which is the same in both cases.[14] Consequently, only selling image to those consumers who value both image and quality already yields strictly higher profit then selling a pure image good to all image-concerned consumers. The firm can further increase its profit by producing a positive quality product (instead of a pure image good with zero quality) that allows it to charge an even higher price to consumers who value not only image but also quality.

Lemma 4 rules out all remaining but four specific types of consumer partitions.

Lemma 4. *The equilibrium features one of four consumer partitions: (1) Standard good: types* 10 *and* 11 *buy* (s,p)*, types* 00 *and* 01 *choose* $(0,0)$*. (2) Mass market: types* 01*,* 10*, and* 11 *buy* (s,p)*, type* 00 *chooses* $(0,0)$*. (3) Image building: types* 01 *and* 10 *buy* (s_L, p_L)*, type* 11 *buys* (s_H, p_H)*, type* 00 *chooses* $(0,0)$*. (4) Exclusive good: type* 11 *buys* (s,p)*, others choose* $(0,0)$*.* $(s,p), (s_i, p_i) \neq (0,0)$ *for* $i = L, H$*.*

For each of these partitions, I derive the prices and qualities that maximize the firm's profit subject to the corresponding incentive compatibility and participation constraints *given* each of the four partitions and optimal consumer behavior (see Lemmas A1 to A4 in the appendix). These product lines constitute my set of equilibrium candidates. Each is described below and illustrated in Figure 1.

[14]The surplus generated by image alone is $(\alpha_s\beta + \alpha_n(1-\beta))R_P = \alpha_s\beta$ with a pure image good, and $\alpha_s\beta R_E = \alpha_s\beta$ when separating the high type.

The **standard good** is identical to the separating product offer that we would expect without image concerns; all quality-concerned consumers buy a product $(s, p) \neq (0, 0)$ whether or not they are also interested in image. The downward incentive constraint of purely quality-concerned consumers binds.

In a **mass market** consumers who value neither quality nor image are excluded while all consumers who value at least one of the two characteristics buy the same product. This is the product line with the largest market coverage and no differentiation with respect to the level of quality or price. For relatively low values of image, the downward incentive constraints of purely image-concerned and purely quality-concerned consumers bind. If the value of image becomes large, only the incentive constraint of purely quality-concerned consumers binds.

In the **image-building** product line, the firm offers two distinct products: a lower quality, lower price version and a premium version. The premium product offers higher quality and higher image at a higher price; it is bought by consumers who value both image and quality. Consumers who value either quality or image buy the lower quality product that is cheaper. Prices are set such that consumers who value only image do not imitate those who value both quality and image. Typically, the downward incentive constraints of all consumers except the one who values neither image nor quality bind. However, if the value of image is large, the firm leaves the incentive constraint of purely image-concerned consumers slack, and offers two products that differ in image and price but not in quality (see Corollary 2). Market coverage is the same as in a mass market.

If the firm sells an **exclusive good**, this product—independent of the value of image—features the quality level that would be offered to quality-concerned consumers in a market without image concerns. This product is only bought by consumers who value both image and quality. The premium price, which reflects the image gain over the outside good, is sufficient to deter purely image-concerned consumers from buying this product because they are not willing to pay for quality in addition to the image. At the same time, the price premium is so high that it renders the exclusive product also unattractive to purely quality-concerned consumers. Only the downward incentive constraint of the consumer who values image and quality binds.

We can now compare profits across the product lines. Note first that a mass market is never optimal. The reason is that the mass market does not screen with respect to either image concerns or taste for quality. The image-building product line partially screens along both dimensions, and in doing so yields not only higher profit but also higher social surplus than the mass market for any value of image.

Lemma 5. *Offering a mass market product, i.e. a product that attracts all but the ignorant consumers, is never optimal for the firm.*

Proposition 1 formally states when each of the three remaining partitions prevails in equilibrium and which product line the firm uses to implement it.

Proposition 1. *There exist $0 < \tilde{\lambda}_m < 1$, and $\tilde{\tilde{\lambda}}_m \geq \tilde{\lambda}_m$ such that the equilibrium is*[15]

(i) a standard good if $\lambda \leq \tilde{\lambda}_m$. Consumers who value quality buy (s, p) and those who do not value quality choose $(0, 0)$ with $R_0^S = 0$, $R^S(s, p) = 1$, and $(s, p) = (1, 1)$.

[15] The formulas for $\tilde{\lambda}_m$ and $\tilde{\tilde{\lambda}}_m$ are given in equations (A8) and (A11) in Appendix A.

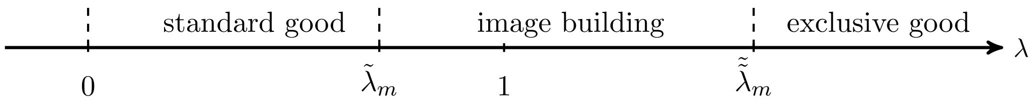

Figure 2: Type of equilibrium depending on λ.

(ii) an image-building product line if $\tilde{\lambda}_m \le \lambda \le \tilde{\tilde{\lambda}}_m$. Consumers who value both quality and image buy (s_H^I, p_H^I), those who value either quality or image buy (s_L^I, p_L^I), and those who value neither quality nor image choose $(0,0)$ with $R_0^I = 0$, $R_L^I = \frac{(1-\alpha_s)\beta}{(1-\alpha_s)\beta+\alpha_n(1-\beta)}$, $R_H^I = 1$, and

$$(s_L, p_L) = \begin{cases} (\lambda R_L^I, \lambda R_L^I) & \text{if } \lambda R_L^I \le 1 \\ (1,1) & \text{if } \lambda R_L^I > 1 \end{cases}, (s_H, p_H) = \left(1, 1 + \lambda(R_H^I - R_L^I)\right).$$

(iii) an exclusive good if $\lambda \ge \tilde{\tilde{\lambda}}_m$. Consumers who value both quality and image buy (s,p) and all others choose $(0,0)$ with $R_0^E = \frac{(1-\alpha_s)\beta}{1-\alpha_s\beta}$, $R^E(s,p) = 1$, and $(s,p) = (1, 1+\lambda(R^E - R_0^E))$.

Image building is not optimal for any λ, i.e., $\tilde{\lambda}_m = \tilde{\tilde{\lambda}}_m$, if and only if the fraction of quality-concerned consumers and the fraction of purely image-concerned consumers are low enough, $\beta < \frac{3\alpha_s - 1}{\alpha_s + \alpha_s^2}$ and $\alpha_n < \frac{\beta(1+\alpha_s(\beta+\alpha_s\beta-3))^2}{4\alpha_s(1-\beta)^2}$.

Figure 2 illustrates Proposition 1. The exact positions of the thresholds depend on the prevalence of quality and image concerns, with the incidence of the image-building product line vanishing if image concerns and willingness to pay for quality are strongly positively correlated (see Corollary 1 and Figure 3 below). Holding fixed a preference distribution, the equilibrium is a standard good for low λ, exclusive good for high λ, and typically image building for intermediate λ. The results would be the same if consumers were affected by social pressure instead of image concerns (see Appendix C.1).

The intuition is as follows. Image concerns only matter if they are intense enough. For λ close to zero, the potential surplus from image is so small that it does not pay for the firm to react to image concerns by modifying its product line because doing so reduces the profit made from quality-concerned consumers. When λ increases, and image become more important, the firm extracts part of the surplus from image concerns by offering the image-building product line with two different products of positive quality. As in the case of a masstige product (Heine, 2012), the lower-quality product targets those consumers who want to buy into the prestige but who do not contribute to it. The partial pooling predicted on the lower-quality product explains why purely image-concerned consumers, seeking to imitate quality-concerned consumers, find it attractive while at the same time the prestige product's image is not sacrificed. When image concerns become even more important, the firm has an incentive to market a high-quality product exclusively to consumers who value both image and quality. Doing so, it can further increase the price of the high-quality product, thereby capitalizing on the higher willingness-to-pay of image-concerned quality lovers. The image rent left to these consumers is lower than in image building because all other consumers pool on the outside option that is associated with a relatively low image.

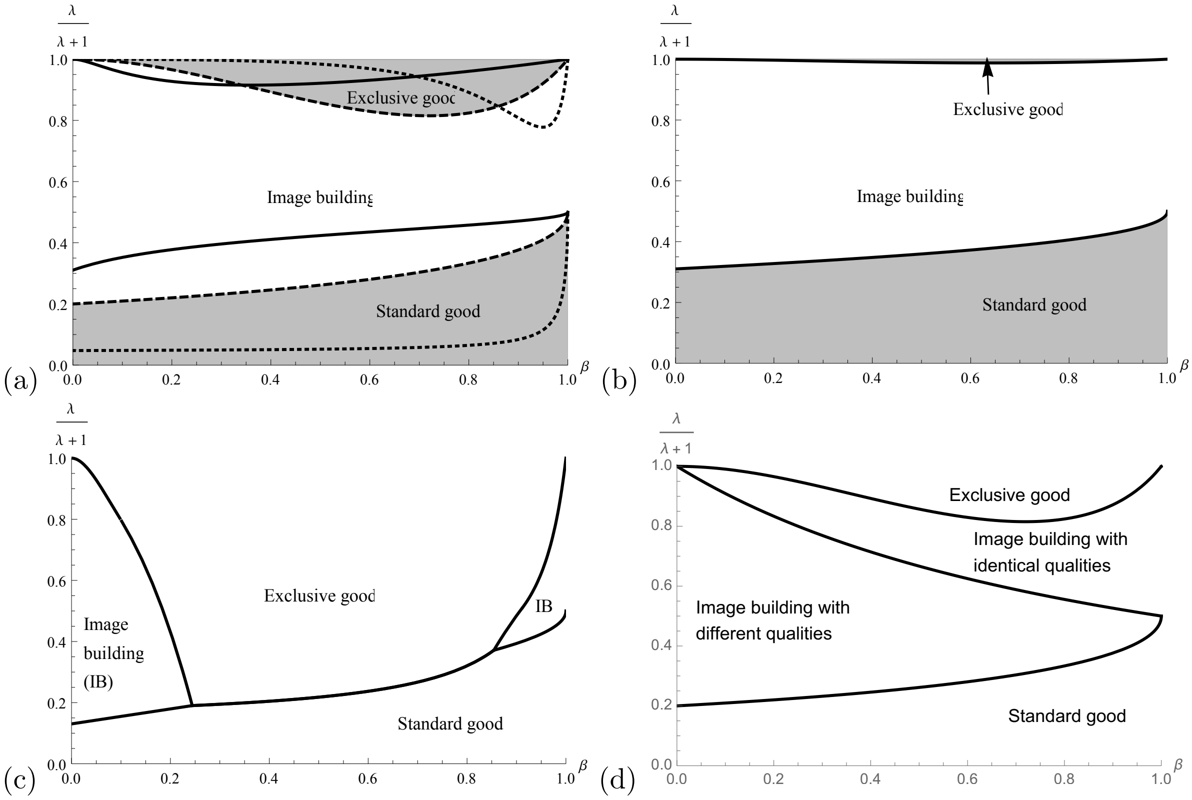

Figure 3: Equilibrium thresholds. (a): Uncorrelated, $\alpha_s = \alpha_n = 0.1$ (solid), 0.5 (dashed), 0.9 (dotted). (b): Negative correlation, $\alpha_n = 0.7, \alpha_s = 0.1$. (c): Positive correlation, $\alpha_n = 0.1, \alpha_s = 0.7$. (d): Uncorrelated, $\alpha_s = \alpha_n = 0.5$.

As the images associated with the different products change when the frequencies of different consumer types change, the relative profitability of a product line for a given value of image and, therefore, the thresholds $\tilde{\lambda}$ and $\tilde{\tilde{\lambda}}$ depend on the distribution of preferences. Figure 3 illustrates these results. The image-building product line is the firm's preferred outcome if neither image nor quality plays a dominant role or if most consumers value quality or image but not both. The exclusive good is most profitable if image is the dominant product attribute or if the fraction of consumers who value both image and quality is high. An image-building product line is offered for a larger range of λ if more of those consumers who do not value quality care about their image. Formal comparative statics results can be found in Appendix C.2.

Proposition 1 implies that an image-building equilibrium always exists if those consumers who can be profitably pooled are frequent enough. Specifically, if those with a low taste for quality are at least equally likely to care about their image as those with a high taste for quality, $\alpha_n \geq \alpha_s$, (see also Figure 3).[16] This condition is sufficient but not necessary for the existence of an image-building product line.

Corollary 1. *If image concerns and quality concerns correlate negatively or are uncorrelated ($\alpha_n \geq \alpha_s$), image building is optimal for some λ. If they correlate positively, image building may not be optimal for any λ.*

[16] This corresponds to the 'covariance' ϱ being negative in Armstrong and Rochet (1999). The problem here, and its solution, differ because the image of a product cannot be freely chosen.

Proposition 1 further implies that a market outcome may arise where products differ only in price and image but are physically identical. If the image attached to the second-tier product is valuable enough to purely image-concerned consumers, i.e., if this product's image exceeds one, the firm does not need to lower the associated quality to satisfy incentive compatibility.[17] The more consumers care about image, the lower is the image associated with the low quality product, and the higher λ has to be for this outcome to occur.

Corollary 2. *If $\lambda \in (\frac{(1-\alpha_s)\beta+(1-\beta)\alpha_n}{(1-\alpha_s)\beta}, \tilde{\tilde{\lambda}})$, the equilibrium is an image-building product line with two products differing only in the associated image and the price.*

Consistent with this result, a large fraction of private-label products is of the same quality as national brands but price differences are substantial (Connor and Peterson, 1992). The national brand is often more heavily advertised (Griffith et al., 2015) and conveys the impression that it is to be bought by the tasteful consumer.[18] Image concerns are likely relevant because even food purchases for home consumption are relatively visible (Heffetz, 2011). Models that screen on quality without image concerns do not square with this observation. Moreover, if a firm moves from an exclusive good to an image-building product line by introducing a lower-priced quality-equivalent product, average category prices increase as has been documented empirically (Soberman and Parker, 2006). Thus, the model also rationalizes this otherwise puzzling observation.

2.3 Welfare-analysis

The analysis of profit-maximizing behavior focused on consumer partitions that can be sustained as incentive-compatible product lines and profit motives. But the welfare-maximizing partition need not be the one that maximizes profits and it may not be possible to implement it in an incentive-compatible way. The welfare measure underlying the following result is aggregate consumer utility including utility from image minus the cost of producing the respective quality levels (= consumer surplus + profits), and I will show that the welfare-maximizing allocation for this setting can be implemented by choosing appropriate prices.

Since image cannot be allocated independently of quality (it depends on equilibrium behavior), even a welfare maximizer is bound to trade off efficiency in allocating image versus efficiency in allocating quality. Moreover, the partition of consumers determines how much image is allocated in the market. Therefore, prices—as an instrument to enforce a partition—are not welfare neutral in market-based allocations but affect the social surplus.

Proposition 2. *Welfare is maximized by providing quality as if image concerns were absent if $\lambda \leq \frac{1}{2}$. If $\lambda > \frac{1}{2}$, welfare is maximized by providing zero quality to consumers who value neither quality nor image, $s_L^w = \frac{(1-\alpha_s)\beta}{(1-\alpha_s)\beta+\alpha_n(1-\beta)} < 1$ to consumers who value either quality or image, and $s_H^w = 1$ to consumers who value both quality and image. Denoting the associated images by R_0, R_L, and R_H, it is $s_L^w = R_L$.*

[17] This is the case when $\lambda R_L = \lambda \frac{(1-\alpha_s)\beta}{(1-\alpha_s)\beta+(1-\beta)\alpha_n} > 1$.

[18] Soberman and Parker (2004) rationalize this empirical observation by assuming that consumers differ in their intrinsic valuation of advertising so that products of identical quality can be differentiated through advertising levels. In my model, consumers differ in their valuations for quality and differentiation occurs with the help of endogenous images.

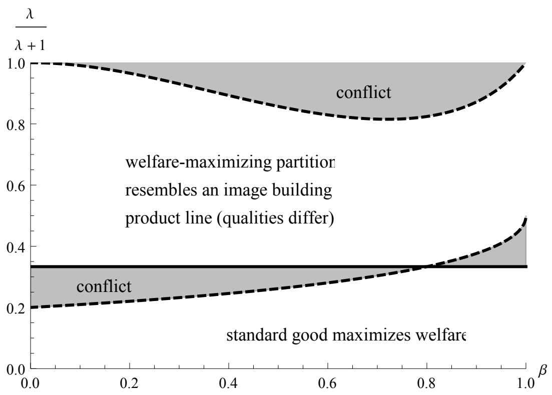

Figure 4: Welfare maximizing partition (solid line) compared with monopoly outcome for $\alpha_s = \alpha_n = 0.5$ (dashed).

Figure 4 illustrates where the welfare-maximizing partition differs from the firm's choice. If the fraction of quality-concerned consumers is low, the increase in profits from selling to purely image-concerned consumers is very attractive. If instead the fraction of quality-concerned consumers is high, the image-building product line is associated with a large image rent to consumers who value both quality and image. An exclusive good never maximizes welfare but is offered by the firm if the value of image is high enough because it would have to leave relatively high rents to image-concerned consumers in the image-building product line but can extract a larger share of the (smaller) surplus with an exclusive good.

In contrast to existing separation results, where all signaling efforts are wasted (Hopkins and Kornienko, 2004), the image-building product line in my model allows consumers to flaunt their image successfully by inducing a specific partial pooling that is often beneficial for welfare. However, even if the firm induces the welfare-maximizing partition of consumers and thus allocates images optimally, we cannot in general expect the firm to offer the welfare-maximizing quality levels.

Corollary 3. *Suppose $\lambda > \max\{\frac{1}{2}, \tilde{\lambda}\}$. The welfare-maximizing quality s_L^w is independent of the value of image, λ. The firm underprovides quality to purely image-concerned consumers and to purely quality-concerned consumers for $\lambda < 1$ and $\lambda > \tilde{\tilde{\lambda}}$, and overprovides it for $1 < \lambda < \tilde{\tilde{\lambda}}$.*

This follows directly from comparing the qualities from Propositions 1 and 2.

Although quality is costly to provide, both under- and overprovision may occur. Both are a consequence of the partial pooling that characterizes the image-building product line and the fact that the firm typically chooses the quality level such that it equals the value of the associated image which depends on λ and, therefore, differs from the welfare maximizing level.

2.4 Regulation and image campaigns

As illustrated in Figure 4, the monopoly firm typically implements an allocation that differs from the welfare-maximizing one. While this is partly due to the firm implementing a different partition of consumers, there is a set of parameters for which both the firm and the welfare maximizer want an image-building partition but disagree on the quality allocated to the pool of purely image-concerned and purely quality-concerned consumers. Therefore, in this subsection, I investigate the effect of regulating the firm. First I look at optimal regulation that by setting prices and qualities can indeed achieve the first best. Then, I consider a naïve minimum quality standard that targets the observed downward distortion in the image-building product line, and show that it may be harmful. Such a regulation may be motivated by complaints about the dilution of standards through new lower-quality products, as is observed for instance in the context of sustainable consumption (Clark, 2011). Finally, I discuss in which sense increased awareness for product images may backfire, thereby casting doubt on the value of public image campaigns for sustainable consumption.

Optimal regulation Consider the case where, for a given preference distribution, the regulator can set both prices and qualities. Doing so, the regulator can ensure that the welfare-maximizing outcome obtains in the market. The reason is that only profit maximization works against an optimal allocation of quality and image, but incentive-compatibility is not a problem. Using Lemmas A1 and A3, we easily find prices that implement the welfare-maximizing allocation.

Corollary 4. *The welfare-maximizing allocation is implementable by setting $p = s$ for $\lambda \leq \frac{1}{2}$, and $p_L = \min\{R_L, \lambda R_L\}$, $p_H = p_L + \lambda(R_H - R_L) + s_H - s_L$ for $\lambda > \frac{1}{2}$.*

Minimum quality standard Suppose the regulator mandates any quality level to weakly exceed $\underline{s} = 1$. Such a minimum quality standard (MQS), which is intended to ensure that all consumers get a high quality product, can hurt consumers. The intuition is that the monopolist may have to adjust the low quality product in the image-building product line upwards to conform with the MQS. Doing so is only possible when it simultaneously decreases the price of the high quality product because the quality increase sharpens the incentive compatibility constraint; this benefits consumers. However, the adjustments make product differentiation less profitable because the monopolist not only incurs higher cost of production but also has to lower part of its prices. Therefore, the monopolist will resort to an exclusive good or standard good regime for a larger set of parameters. Due to this change in equilibrium, this simple quality regulation can trigger decreases in consumer surplus and in welfare.

Proposition 3. *We find parameters so that the introduction of a minimum quality standard $\underline{s} = 1$ in a monopoly market decreases consumer surplus and welfare.*

One may object that such an MQS is naïve because it ignores that purely image-concerned consumers exert a negative externality on the image of their purchase. In particular, the MQS that maximizes welfare is only equal to one when this externality is ignored or in a market without image concerns. Taking into account the consequences of heterogeneous image concerns, a good of intermediate quality $s_L^w < 1$ is welfare-improving as discussed above.

A more sophisticated minimum quality standard would, therefore, require that quality be at least equal to $s_L^w = \frac{(1-\alpha_s)\beta}{(1-\alpha_s)\beta+\alpha_n(1-\beta)} < 1$, which is the welfare-optimal level of the lower-quality product if the externality of purely image-concerned consumers is taken into account. For this more lenient MQS, the monopolist is less constrained in its product line design. Still, it switches to the (regulated) image building product line later, i.e., for higher values of image,

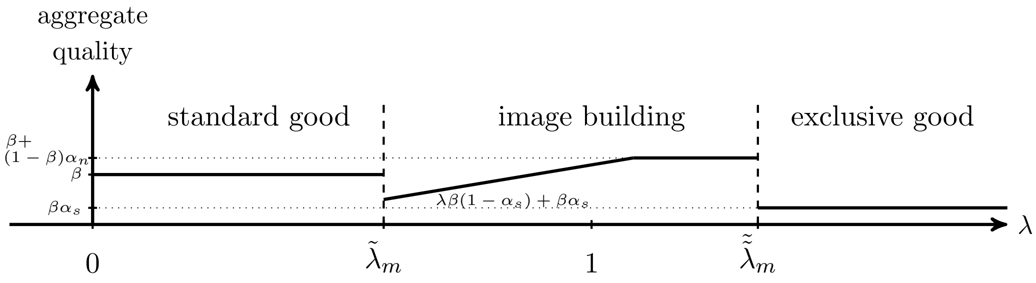

Figure 5: Aggregate quality provision in monopoly computed from Proposition 1. In the absence of image concerns, average quality equals β.

than in the unregulated case. This sophisticated MQS always benefits consumers but there exist cases where welfare decreases.[19]

Image campaigns Suppose the purchase of quality involves a private contribution to a public good, as in Besley and Ghatak (2007). As in the model above some consumers realize utility directly from purchasing the good with the bundled contribution.[20] Due to the public good character of quality, the firm may under- or overprovide quality. The efficient provision level is, in general, not reached because the socially efficient level of contributions (quality) does not depend on the value of image, whereas the market-based provision of quality does.

In such a situation, raising awareness for the public good contributions involved with a purchase may lead to increases in the value of the associated image but nonetheless trigger a decrease in the provision of quality as the aggregate provision is not monotonically increasing in the value of image (see Figure 5). The reason is that changes in the value of image may induce the firm to offer a different product line, thus affecting the aggregate provision due to the introduction of a lower quality product or due to a reduced share of the market being served.

Corollary 5. *There exist parameters such that an increase in the value of image λ decreases the average quality in the monopoly market.*

2.5 Testable predictions

We obtain testable predictions by comparing a market without image concerns to one with image concerns but with the same fraction of intrinsically motivated consumers. Alternatively, we investigate changes in the value of image, λ, given that the distribution of preferences remains constant. A change in the value of image can be induced by changes in public attention to purchasing behavior or in the visibility of purchases, for instance, because it is advertised differently, because it was featured in a popular TV series, or because it is sold in more public locations. Changes in the fraction of image-concerned consumers could be elicited through surveys. Among the outcomes of interest, product lines, qualities, and prices are in principle

[19] An alternative regulation where the firm may only offer quality levels that are part of the first-best allocation for some preference distribution may also backfire (see Appendix C.3).

[20] This utility could be due to altruism, warm glow, an internalized norm, another pro-social preference (see, e.g., Andreoni, 1990; Alger and Weibull, 2013), or a related image concern (e.g., Glazer and Konrad, 1996; Bénabou and Tirole, 2006; Andreoni and Bernheim, 2009).

observable. Changes in consumer surplus require information that could be elicited through well-designed consumer surveys or choice experiments.

Prediction 1. *The price-quality ratio is larger in a market with image concerns than in one without image concerns. As the value of image λ increases, (a) the price-quality ratio weakly increases, and (b) eventually the set of available qualities changes, i.e., number or level of available qualities are affected, first increasing as the firm builds image and then decreasing as the firm moves to exclusivity.*

Whether or not image concerns play a role, the number of available qualities may be the same. But in the image market, at least the highest quality product is sold at a premium price (the lowest quality product is not). If image concerns play a role, the ratio of price to the value of a product's quality is weakly greater than one but it is weakly smaller than one if image concerns are absent. In the wine market, for example, the model predicts that the spread in prices for a given set of qualities is larger for producers who are better-known and thus have a higher signaling value λ, than it is for a less well-known producer.

Cases where the product line changed in response to changes in the value of image are unexplained by existing (one-dimensional) models with or without image concerns but can be rationalized with heterogeneous image concerns.[21] For instance, Apple's decision to introduce the iPhone SE in early 2016 in addition to the iPhone 6s was such a change in the product line. The iPhone SE looks like an iPhone 5 but contains the technology of an iPhone 6s, and it was positioned and priced as an entry-level product targeted among others at emerging markets. According to my model, this move can be seen a masstige strategy in response to a decreasing value of image as measured by Apple's stock market value.[22] Offering two iPhone versions simultaneously allowed Apple to price-discriminate between those consumers who wanted to have the most high-end product and be seen with it, e.g., in high-income countries, and those who are either not interested in the signaling value and are happy with the more basic functionality at the lower price, or who are mostly interested in the phone's signaling value, e.g., in the context of emerging middle classes in developing countries.

Finally, if the prevalence of image concerns in the population changes at a positive level, this benefits the firm at the expense of consumers. If the prevalence of image concerns is different across markets, for instance, a firm active in both markets would *ceteris paribus* be expected to make higher profits in the market with more image concerned consumers whereas the population of consumers should be worse off there.

Prediction 2. *If the fraction of image-concerned consumers, α_s or α_n, increases, the firm reacts by offering a product line with (weakly) lower qualities and higher prices. Profits increase but individual consumers are worse off.*

[21] If consumers do not care about their social image, the difference in signaling potential should not have an effect on qualities or prices. If image concerns are homogeneous or perfectly positively correlated with taste for quality (as in Rayo, 2013), an increase in the value of image only leads to price changes; the set of available qualities is unaffected.

[22] See `https://www.recode.net/2016/3/20/11587094/apple-why-small-iphone-5se` and `https://www.bloomberg.com/quote/AAPL:US`.

3 Competition

As a product becomes more familiar, more producers can credibly supply any desired quality level and a monopolistic market becomes less likely. This section illustrates that, even in the absence of market power on the supply side, heterogeneous image concerns promote product differentiation that is not driven by heterogeneous quality valuations but by heterogeneous image concerns. A crucial difference in a competitive market is, however, that for large enough image concerns all consumers who value image or quality buy a product with positive quality, whereas a monopolist would offer an exclusive good that is only bought by consumers who derive utility from both image *and* quality. Moreover, the mechanisms of separation are different. Taking the quality level that would be sold in a market without image concerns as a benchmark, product differentiation occurs through an additional product with higher quality in the competitive market (upward distortion). In contrast, the monopolistic firm induces separation through an additional product with lower quality (downward distortion).

3.1 A model of perfect competition

The consumer side is set up exactly as in Section 2. For the supply side, suppose that all quality-price combinations, for which prices are equal to or above the marginal cost of provision, $p(s) \geq c(s) = \frac{1}{2}s^2$, are available. This captures a situation of competition without actually modeling the interaction among producers and is more general than assuming zero profits as is often done to model perfect competition. The product design problem is assumed away on purpose in order to better understand how strategic product design contributes to the results in the monopoly case.[23] The game then reduces to all consumers simultaneously choosing a product $(s, p) \in \mathcal{M}$ to maximize utility. The choice set is given as

$$\mathcal{M} = \left\{ (s, p) \in \mathbb{R}^2 | s \geq 0 \text{ and } p \geq \frac{1}{2}s^2 \right\}.$$

An equilibrium is given by consumer choices satisfying Definition 1. Images are formed as an outside spectator would form them and are consistent with consumers' actual choices in equilibrium.

Note first that consumers who value neither image nor quality never buy any product $(s, p) \neq (0, 0)$ because it must hold that $p \geq \frac{1}{2}s^2 \geq 0$ with one of the inequalities being a strict one. Furthermore, a consumer who values quality alone always buys the product that offers the best deal in terms of quality and price. Her utility is independent of beliefs and maximized at

$$(s, p)^* := (1, \frac{1}{2}), \tag{4}$$

which is the efficient quality level in the absence of image concerns priced at marginal cost and which is always available. This product will, therefore, always be part of the equilibrium.

[23]The assumptions preclude oligopolistic multi-product firms. Competition between such firms in the absence of image concerns is analyzed, e.g., in Johnson and Myatt (2003, 2006). For a duopoly model of a market with image concerns see Diaz-Diaz and Rayo (2009).

The driving forces behind the equilibrium outcome are the decisions of the two consumer types who care about image. Since unconcerned consumers always choose the outside option, the image of not buying is equal to zero unless any quality-concerned consumer also chooses this option.

In general, several competitive equilibria coexist. Therefore, I analyze different classes of equilibria, those with a single product of positive quality and those with two products, separately, and employ a refinement in the spirit of the Intuitive Criterion by Cho and Kreps (1987) to obtain a unique equilibrium prediction.[24]

3.2 Single-product equilibria

Consider first equilibria such that unconcerned consumers do not buy, and all other consumer types pool on the product $(s,p)^*$.

Lemma 6. *There exists a partial-pooling equilibrium where all consumers who value quality buy $(s,p)^*$ and purely image-concerned consumers randomize between buying $(s,p)^*$ with probability q and not buying at all with probability $1-q$ where*

$$q = \begin{cases} 0 & \text{if } \lambda \leq \frac{1}{2} \\ (2\lambda - 1)\frac{\beta\alpha_s}{(2-\beta)\alpha_n} & \text{if } \frac{1}{2} < \lambda \leq \frac{1}{2}\frac{(1-\alpha_s)\beta + q\alpha_n(1-\beta)}{(1-\alpha_s)\beta} \\ 1 & \text{otherwise.} \end{cases} \tag{5}$$

The image associated with buying $(s,p)^*$ is $R((s,p)^*) = \frac{\beta}{q(1-\beta)\alpha_n + \beta}$, and $R_0 = 0$.

For values of image up to $\frac{1}{2}$, $(s,p)^*$ is only bought by the fraction β of consumers who care about quality. Those who do not value quality choose the outside option. This is the competitive version of a **standard good**, where image does not manifest itself in quality, price or purchasing behavior. For $\lambda > \frac{1}{2}$, the only single-product equilibrium is one of **(partial) mainstreaming** where consumers who value image or quality all buy $(s,p)^*$. Since $(s,p)^*$ is associated with the image $R((s,p)^*) = 1$ in the standard good case, purchasing this product becomes attractive to purely image-concerned consumers for values of image $\lambda > \frac{1}{2}$. But as purely image-concerned consumers buy $(s,p)^*$ with positive probability, the associated image decreases so that in a partial mainstreaming equilibrium only a fraction $q \in (0,1)$ of purely image-concerned consumers buys $(s,p)^*$. When image becomes valuable enough, purely image-concerned consumers purchase $(s,p)^*$ with certainty because even the value of the imperfect image exceeds the price of $\frac{1}{2}$.

3.3 Two-product equilibria

Consider equilibria with two products and note, first, that no two-product equilibrium exists for $\lambda < \frac{1}{2}$. The reason is that purely image-concerned consumers prefer the outside option

[24] Formally, the model does not have a receiver of signals and, therefore, is not a proper signaling game but can be rephrased as one, as detailed in Footnote 13. See also Gradwohl and Smorodinsky (2017) for using the Intuitive Criterion in Perception Games.

over buying the product $(s,p)^*$, even when the latter is associated with the best possible image as long as $\lambda R((s,p)^*) = \lambda < \frac{1}{2}$. As purely quality-concerned consumers choose $(s,p)^*$ independent of images, consumers who value image and quality cannot do better than choosing $(s,p)^*$ too because it confers the perfect image and is efficient in terms of quality for price. Second, partially separating two-product equilibria must induce a consumer partition where purely quality-concerned and purely image-concerned consumers pool on the product $(s,p)^*$, consumers who value both quality and image separate from the others by buying another product (s',p'), and those who value neither quality nor image choose the outside option. Suppose to the contrary that consumers who value only quality buy $(s,p)^*$ whereas purely image-concerned consumers and those who value image and quality pool on some $(s,p) \neq (s,p)^*$. Then, the image of (s,p) is smaller than 1 due to the purchases of purely image-concerned consumers. Consumers who value image and quality would then be better off by purchasing $(s,p)^*$, which has an image of 1 and offers the best quality-price combination.

Lemma 7. *For $\lambda > \frac{1}{2}$, we find $s \geq 1$ and $\eta \geq 0$ such that the two products $(s_L, p_L) = (1, \frac{1}{2})$ and $(s_H, p_H) = (s, \frac{1}{2}s^2 + \eta)$ form a partially separating equilibrium with*

$$R\left(s, \frac{1}{2}s^2 + \eta\right) = 1, \quad R\left(1, \frac{1}{2}\right) = \frac{\beta(1-\alpha_s)}{\beta(1-\alpha_s) + q(1-\beta)\alpha_n}, \quad R_0 = 0$$

where purely image-concerned consumers buy with probability q and

$$q = \begin{cases} (2\lambda - 1)\frac{\beta\alpha_s}{(1-\beta)\alpha_n} & \text{if } \frac{1}{2} < \lambda \leq \frac{1}{2}\frac{(1-\alpha_s)\beta + q\alpha_n(1-\beta)}{(1-\alpha_s)\beta} \\ 1 & \text{if } \lambda > \frac{1}{2}\frac{(1-\alpha_s)\beta + q\alpha_n(1-\beta)}{(1-\alpha_s)\beta} \end{cases}. \tag{6}$$

The partially separating two-product equilibria fall in two classes: those where products are priced at marginal costs ($\eta = 0$) and those where prices exceed marginal costs ($\eta > 0$). With marginal cost-pricing, consumers who value both quality and image buy $(1+\varepsilon, \frac{(1+\varepsilon)^2}{2})$, a product which provides a **functional excuse** while being priced at marginal cost. Excessive quality provides a way to pay a higher price to signal that the consumer values quality. Purely image-concerned consumers refrain from imitating these purchases because the price of the high quality product exceeds the value of the associated image. Instead, they buy $(1, \frac{1}{2})$. This same product is also bought by consumers who only value quality, such that the associated image is positive. If the price of the high-quality product exceeds marginal costs, consumers who value image and quality pay a direct **price premium** to separate from purely image-concerned consumers. This way of separating mimics the monopolist's strategy of charging the consumers for the image concerns while changing qualities as little as possible.

3.4 Equilibrium refinement

While the above implies a unique single-product equilibrium for $\lambda < \frac{1}{2}$, multiple two-product equilibria and the single-product equilibrium from Lemma 6 coexist for higher values of image. I, therefore, employ a refinement in the spirit of the Intuitive Criterion by Cho and Kreps (1987) to obtain a unique equilibrium prediction. It turns out that the refinement rules out image premia, i.e. equilibria in which consumers who value both quality and image buy overpriced products to

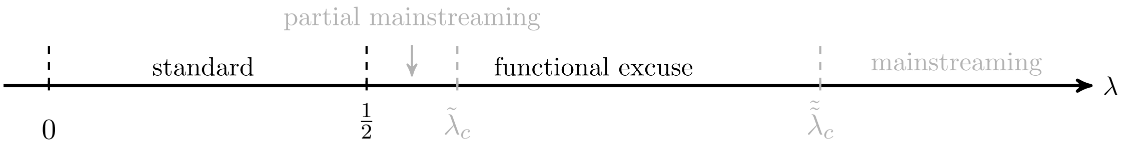

Figure 6: Competitive equilibrium satisfying the Intuitive Criterion. Equilibria marked in gray fail the Intuitive Criterion but would make consumers better off.

obtain an image by spending more money than necessary. Instead they buy excessive quality at marginal cost. Furthermore, it rules out single-product equilibria where purely image-concerned consumers buy positive quality. Proposition 4 characterizes the competitive equilibrium as a function of the value of image λ.

Proposition 4. *The equilibrium satisfying the Intuitive Criterion is unique. All products are sold at marginal cost and the equilibrium is*

(i) competitive standard good with $(s,p) = (s,p)^*$ *if* $\lambda \leq \frac{1}{2}$.

(ii) functional excuse with $(s^E_L, p^E_L) = (s,p)^* = (1, \frac{1}{2})$ *and* $(s^E_H, p^E_H) = (1+\varepsilon, \frac{1}{2}(1+\varepsilon)^2)$ *for* $\varepsilon = \sqrt{1 + 2\lambda \frac{q(1-\beta)\alpha_n}{\beta(1-\alpha_s)+q(1-\beta)\alpha_n}} - 1$ *if* $\frac{1}{2} < \lambda$.

In the functional excuse equilibrium, purely image-concerned types purchase with probability $q = (2\lambda - 1)\frac{((1-\alpha_s)\beta))}{(\alpha_n(1-\beta))}$ *for* $\frac{1}{2} < \lambda < \frac{1}{2}\frac{(1-\alpha_s)\beta + \alpha_n(1-\beta)}{(1-\alpha_s)\beta}$, *and* $q = 1$ *otherwise.*

The first claim is trivial as for $\lambda \leq \frac{1}{2}$ no other equilibrium exists. When proving the second claim, I first rule out all two-product equilibria but the one that separates the consumers at the least cost. Then, I show that the single-product equilibrium is inconsistent with the Intuitive Criterion for $\lambda > \frac{1}{2}$. The intuition is the following. Suppose we are in the single-product equilibrium. There always exists $\varepsilon > 0$ such that a consumer who values both quality and image profits from deviating to a product $(s', p') = (1+\varepsilon, \frac{(1+\varepsilon)^2}{2})$ if he believes this to be associated with $R = 1$. But a purely image-concerned consumer cannot profit from deviating to (s', p') for any belief. Then, the associated image must be $R(s', p') = 1$. Otherwise the image would assign positive probability to a type who would never gain from choosing this product. But given $R(s', p') = 1$ a consumer who values quality and image always wants to deviate and purchase (s', p').

Figure 6 illustrates the result. If the intensity of image concerns is small, the equilibrium resembles the monopolistic **standard good** case where a product with quality $s = 1$ is bought by all consumers who value quality. But if the value of image increases, purely image-concerned consumers are attracted by the same product and, thus, separation becomes worthwhile for the consumer who values image and quality. Product differentiation within the quality segment occurs even though the market is perfectly competitive because consumers who value both quality and image are willing to buy excessive quality. They use a **functional excuse** to separate from other consumers and obtain a higher image. In contrast to the image-building strategy of the monopolistic firm, product differentiation in the competitive market features an upward distortion in quality. The lower quality product has quality $s = 1$, which is the high quality in a monopoly market, and it is bought by consumers who value either image or quality. The high quality product with $s > 1$ is not attractive for the purely image-concerned consumers due to its high price even at marginal cost pricing.

If the intensity of image concerns is low, separation is relatively cheap but not very worthwhile. If however the intensity of image concerns becomes very large, separation is very desirable but the required upward distortion in quality becomes expensive. Due to these effects, we find $\frac{1}{2} < \tilde{\lambda}_c < \tilde{\tilde{\lambda}}_c$ such that consumers who value image and quality would be better off by pooling on the lower quality product for all $\lambda \in (\frac{1}{2}, \tilde{\lambda}_c)$ and $\lambda > \tilde{\tilde{\lambda}}_c$ (**mainstreaming**, see Lemma 6 and Figure 6). This (partial) pooling equilibrium fails the Intuitive Criterion because consumers who value image, quality, or both all purchase the same product, giving an individual consumer who values image and quality an incentive to deviate, which does not exist for purely image-concerned consumers. See supplementary material C.4.

3.5 Does competition yield higher welfare?

Although the monopolist does not typically implement the welfare maximizing allocation, competition does not do better in general. I first show that the competitive outcome may differ from the welfare optimum.

Corollary 6. *The competitive market implements the welfare optimum for $\lambda \leq \frac{1}{2}$. For $\lambda > \frac{1}{2}$, the competitive market overprovides quality to all consumers but those who value neither image nor quality, i.e. $s_L^w < s_L^c$ and $s_H^w < s_H^c$.*

If image concerns are not too strong, competition yields the welfare-maximizing allocation of quality and image. Moreover, this market outcome is optimal from the consumers' perspective because products are supplied at marginal costs. As image becomes more valuable, the consumers' image concerns distort the market outcome even under competition. Specifically, for $\lambda > \frac{1}{2}$, the desire to increase one's image by separating from other consumers through a high-quality product is so strong that the equilibrium features excessively high levels of quality, which are used by consumers as a means to pay for the associated image.[25]

While consumers use excessive quality to separate in competition, the monopolistic firm can use prices to induce consumers to partially separate. Distorting qualities to achieve separation is less cost-effective than using prices, such that the monopoly outcome often yields higher welfare than competition.

Proposition 5. *Monopoly yields higher welfare than competition on a non-empty subset of the preference parameter space.*

Specifically, there exist preference parameters such that monopoly yields strictly higher welfare than competition. This is, for instance, the case when half of the population values quality, half is concerned with their image, the image concern is independent of the taste for quality, and image and quality are weighed equally in the utility function, $(\beta, \alpha_s, \alpha_n, \lambda) = (\frac{1}{2}, \frac{1}{2}, \frac{1}{2}, 1)$.

[25] The welfare-maximizing allocation trades off the desire of purely image-concerned consumers for image with the desire of purely quality-concerned consumers for quality. Without image concerns, the level of quality that is provided to purely quality-concerned consumers in competition is optimal.

Continuity of the profit functions and constraints imply that monopoly does better than competition for parameters in an open neighborhood of this parameter vector. Assuming a preference distribution with everywhere positive density, this outcome has positive probability. This result does not depend on the refinement used in the competitive setting, nor the equilibrium selection in monopoly (see supplementary material D.2 and D.3).

When competition leads to higher welfare than monopoly, it also leads to higher consumer surplus. However, even if competition reduces welfare, consumers may still profit. Whether consumers are better off in competition or monopoly depends on the consumer type and the product line offered by the monopolistic firm.

Corollary 7. *Consumers who value quality always benefit from competition but consumers who value only image are better off in monopoly for some parameters.*

Corollary 8. *If the monopolist offers an image building product line, all consumer types would be (weakly) better off in a competitive market.*

3.6 Benefits of a luxury tax

In the competitive market, a minimum quality standard would have no effect. Regulating that only quality levels that are part of the welfare optimum may be offered, would leave the standard good equilibrium unaffected but would prevent any upward distortion in qualities. Instead of the functional excuse equilibrium, the market would be in a mainstreaming equilibrium, where only one product of quality $s = 1$ would be sold. However, pooling the purely image-concerned with the purely quality-concerned consumers, as is the case in the functional excuse equilibrium, is desirable for many parameters (see the range where image-building is optimal in Figure 4). Therefore, I now study a different policy intervention, a tax on excessive qualities, which can improve welfare in a competitive market. By increasing consumer prices above marginal costs, it allows consumers to achieve a high image at lower qualities that can be produced at lower cost.

Proposition 6. *In competition, we can design a luxury tax on excessive quality such that welfare strictly increases.*

The tax shifts the equilibrium from one in which quality differences ensure separation to one where price differences ensure separation. It does, however, not always constitute a Pareto improvement without further redistributive measures. Consumers who value quality and image might be worse off with a luxury tax than without it because the tax might exceed the private gain from regulation.[26]

This finding mirrors the results in, e.g., Ireland (1994) and Hopkins and Kornienko (2004) that taxation improves welfare in the presence of image or status concerns. In Ireland (1994), the tax corrects a problem of overconsumption without affecting the sorting of consumers. In Hopkins and Kornienko (2004), the optimal (Pigouvian) tax that corrects the distortions from status concerns depends on a consumer's income. In my model, a tax on certain products that does not require knowledge about consumers' incomes is sufficient to improve welfare.

[26]The private gain is given by the reduction in price(=marginal cost) corrected for the utility loss from reduced quality. The social gain is positive as quality moves down, closer to first best, narrowing the gap between the consumer's quality valuation and marginal cost.

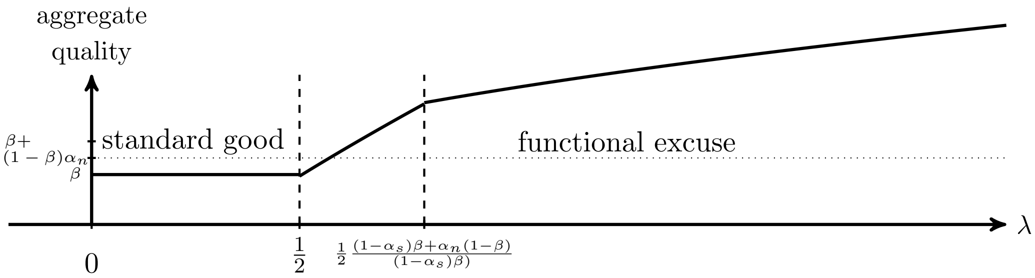

Figure 7: Aggregate quality provision in competition computed from Proposition 4. In the absence of image concerns, average quality equals β.

3.7 Testable predictions

Having analyzed both monopoly and competition, we can derive further predictions that exploit also the comparison of the two market structures. Prediction 3 can be directly read off from Figures 5 and 7.

Prediction 3. *In a competitive market, (i) aggregate quality is (weakly) higher than in monopoly, and (ii) aggregate quality increases in the value of image λ.*

In contrast, in a model where image concerns are not taken into account, are assumed to be homogeneous across individuals, or are perfectly positively correlated with tastes for quality, we would not predict aggregate quality to be higher in a competitive setting than in monopoly and we would not predict it to change with the value of image. However, in case of sustainable consumption, an increase in competition for organic products and a higher degree of publicity through publicly funded campaigns for sustainable shopping were accompanied by an increase in the number of labels and by increasing market shares for private standards exceeding the one behind the public EU organic label (see, e.g., Die Zeit, 2014). As compared to the alternative explanation that this change in supply could be driven by an increase in intrinsic preferences for sustainability, the image-based explanation is more parsimonious as is rationalizes not only the growth of sustainable markets but also the introduction of both products with stricter and with more lenient sustainability standards as a response to an increase in the value of image in competitive and monopolistic environments, respectively.

Prediction 4. *In a competitive market, aggregate quality increases in α_s and α_n and is non-monotone in β.*

Prediction 4 follows from comparative static analysis (see supplementary material C.2). In contrast, a model without image concerns only predicts that an increase in β triggers an increase in aggregate quality due to an enlarged market share for the high-quality product. While Prediction 4 is currently difficult to test, the ongoing increase in data collected on consumer behavior and motivations may imply that the necessary data to test this prediction will be available in the future.

Whereas all consumers would profit from the market becoming more competitive in a standard model without image concerns, my model predicts that consumers are differently affected. Moreover, the mentioned policy measures affect market participants differently, with Predictions

5 and 6 following from the welfare analysis above. To investigate these in detail, one needs data on consumer satisfaction and purchasing motivations for a period where a market with image concerns becomes more competitive. Consumer surveys may be a reasonable source.

Prediction 5. *If a market with image concerns becomes more competitive, purely image-concerned consumers may be worse off whereas other consumer types benefit.*

Prediction 6. *If any consumer type opposes a luxury tax, it is the one who values quality and image.*

4 Discussion

In this section, I first argue that the model can be informative in settings where consumers differ in wealth and in their preferences, with the latter not entirely explained by differences in wealth. Second, I discuss how the partial pooling result relates to pooling results in the literature. Third, I compare the results with those of a one-dimensional screening model with more than two types.

4.1 Wealth heterogeneity

While the model is framed as one in which consumers have different tastes for quality which they want to signal, there is a dual interpretation in which consumers differ in wealth and want to signal their wealth level. The tastes for quality in the indirect utility functions of the presented model can be derived from direct utility functions with identical reservation prices but income heterogeneity (see e.g. Peitz, 1995). Consumers with higher income or wealth look as if they value quality more because their opportunity cost of money is lower.

But income or wealth may be poor predictors for a consumer's marginal valuation for quality because consumers' have different intrinsic preferences and valuations. A simple way to capture the effects of additional wealth heterogeneity is to interpret λ as the product of the informativeness of the purchasing decision with respect to taste and the value of the social image as such. If the distribution of wealth and tastes are not aligned, a purchase is not very informative about tastes and, thus, the realized utility from image is low, and vice versa. In line with recent experimental evidence, such an extended model would then predict that no effects of image concerns should be observed if heterogeneity in wealth and taste impedes precise inferences on one or the other.[27]

As the monopolist benefits from image concerns, it has an incentive to allow for the signaling of desired characteristics. A natural response to multidimensional signaling concerns, like the signaling of income and taste for quality, is to differentiate products in two quality dimensions, one that appeals to the intrinsic quality valuation and one that targets income. For instance, in the car market different categories of cars target consumers of different income levels but cars also differ in how environmentally friendly they are. Within each category, signaling of income

[27] Bracha and Vesterlund (2017) study the effect of donation visibility on charitable giving when income varies across individuals and argue that donors may prefer to be seen as poor and generous rather than as rich and stingy. Indeed, they find that donation visibility does not increase giving when the size of a donation signals both income and generosity.

is less salient so that the choice of a model with particular environmental characteristics in a category again becomes a signal of attitudes toward the environment and thus taste for quality (see Example 5 in Section 5). Similarly, competitive pressure will react to consumers' desire to signal in multiple dimensions.

4.2 Welfare properties and partial pooling

Partial pooling characterizes not only the equilibrium but also the welfare optimum of my model because the allocation of image is not a zero-sum game. If tastes for quality and image concerns are independently normally distributed or homogeneous, the allocation of images is a zero-sum game and does not matter for welfare. Moving away from this assumption fundamentally changes the game.

The non-existence of a separating product line cannot simply be attributed to the lack of a screening instrument, as the firm designs product characteristics in both the quality and the image dimension subject to a consistency requirement for product images. The firm can generate a large set of different images by inducing appropriate randomness into consumers' decisions and, in principle, it could offer a perfectly separating product line. However, full separation is neither profit-maximizing nor desirable from a welfare point of view because of the heterogeneity in image concerns. Some consumers are willing to pay for image while themselves exerting a negative externality on a product's image. Other consumers provide a positive image but do not care about it and do not suffer from image externalities.

In existing (multi-dimensional) screening models, bunching or bundling occurs to better extract surplus but separation would maximize welfare (Rochet and Choné, 1998; Armstrong and Rochet, 1999). Specifically, in multidimensional screening problems, firms may profitably bundle several characteristics or goods (e.g. Bolton and Dewatripont, 2004, p. 210). If consumers have unit demand and qualities in each dimension are fixed, bundling typically means that different consumer types pool by making identical choices. In contrast, in 2x2 non-linear pricing problems similar to my model, the pricing schedule can be used so as to perfectly separate consumers by letting them choose different bundles of the two goods (or characteristics). In particular, the firm would typically offer a perfectly separating product line with certain distortions in image and quality if it could freely choose image and quality, as in Armstrong and Rochet (1999) or Frankel (2014).[28]

4.3 Relation to one-dimensional screening models

In a model with n vertically differentiated consumers, one naturally expects a product line with n products of different qualities and full separation in both the first-best and the second-best under standard regularity conditions (see, e.g., Bolton and Dewatripont, 2004). This prediction holds with homogeneous and without image concerns. When the number of types increases due to heterogeneous image concerns, the predictions differ from those of a model without image

[28] With a continuous distribution of valuations in two dimensions, partial pooling along rays in the type space occurs (Laffont et al., 1987). We should also expect partial pooling in a continuous extension of my model, where the monopolist can again use consumers with a high taste for quality but low taste for image to build product value in the form of images that are valued by consumers with a low taste for quality but a high taste for image.

concerns but more different tastes for quality, and partial pooling becomes natural. A key difference is that consumer types are clearly ordered in the one-dimensional screening model while they are not in the two-dimensional one. Specifically, it is the sorting of consumers that determines the images in a product line and, thereby, the ordering of consumers in my two-dimensional model. The relationship between image concerns and tastes for quality is crucial here. Single crossing holds if nobody values image ($\alpha_s = \alpha_n = 0$), if everybody values image ($\alpha_s = \alpha_n = 1$), and if there is a perfect positive correlation between preferences for image and quality ($\alpha_s = 1, \alpha_n = 0$). In these cases, the results regarding quality provision from the one-dimensional model with several types carry over, and image concerns will only affect prices, similar to the findings by Rayo (2013).

Consider now a one-dimensional model with three distinct tastes for quality and suppose the utility function fulfills the single-crossing condition. In such a model, the welfare-maximizing solution is full separation with three distinct quality levels. Moreover, the profit-maximizing product line (call it a *diffusion line*) will also have three different quality levels (the monopolist may want to exclude the lowest type, i.e., allocate zero quality to him). Comparing the monopolist's product line with the welfare-maximizing solution, the highest type consumes an efficient quality level but all lower types underconsume quality (see, e.g., the textbook treatment by Bolton and Dewatripont, 2004). For each of the three products that the monopolist offers, the downward incentive constraint is binding. Each consumer but the lowest type receives strictly positive surplus (an "informational" rent), whereas the lowest type receives zero surplus because her participation constraint is binding.

Consider next an image-building product line in a model with heterogeneous image concerns. As compared to a one-dimensional model with two different tastes for quality, this model has more types but an unchanged number of different tastes for quality. Whereas a diffusion line exploits the clear sorting of consumers with respect to their taste for quality, the intermediate (or mixed) types are not clearly ordered here. The image-building product lines deals with this problem by inducing consumers with different tastes for quality to pool on an intermediate-quality product. Due to their different motivations, the incentive constraint of one of the two consumer types pooling on the middle quality level may be slack. If it is not, the middle quality level is constrained by the value of image associated with this product and consumers who value either image or quality receive zero surplus. Both the partial pooling and the strictness of the constraints, are potentially testable if consumer motivations to purchase are elicited.

In a diffusion line, prices correspond to the respective consumer's valuation of the quality level minus a potential information rent so that the ratio between price and value of quality is weakly below one. In contrast, in a product line with image concerns prices correspond to those from the diffusion line plus an image term. The ratio between price and value of quality strictly exceeds one for the highest quality valuation type, and, for each lower quality product, increases in the value of image and exceeds that in the model without image concerns.

5 Detailed empirical examples

Example 1: Socially Responsible Products It has become increasingly important to consumers that goods are ethically acceptable and sustainably produced. Accordingly these markets experience high growth rates (Sahota, 2009, http://www.fairtrade.net/annual-reports.html). At the same time, consuming ethically and sustainably is becoming a status symbol (Kapferer, 2010; Frick and Hauser, 2008, p. 28). Empirical studies find that higher prices for green products can be partly explained by image concerns (e.g., Sexton and Sexton, 2014; Delgado et al., 2015). While there is much acceptance of the mainstreaming of responsible consumption, critical voices lament a dilution of the underlying principles as products are tailored to a broader audience (for instance Clark, 2011). According to my model, this observation is consistent with a discounter optimizing its product listings in response to rising image concerns: To profit from image concerns and attract consumers who do not so much care about sustainable production per se, the discounter will offer an inferior version of a sustainable product, for example a private label product, in addition to the fully sustainable product, which can consequently be sold at a premium. In line with this, the discounter Lidl offers chocolates that satisfy various sustainability standards that differ in their strictness. Furthermore, there is empirical support that partial pooling takes place in line with the image-building product line (Vermeir and Verbeke, 2006; Bellows et al., 2008). Such a line cannot be rationalized with only vertically differentiated status-conscious consumers or with existing models on conspicuous consumption.

Also, the soft drinks "ChariTea" and "LemonAid" appeal to non-consumption values, and the bottles are easily recognized even from a distance through their unusual design.[29] Bars and cafés where consumption is more visible and signaling desires more relevant (Griskevicius et al., 2007) are frequent outlets for these drinks, making image concerns the most plausible explanation for their premium price. Quality-based models do not predict higher popularity of responsible products in public spaces. A model with homogeneous image concerns on the other hand does not explain the existence of a second-tier sustainable product which is, however, often available rationalized by the image-building product line.

Example 2: Bordeaux Wines The finest wine producers in France, particularly in the Bordeaux region, commonly offer a so-called "second label wine" in addition to their first label. The second wine is produced from grapes grown on the same estate, but it may be based on special plots, on vines that are younger, or those that do not perform as well. While the quality difference may be small, the price differential is typically large. According to an empirical study by Ashenfelter (2008), there are two motivations for buying mature Bordeaux: interest in the wine itself and interest in the status symbol. In line with my theoretical analysis for the heterogeneous purchasing motives documented in Ashenfelter (2008), wine producers have adopted a two-tier product line. The *Grand vin* of superior quality receives an enormous image premium that is paid by those who want a status symbol but also value the underlying quality. The image of a great wine maker's second label is considerably better than the image associated with an unknown producer's wine. Moreover, the (expected) quality of this wine is higher than that of the unknown wine. Hence, the lower quality second label wine appeals to those who are

[29] See http://www.lemon-aid.de/.

unwilling to pay a reputation premium for the *Grand vin* and choose the second label for its good quality-to-price ratio. But the second label wine also appeals to those who care mostly about the associated image, possibly because they are ignorant of the quality; they buy for the good image-to-price ratio.

Example 3: Cars Automobile manufacturers usually offer product lines, and social status has come to be associated more with particular vehicles than with the manufacturer itself. Luxury cars such as Lexus, Mercedes S-class, or Tesla offer not only increased comfort and safety to their owners as compared to less expensive variants from the same manufacturers, but they also confer status benefits. The associated status depends on price, style, and engineering of the car but also on public opinion (Berger, 2001, p. 160). Moreover, Mercedes Benz introduced the BlueTEC and BlueEFFICIENCY label that additionally allow consumers to signal their concern for the environment in several categories of cars.[30] Mercedes thereby addresses signaling desires in several dimensions: wealth through size of the car and environmental preferences through the label (see Section 4.1).

6 Conclusion

In this paper, I analyze quality provision and prices under the assumption that individuals differ in their valuation of both a product's quality and the social image attached to it. Using a tractable model of heterogeneous image concerns, I show that a monopolistic firm designs a product line to induce a non-trivial partial pooling of consumers. In case of a weakly negative correlation, the empirically most plausible case, the equilibrium prediction generically is an image-building product line with a lower quality masstige good and a high quality luxury good, and thus explains a type of product line that is observed in markets where image concerns play a role (Truong et al., 2009; Heine, 2012). For a given set of parameters, qualities in the image-building product line may be identical while prices differ, and the goods are differentiated in terms of the associated images. This prediction can rationalize the introduction of quality-equivalent store brands in many consumer goods markets (Soberman and Parker, 2006). Counterintuitively, image concerns do not always increase the provision of quality, meaning that image concerns can be detrimental if quality is considered a public good, as seems reasonable when quality is representing working standards, environmentally friendly production methods, or other corporate social responsibility measures.

In a competitive market, consumers' image concerns also induce differentiated product purchases. In contrast to the monopoly case, consumers use excessive quality as a functional excuse to separate from others and improve their image. This upward pressure on quality through image concerns can, for instance, explain the entry of higher-quality private labels in the market for organic products, a market in which increased public attention and political pressure have arguably increased the value of image. While consumers are typically better off with competition, the competitive outcome of separation via excessive quality is less cost-effective than separation in monopoly via strategic product line design. Welfare is higher in monopoly than in competition for a subset of the parameter space.

[30] See `http://www.mercedes-benz.com/fleet-CO2`.

As the paper shows that competition and certain policy measures may have counterintuitive effects, policies in areas where image concerns prevail should rely on a careful combination of theoretical and empirical arguments in order to avoid unintended consequences. Think for instance of non-governmental organizations or government initiatives that “raise awareness” to support products that comply with social or environmental standards and thereby have a public good character. If these actors are not simultaneously in charge of the product line but instead face a profit-maximizing supermarket, as is typically the case, such a policy may have unintended consequences and may lead to lower quality provision in the aggregate.

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A Proofs

In the proofs, consumers are referred to by $\sigma\rho$, i.e. I refer to unconcerned consumers as type 00, to purely image-concerned consumers as type 01, to purely quality-concerned consumers as type 10, and to consumers who value both quality and image as type 11. I index images, qualities, and prices within a product line by L and H to indicate that these values belong to, respectively, the 'low' and 'high' product, where the ranking is based on the image.

Proof of Lemma 1

Proof. Suppose the firm offers a **separating** contract and that given this contract the preferred equilibrium of the firm is played. Due to separation $R_1 = 1$ and $R_0 = 0$. In analogy to the case without image concerns, by profit maximization type 0's participation constraint and type 1's incentive compatibility constraint bind: $p_0 = 0 \cdot s_0 + \lambda R_0 = 0$ and $p_1 = 1 \cdot s_1 - (1-0)s_0 + \lambda(R_1 - R_0) = s_1 - s_0 + \lambda$.

The maximization problem becomes

$$\max_{s_0, s_1} \beta(s_1 - s_0 + \lambda - \frac{1}{2}s_1^2) + (1-\beta)(-\frac{1}{2}s_0^2).$$

Taking derivatives and observing that quality cannot be negative gives

$$\beta(1 - s_1) = 0 \Rightarrow s_1^* = 1 \quad \text{and} \quad -\beta - (1-\beta)s_0 < 0 \Rightarrow s_0^* = 0.$$

Prices are $p_1^* = 1 + \lambda$ and $p_0^* = 0$. It is easily seen that the participation constraint of type 1 and the incentive compatibility constraint of type 0 are fulfilled at these values. The profit corresponding to the separating product line is $\Pi^S = \frac{\beta}{2} + \beta\lambda > 0$. Profit decreases with imperfect separation since then consumers of type 1 do not buy, the image of non-participation becomes positive, and therefore those who do buy pay less.

Suppose there is full **pooling**, i.e. the same product $(s, p) \neq (0, 0)$ is bought by all consumers. The participation constraint of type 0 is the strictest and thus binds: $p = 0 \cdot s + \lambda(\beta 1 + (1-\beta)0 - R_0) = \lambda(\beta - R_0)$. Since the outside good is chosen only out of equilibrium, the consumption stage has a continuum of equilibria with associated images $R_0 = \text{Prob}(\sigma = 1|(0,0)) \in [0, \beta]$. Obviously, the firm's profit from pooling is largest for $R_0 = 0$. In this case profit maximization gives $s^* = 0$ and $p^* = \beta\lambda$. The corresponding profit is $\Pi^P = \beta\lambda < \Pi^S$. The equilibrium offer is separating. If non-participation is associated with higher image out of equilibrium, profits will be even lower and thus pooling is not optimal.[31] □

Proof of Lemma 2

Proof. In a fully separating equilibrium, consumer types are correctly identified with respect to their interest in quality. This prevents purely image-concerned consumers from paying $p > 0$

[31] After the separating contract has been offered, there is another equilibrium in the consumer game. High type consumers could collectively deviate to buying the lower quality thereby realizing higher utility since then $R(0,0) = \beta$. Since the firm would in this case make zero profits, offering this product line cannot be optimal for the firm so that I do not have to consider it further. The same argument applies to equilibria where only a fraction of consumers coordinates.

for $q \geq 0$ as this alone is worthless to them. But offering $q > 0$ at $p \leq 0$ or $q = 0$ at $p < 0$ is not profitable to the monopolist. Thereby purely image-concerned pool with consumers interested in neither image nor quality on the outside option $(0,0)$. □

Proof of Lemma 3

Proof. Suppose to the contrary that the monopolist offers (s_P, p_P) to types 01 and 11, and types 10 and 00 choose $(0,0)$.

Then, $R(0,0) = \frac{\beta(1-\alpha_s)}{(1-\beta)(1-\alpha_n)+\beta(1-\alpha_s)}$, whereas the product (s_P, p_P)—chosen by consumers of types 11 and 01—has $R(s_P, p_P) = \frac{\beta\alpha_s}{(1-\beta)\alpha_n+\beta\alpha_s}$. The maximum price s_P is determined by type 01's participation constraint, $\lambda R(s_P, p_P) - p_P \geq \lambda R(0,0)$. If this is fulfilled, type 11's participation constraint is automatically fulfilled. Thus, $p_P = \lambda(R(s_P, p_P) - R(0,0))$ and the optimal price is independent of quality. Since quality is costly, the monopolist sets $s_P = 0$. The resulting profit is at most $\Pi^* = (\beta\alpha_s + (1-\beta)\alpha_n)\lambda(R(s_P, p_P) - R(0,0)) = (\beta\alpha_s + (1-\beta)\alpha_n)\lambda(\frac{\beta\alpha_s}{(1-\beta)\alpha_n+\beta\alpha_s} - \frac{\beta(1-\alpha_s)}{(1-\beta)(1-\alpha_n)+\beta(1-\alpha_s)})$. Selling instead only to type 11 allows to sell $(s,p) = (1, 1 + \lambda(1 - \frac{\beta(1-\alpha_s)}{1-\alpha_s\beta})$, where the price is determined as the value of quality plus the values of the image achieved on top of the image $R(0,0) = \frac{\beta(1-\alpha_s)}{1-\alpha_s\beta}$ that is in this case associated with the outside option. The corresponding profit is $\Pi^E = \beta\alpha_s(1 + \lambda(1 - \frac{\beta(1-\alpha_s)}{1-\alpha_s\beta}) - \frac{1}{2})$. Profit from only selling to type 11 strictly dominates profits from the offer that pools type 01 and 11:

$$\begin{aligned}\Pi^E - \Pi^* > \frac{\alpha_s\beta}{2} - \alpha_s\beta\lambda\frac{\beta(1-\alpha_s)}{1-\alpha_s\beta} + (\beta\alpha_s + (1-\beta)\alpha_n)\lambda\frac{\beta(1-\alpha_s)}{1-\alpha_s\beta}& \\ = \frac{\alpha_s\beta}{2} + (1-\beta)\alpha_n\lambda\frac{\beta(1-\alpha_s)}{1-\alpha_s\beta} > 0&\end{aligned}$$

□

Proof of Lemma 4

Proof. As consumers who value neither image nor quality always choose $(0,0)$, Lemma 2 implies that no equilibrium product line has more than two different non-zero products. Then, a product line can induce one of 15 consumer partitions (see Proof of Proposition 2). Most of these are inconsistent with profit maximization. First, any equilibrium product line must yield strictly positive profits as the firm would earn a positive profit by offering the same product line as in the absence of image concerns. Second, type 00 chooses $(0,0)$ in any equilibrium, and it is always profitable to sell $s > 0$ to type 11. Thus, no equilibrium will pool 00 and 11. Third, type 01 only buys at $p > 0$ if pooled with type 10 or type 11 because he will only pay for a strictly positive image. Fourth, types 10 and 11 cannot be profitably separated from each other and from a pool of types 01 and 00 because they prefer the same quality-price combination and each of them alone induces image $R = 1$. Fifth, types 01 and 11 cannot be pooled together if the pool does not also include type 10. Suppose to the contrary that the firm offers (s_P, p_P) to types 01 and 11, a different product $(s_{10}, p_{10})) \neq (0,0)$ to type 10, and type 00 chooses $(0,0)$. Then, consumers obtain images $R_0 = 0, R_P = \frac{\beta\alpha_s}{(1-\beta)\alpha_n+\beta\alpha_s}$, and $R_{10} = 1$. Incentive compatibility (IC) for purely quality-concerned consumers requires $s_P - p_P = s_{01} - p_{01} \leq s_{10} - p_{10}$ which implies by $R_P < 1$ that $s_P + \lambda R_P - p_P < s_{10} + \lambda - p_{10}$. This contradicts IC for consumers of type 11. Fourth, suppose that the firm offers $(s,p) \neq (0,0)$ to consumers who care about image, and consumers who do not value image choose $(0,0)$.[32] Then p is determined by the purely image-concerned consumer's participation constraint as $p = \lambda(R(s,p) - R_0)$. As p is independent of quality, and quality is costly, the firm sets $s = 0$. Profit from this type of product line is at most the created image value $\Pi^* = (\beta\alpha_s + (1-\beta)\alpha_n)\lambda(\frac{\beta\alpha_s}{(1-\beta)\alpha_n+\beta\alpha_s} - \frac{\beta(1-\alpha_s)}{(1-\beta)(1-\alpha_n)+\beta(1-\alpha_s)})$. Selling instead only to consumers who value both image and quality allows to sell $(s,p) = (1, 1+\lambda(1-\frac{\beta(1-\alpha_s)}{1-\alpha_s\beta})$ and obtain profits $\Pi^E = \beta\alpha_s(1+\lambda(1-\frac{\beta(1-\alpha_s)}{1-\alpha_s\beta}) - \frac{1}{2}) > \Pi^*$. Finally, Lemmas 2 rules out full separation. The remaining partitions are stated here. $\square$

Optimal product lines for given partitions of consumers The following Lemmas derive the optimal product lines conditional on a specific consumer sorting being the outcome. These product lines are used in Lemma 5 and Proposition 1 to identify which product line maximizes profits.

Lemma A1. *In **standard good**, the firm maximizes profits by*

$$(s,p) = \begin{cases} (1,1) & \text{if } \lambda \leq 1 \\ (\lambda,\lambda) & \text{if } \lambda > 1 \end{cases}$$

for $\lambda \leq 2$. If $\lambda > 2$ a standard good cannot be profitably sustained.

Proof. Types 01 and 00 are not willing to pay for quality, do not buy, and obtain an image of zero $R_0 = 0$. Type 10 buys (s,p) if $s - p \geq 0$. Type 11 receive additional image utility and buys too. As profit increases in p, $s = p$. To prevent type 01 from buying (s,p), it has to fulfill $\lambda R_0 \geq \lambda R - p = \lambda R - s$. Hence, the firm chooses s to maximize $\beta(s - \frac{1}{2}s^2)$ such that $s \geq \lambda R = \lambda$. If the separation is sustained $R = 1$ and thus, $s = \max\{1,\lambda\}$ since $s - \frac{1}{2}s^2$ is maximized at $s = 1$. A standard good is not feasible if $\lambda > 2$. Hindering type 01 from buying would require a quality so high that profit is negative. $\square$

Lemma A2. *In **mass market**, the firm maximizes profits by*

$$(s,p) = \begin{cases} (\lambda R, \lambda R) & \text{if } \lambda R \leq 1 \\ (1,1) & \text{if } \lambda R > 1 \end{cases} \quad \text{where} \quad R = \frac{\beta}{\beta + \alpha_n(1-\beta)}.$$

Proof. Type 00 does not buy and receives image $R_0 = 0$. The remaining group has image $R = \frac{\beta}{\beta+\alpha_n(1-\beta)}$. IC for types 01 and 10 requires $p \leq \min\{\lambda R, s\}$. If these hold, IC for type 11 follows. Since profit is increasing in price and a higher p does not violate any other constraint, $p = \min\{\lambda R, s\}$. I show in two steps that profit maximization requires $s \leq \min\{\lambda R, 1\}$. As profit is increasing in s for $s \leq 1$, $s = \min\{\lambda R, 1\}$.

First, show that $s \leq \lambda R$. Suppose to the contrary $s > \lambda R$. Consider an alternative product $(s', p') = (\lambda R, \lambda R)$. IC is still fulfilled and profit increases. Second, show that $s \leq 1$. From above we know $s \leq \lambda R$ and therefore $p = s$. The firm chooses s to maximize $(\beta + \alpha_n(1-\beta))(s - \frac{1}{2}s^2)$

[32] If the firm offers $(s', p') \neq (0,0)$ to purely quality-concerned consumers, it may decide to sell $s > 0$ to image-concerned consumers. While this would yield a higher profit than the pure image good described in the main text for certain parameters, it is still not optimal.

such that $s \leq \lambda R$. If $\lambda R > 1$, the quality choice is unconstrained and thus $s = 1$. If instead $\lambda R \leq 1$, quality is constrained by $s \leq \lambda R$. $\square$

Lemma A3. *In **image building**, the firm maximizes profits by*

$$(s_L, p_L) = \begin{cases} (\lambda R_L, \lambda R_L) & \textit{if } \lambda R_L \leq 1 \\ (1,1) & \textit{if } \lambda R_L > 1 \end{cases} \textit{ and } (s_H, p_H) = (1, 1 + \lambda(R_H - R_L))$$

where $R_L = \frac{\beta(1-\alpha_s)}{(1-\alpha_s)\beta + \alpha_n(1-\beta)}$ *and* $R_H - R_L = \frac{\alpha_n(1-\beta)}{(1-\alpha_s)\beta+\alpha_n(1-\beta)}$

Proof. Type 00 does not buy and $R_0 = 0$. The group of types 10 and 01 receives image $R_L = \frac{\beta(1-\alpha_s)}{(1-\alpha_s)\beta+\alpha_n(1-\beta)}$ and type 11 gets image $R_H = 1$. IC for type 11 requires $p_H \leq p_L + \lambda(R_H - R_L) + s_H - s_L$. Downward IC of 10 and 01 requires $p_L \leq \min\{\lambda R_L, s_L\}$. Upward IC requires $s_L - p_L \geq s_H - p_H$ and $\lambda R_L - p_L \geq \lambda R_H - p_H$. Profit increases in p_H and all other constraints are relaxed if the price for high quality goes up. Thus, IC for type 11 binds and $p_H = p_L + \lambda(R_H - R_L) + s_H - s_L$. Then, price is chosen as high as possible at $p_L = \min\{\lambda R_L, s_L\}$. Using the same arguments as in the proof of Lemma A2, it follows that $s_L \leq \min\{\lambda R_L, 1\}$. Letting the firm optimize over qualities s_L, s_H yields $s_H = 1$ and $s_L = \min\{\lambda R_L, 1\}$. $\square$

Lemma A4. *In **exclusive good**, the firm maximizes profits by*

$$(s,p) = (1, 1 + \lambda(R - R_0)) \quad \textit{where} \quad R = 1 \textit{ and } R - R_0 = \frac{1-\beta}{1-\alpha_s\beta}.$$

Proof. If 00, 01, and 10 make the same choice, none of them buys because 00 will never buy. The group's image is positive, $R_0 = \frac{(1-\alpha_s)\beta}{1-\alpha_s\beta} < 1$. Type 11 has image $R = 1$. IC for 11 requires $p \leq s + \lambda(R - R_0)$. For 10 not to prefer 11's product requires $s \leq p$ and for 01 IC requires $p \geq \lambda(R - R_0)$. Both are relaxed if p increases and profit goes up. Thus, $p = s + \lambda(R - R_0)$. The profit maximization problem of the firm is then $\max_s \Pi = \beta\alpha_s(s + \lambda(R - R_0) - \frac{1}{2}s^2)$, and it is solved by $s = 1$ and $p = 1 + \lambda(R - R_0) = 1 + \lambda\frac{1-\beta}{1-\alpha_s\beta}$. $\square$

Proof of Lemma 5

Proof. From Lemma A2, profit in mass market is

$$\Pi^M = \begin{cases} \frac{1}{2}\beta\lambda\left(2 - \frac{\beta\lambda}{\beta+\alpha_n(1-\beta)}\right) & \text{if } \lambda \leq \lambda_1 \\ \frac{1}{2}(\alpha_n(1-\beta)+\beta) & \text{otherwise} \end{cases} \tag{A1}$$

Suppose $\lambda \leq \lambda_1$. Rearranging profits $\Pi^I - \Pi^M$ as given in equations A4 and A3, yields

$$\Pi^I - \Pi^M > 0 \Leftrightarrow \lambda^2 \underbrace{\frac{\alpha_s\beta^2(\alpha_n(2-\alpha_s)(1-\beta)+\beta(1-\alpha_s))}{2(\alpha_n(1-\beta)+\beta)((1-\alpha_s)\beta+\alpha_n(1-\beta))}}_{A} + \lambda \underbrace{\frac{(1-\alpha_s)\alpha_s\beta^2}{(1-\alpha_s)\beta+\alpha_n(1-\beta)}}_{B} + \frac{\alpha_s\beta}{2} > 0$$

Since A>0 and B<0, $\Pi^I - \Pi^M$ does not have a real root but $\Pi^I > \Pi^M$ for all $\lambda \geq 0$.

Suppose $\lambda_1 < \lambda \leq \lambda_2$.

$$\Pi^I - \Pi^M > 0$$
$$\Leftrightarrow -\lambda^2 \tfrac{((1-\alpha_s)\beta)^2}{2((1-\alpha_s)\beta+\alpha_n(1-\beta))} + \lambda \tfrac{((1-\alpha_s)\beta)^2+(1-\alpha_s)\beta\alpha_n(1-\beta)+\alpha_n(1-\beta)\alpha_s\beta}{(1-\alpha_s)\beta+\alpha_n(1-\beta)} - \tfrac{(1-\alpha_s)\beta+\alpha_n(1-\beta)}{2} > 0$$

The LHS is a downward-opening parabolic function in λ whose roots enclose the interval $(\lambda_1, \lambda_2]$. Thus, for $\lambda_1 < \lambda \leq \lambda_2$, it takes only positive values and $\Pi^I > \Pi^M$.

Suppose $\lambda > \lambda_2$. In this case, $\Pi^I - \Pi^M = \frac{\alpha_n\alpha_s(1-\beta)\beta\lambda}{(1-\alpha_s)\beta+\alpha_n(1-\beta)} > 0$. □

Proof of Proposition 1 Based on the optimal product lines conditional on a given sorting, I will first characterize the profit functions for all remaining equilibrium candidates, i.e., for standard good, image building, and exclusive good (Lemma A5). Then, I will use these profit functions to identify for which values of λ, each of these equilibrium candidates maximizes profits (Lemmas A6 and A7). Taking both Lemmas together, we arrive at the claim of Proposition 1.

Lemma A5. *Profits from standard good (Π^S), mass market (Π^M), image building (Π^I), and exclusive good (Π^E) are continuous in λ. (i) Π^S is constant for $\lambda < 1$ and decreasing concave for $\lambda \geq 1$. (ii) Π^I is increasing and concave for $\lambda < (R_L^I)^{-1}$ and linearly increasing for $\lambda \geq (R_L^I)^{-1}$. (iii) Π^E is linearly increasing. (iv) Π^M is increasing in λ.*

Proof. Lemmas A1 to A4 yield the following profit functions:

$$\Pi^S = \begin{cases} \frac{\beta}{2} & \text{if } \lambda \leq 1 \\ \beta\left(\lambda - \frac{\lambda^2}{2}\right) & \text{otherwise} \end{cases} \tag{A2}$$

$$\frac{\partial \Pi^S}{\partial \lambda} = \begin{cases} 0 & \text{if } \lambda \leq 1 \\ \beta(1-\lambda) < 0 & \text{otherwise} \end{cases} \qquad \frac{\partial^2 \Pi^S}{\partial \lambda^2} = \begin{cases} 0 & \text{if } \lambda \leq 1 \\ -\beta < 0 & \text{otherwise} \end{cases}$$

$$\Pi^M = \begin{cases} \frac{1}{2}\beta\lambda\left(2 - \frac{\beta\lambda}{\beta+\alpha_n(1-\beta)}\right) & \text{if } \lambda R^M \leq 1 \\ \frac{1}{2}(\alpha_n(1-\beta)+\beta) & \text{otherwise} \end{cases} \tag{A3}$$

$$\frac{\partial \Pi^M}{\partial \lambda} = \begin{cases} \beta - \frac{\beta^2\lambda}{\beta+(1-\alpha_n)\beta} \geq 0 & \text{if } \lambda R^M \leq 1 \\ 0 & \text{otherwise} \end{cases}$$

$$\Pi^I = \begin{cases} \frac{\beta\left(\alpha_n(1-\beta)(\alpha_s+2\lambda)+(1-\alpha_s)\beta\left(\alpha_s(1-\lambda)^2+(2-\lambda)\lambda\right)\right)}{2(\alpha_n(1-\beta)+(1-\alpha_s)\beta)} & \text{if } \lambda R_L^I \leq 1 \\ \frac{1}{2}(\beta+\alpha_n(1-\beta)) + \frac{\alpha_n\alpha_s(1-\beta)\beta\lambda}{(1-\alpha_s)\beta+\alpha_n(1-\beta)} & \text{otherwise} \end{cases} \tag{A4}$$

$$\frac{\partial \Pi^I}{\partial \lambda} = \begin{cases} \frac{\beta(\alpha_n(1-\beta)+(1-\alpha_s)^2\beta(1-\lambda))}{\alpha_n(1-\beta)+(1-\alpha_s)\beta} > 0 \\ \frac{\alpha_n\alpha_s(1-\beta)\beta}{\alpha_n(1-\beta)+(1-\alpha_s)\beta} > 0 \end{cases} \qquad \frac{\partial^2 \Pi^I}{\partial \lambda^2} = \begin{cases} \frac{-(1-\alpha_s)^2\beta^2}{\alpha_n(1-\beta)+(1-\alpha_s)\beta} < 0 \\ 0 \end{cases}$$

$$\Pi^E = \alpha_s\beta\left(\frac{1}{2} + \frac{(1-(1-\alpha_s)\beta-\alpha_s\beta)\lambda}{1-\alpha_s\beta}\right) \qquad \frac{\partial \Pi^E}{\partial \lambda} = \frac{\alpha_s(1-\beta)\beta}{1-\alpha_s\beta} > 0 \qquad \frac{\partial^2 \Pi^E}{\partial \lambda^2} = 0 \tag{A5}$$

Rearranging profits Π^E and Π^I reveals $\Pi^E \leq \Pi^I$ for all λ. $\square$

Lemma A6. *Standard good maximizes profits if* $\lambda \leq \tilde{\lambda}_m$.

Proof. For $\lambda \geq 1$, Π^S is decreasing and Π^M is increasing in λ. Since $\Pi^M > \Pi^S$ at $\lambda = 1$ (equations A2 and A3) and Π^M is never maximal (Lemma 5), we have that $\tilde{\lambda}_m < 1$. Compare first standard good and image building (equations A2 and A4). Rearranging terms gives $\Pi^S - \Pi^I = \lambda^2 - \lambda\frac{2(\alpha_n(1-\beta)+(1-\alpha_s)^2\beta)}{(1-\alpha_s)^2\beta} + \frac{\alpha_n+(1-\alpha_s-\alpha_n)\beta}{(1-\alpha_s)\beta}$, which has two roots $\lambda^{(1),(2)} = 1 + \frac{\alpha_n(1-\beta)}{(1-\alpha_s)^2\beta} \pm \frac{\sqrt{\alpha_n(1-\beta)(\alpha_n(1-\beta)+(1-\alpha_s)^2(1+\alpha_s)\beta)}}{(1-\alpha_s)^2\beta}$ with $\lambda^{(1)} < 1 < \lambda^{(2)}$. Thus,

$$\Pi^S \geq \Pi^I \Leftrightarrow \lambda \leq 1 + \frac{\alpha_n(1-\beta)}{(1-\alpha_s)^2\beta} - \frac{\sqrt{\alpha_n(1-\beta)(\alpha_n(1-\beta)+(1-\alpha_s)^2(1+\alpha_s)\beta)}}{(1-\alpha_s)^2\beta} =: \lambda_{SI} \tag{A6}$$

Comparing standard good and exclusive good (equations A2 and A5) yields

$$\Pi^S \geq \Pi^E \Leftrightarrow \lambda \leq \frac{(1-\alpha_s)(1-\alpha_s\beta)}{2\alpha_s(1-\beta)} =: \lambda_{SE} \tag{A7}$$

From (A6) and (A7) we obtain

$$\tilde{\lambda}_m := \begin{cases} \frac{(1-\alpha_s)(1-\alpha_s\beta)}{2\alpha_s(1-\beta)} & \text{if } \lambda_{SE} \leq \lambda_{SI}. \\ 1 + \frac{\alpha_n(1-\beta)}{(1-\alpha_s)^2\beta} - \frac{\sqrt{\alpha_n(1-\beta)(\alpha_n(1-\beta)+(1-\alpha_s)^2(1+\alpha_s)\beta)}}{(1-\alpha_s)^2\beta} & \text{otherwise.} \end{cases} \tag{A8}$$

We have $\lambda_{SE} \leq \lambda_{SI} \quad \Leftrightarrow \quad \beta < \frac{3\alpha_s-1}{\alpha_s+\alpha_s^2}$ and $\alpha_n \leq \frac{\beta(1+\alpha_s(\beta+\alpha_s\beta-3))^2}{4\alpha_s(1-\beta)^2}$ $\square$

Lemma A7. *Exclusive good maximizes profits if* $\lambda \geq \tilde{\tilde{\lambda}}_m$.

Proof. By Lemma A5 and A6, I have to compare only image building and exclusive good (equations (A4) and (A5)). Suppose $\lambda R_L^I \leq 1$. Rearranging terms yields $\Pi^I - \Pi^E = -\lambda^2 + 2\lambda\frac{\beta(1-\alpha_s)+(1-\beta)\alpha_n-\beta\alpha_s(1-\beta\alpha_s)}{\beta(1-\alpha_s)(1-\beta\alpha_s)}$.

This expression has two real roots $\lambda^{(1)} = 0$ and $\lambda^{(2)} = 2\frac{\beta(1-\alpha_s)+(1-\beta)\alpha_n-\beta\alpha_s(1-\beta\alpha_s)}{\beta(1-\alpha_s)(1-\beta\alpha_s)}$ and it is $\Pi^I > \Pi^E$ if $\lambda \in [0, \min\{\lambda^{(2)}, (R_L^I)^{-1}\}]$. Define for later use

$$\lambda_{\text{IE,low}} := \lambda^{(2)} = 2\frac{\beta(1-\alpha_s)+(1-\beta)\alpha_n-\beta\alpha_s(1-\beta\alpha_s)}{\beta(1-\alpha_s)(1-\beta\alpha_s)} \tag{A9}$$

Suppose now $\lambda R_L^I \geq 1$. Rearranging terms yields

$$\Pi^I \geq \Pi^E \Leftrightarrow \lambda \leq \frac{1}{2}\frac{(\beta(1-\alpha_s)+(1-\beta)\alpha_n)^2(1-\beta\alpha_s)}{(1-\alpha_s)\beta^2\alpha_s(1-\beta)(1-\alpha_n)} =: \lambda_{\text{IE,high}} \tag{A10}$$

Using Lemma A6, we define

$$\tilde{\tilde{\lambda}}_m := \begin{cases} \lambda_{SE} & \text{if } \lambda_{SE} \leq \lambda_{SI}. \\ \lambda_{\text{IE,low}} & \text{if } \lambda_{\text{IE,low}} \leq (R_L^I)^{-1} \text{ and } \lambda_{SE} > \lambda_{SI}. \\ \lambda_{\text{IE,high}} & \text{if } \lambda_{\text{IE,high}} \geq (R_L^I)^{-1} \text{ and } \lambda_{SE} > \lambda_{SI}. \end{cases} \tag{A11}$$

Π^E is linear in λ and Π^I is concave in λ for $\lambda \leq (R_L^I)^{-1}$ and linear thereafter (Lemma A5), and $\Pi^E|_{\lambda=0} < \Pi^I|_{\lambda=0}$. Thus, the range of λ for which image building is optimal is an interval. $\square$

By Lemmas A5 (iv), A6, and A7, the image-building product line maximizes profits if $\lambda \in [\tilde{\lambda}_m, \tilde{\tilde{\lambda}}_m]$, and $\tilde{\tilde{\lambda}}_m = \tilde{\lambda}_m \Leftrightarrow (\beta < \frac{3\alpha_s - 1}{\alpha_s + \alpha_s^2}$ and $\alpha_n < \frac{\beta(1+\alpha_s(\beta+\alpha_s\beta-3))^2}{4\alpha_s(1-\beta)^2})$.

Proof of Corollary 1:

Proof. The proof is by contradiction. Suppose $\alpha_n \geq \alpha_s$ and $\beta < \frac{3\alpha_s-1}{\alpha_s+\alpha_s^2}$ and $\alpha_n < \frac{\beta(1+\alpha_s(\beta+\alpha_s\beta-3))^2}{4\alpha_s(1-\beta)^2}$ so that by Proposition 1 image building is never optimal. As $\beta \geq 0$, we get $\alpha_s \geq \frac{1}{3}$. It is $\alpha_s \leq \alpha_n < \frac{\beta(1+\alpha_s(\beta+\alpha_s\beta-3))^2}{4\alpha_s(1-\beta)^2} < \frac{(1+\alpha_s)(3\alpha_s-1)^3}{16\alpha_s}$. While $\alpha_s < \frac{(1+\alpha_s)(3\alpha_s-1)^3}{16\alpha_s} \Leftrightarrow 27\alpha_s^4 - 34\alpha_s^2 + 8\alpha_s - 1 > 0$, for $\alpha_s > \frac{1}{3}$ we obtain $27\alpha_s^4 - 34\alpha_s^2 + 8\alpha_s - 1 < 0$. $\square$

Proof of Corollary 2

Proof. If $\lambda \in (\frac{(1-\alpha_s)\beta + (1-\beta)\alpha_n}{(1-\alpha_s)\beta}, \tilde{\tilde{\lambda}}_m)$, the monopolist offers an image-building product line according to Proposition 1 because $\frac{(1-\alpha_s)\beta+(1-\beta)\alpha_n}{(1-\alpha_s)\beta} > 1$. Then, $\lambda R_L^I \geq 1$ because $\lambda \geq \frac{(1-\alpha_s)\beta+(1-\beta)\alpha_n}{(1-\alpha_s)\beta}$. Therefore, $s_L = 1 = s_H$. $\square$

Proof of Proposition 2

Proof. The proof proceeds as follows. First, I compute the social welfare for each of the 15 theoretically feasible partitions of consumers. To keep this as clear as possible, partitions are ordered according to the number of groups of consumers that they contain. Based on welfare functions, I can then identify which partitions maximizes social welfare.

The population of four types of consumers can be partitioned in 15 different ways. For each of these, I compute optimal qualities and corresponding welfare.

One group: 1. $\{00, 01, 10, 11\}$ (full pooling): Maximizing the welfare function with respect to qualities yields $s = \beta$. Welfare is

$$\text{(A12)} \quad W_1 = \alpha_n(1-\beta)\left(\lambda\beta - \tfrac{1}{2}\beta^2\right) + \alpha_s\beta\left(\lambda\beta - \tfrac{1}{2}\beta^2 + \beta\right) + (1-\alpha_s)\beta\left(\beta - \tfrac{1}{2}\beta^2\right) - \tfrac{1}{2}(1-\alpha_n)(1-\beta)\beta^2.$$

Two groups: 2. $\{00, 01\}, \{10, 11\}$ (standard good): Maximizing the welfare function with respect to qualities yields $s_L = 0$, $s_H = 1$. Welfare is

$$\text{(A13)} \qquad W_2 = \alpha_s\beta\left(\lambda + \tfrac{1}{2}\right) + (1-\alpha_s)\beta\tfrac{1}{2}.$$

3. $\{00, 10\}, \{01, 11\}$ (image good): Maximizing the welfare function with respect to qualities yields $s_L = \frac{(1-\alpha_s)\beta}{1-\alpha_n(1-\beta)-\alpha_s\beta}$ and $s_H = \frac{\alpha_s\beta}{\alpha_n(1-\beta)+\alpha_s\beta}$. Welfare is

$$\text{(A14)} \quad W_3 = \alpha_s\beta\left(-\frac{\alpha_s^2\beta^2}{2(\alpha_n(1-\beta)+\alpha_s\beta)^2} + \frac{\alpha_s\beta\lambda}{\alpha_n(1-\beta)+\alpha_s\beta} + \frac{\alpha_s\beta}{\alpha_n(1-\beta)+\alpha_s\beta}\right) + \alpha_n(1-\beta)\left(\frac{\alpha_s\beta\lambda}{\alpha_n(1-\beta)+\alpha_s\beta} - \frac{\alpha_s^2\beta^2}{2(\alpha_n(1-\beta)+\alpha_s\beta)^2}\right) - (1-\alpha_n)(1-\beta)\frac{(1-\alpha_s)^2\beta^2}{2(\alpha_n(1-\beta)+\alpha_s\beta-1)^2} + (1-\alpha_s)\beta\left(\frac{(1-\alpha_s)\beta}{1-\alpha_n(1-\beta)-\alpha_s\beta} - \frac{(1-\alpha_s)^2\beta^2}{2(1-\alpha_n(1-\beta)-\alpha_s\beta)^2}\right).$$

4. $\{00,01,10\},\{11\}$ (exclusive good): Maximizing the welfare function with respect to qualities yields $s_L = \frac{(1-\alpha_s)\beta}{1-\alpha_s\beta}$, $s_H = 1$. Welfare is

$$(A15)\quad W_4 = \alpha_s\beta\left(\lambda+\tfrac{1}{2}\right) + \alpha_n(1-\beta)\left(\tfrac{(1-\alpha_s)\beta\lambda}{1-\beta+(1-\alpha_s)\beta} - \tfrac{(1-\alpha_s)^2\beta^2}{2(1-\alpha_s\beta)^2}\right)$$
$$-(1-\alpha_n)(1-\beta)\tfrac{(1-\alpha_s)^2\beta^2}{2(1-\alpha_s\beta)^2} + (1-\alpha_s)\beta\left(\tfrac{(1-\alpha_s)\beta}{1-\alpha_s\beta} - \tfrac{(1-\alpha_s)^2\beta^2}{2(1-\alpha_s\beta)^2}\right).$$

5. $\{00\},\{01,10,11\}$ (mass market): Maximizing the welfare function with respect to qualities yields $s_L = 0$, $s_H = \frac{\beta}{\alpha_n(1-\beta)+\beta}$.

Welfare is

$$(A16)\quad W_5 = \alpha_s\beta\left(-\tfrac{\beta^2}{2\alpha_n(1-\beta)+\beta)^2} + \tfrac{\beta\lambda}{\alpha_n(1-\beta)+\beta} + \tfrac{\beta}{(1-\alpha_n)\beta+\beta}\right)$$
$$+(1-\alpha_s)\beta\left(\tfrac{\beta^2}{2\alpha_n(1-\beta)+\beta)^2} - \tfrac{\beta}{\alpha_n(1-\beta)+\beta}\right) + \alpha_n(1-\beta)\left(\tfrac{\beta\lambda}{\alpha_n(1-\beta)+\beta} - \tfrac{\beta^2}{2\alpha_n(1-\beta)+\beta)^2}\right).$$

6. $\{10\},\{00,01,11\}$: Maximizing the welfare function with respect to qualities yields $s_L = \frac{\alpha_s\beta}{1-\beta(1-\alpha_s)}$ and $s_H = 1$. Welfare is

$$(A17)\quad W_6 = \alpha_n(1-\beta)\left(\tfrac{\alpha_s\beta\lambda}{1-\beta(1-\alpha_s)} - \tfrac{\alpha_s^2\beta^2}{2(1-\beta(1-\alpha_s))^2}\right) - \tfrac{(1-\alpha_n)\alpha_s^2(1-\beta)\beta^2}{2(1-\beta(1-\alpha_s))^2}$$
$$+\alpha_s\beta\left(-\tfrac{\alpha_s^2\beta^2}{2(1-\beta(1-\alpha_s))^2} + \tfrac{\alpha_s\beta\lambda}{1-\beta(1-\alpha_s)} + \tfrac{\alpha_s\beta}{1-\beta(1-\alpha_s)}\right) + \tfrac{1}{2}(1-\alpha_s)\beta.$$

7. $\{01\},\{00,10,11\}$: Maximizing the welfare function with respect to qualities yields $s_L = 0$ and $s_H = \frac{\beta}{1-\alpha_n(1-\beta)}$. Welfare is

$$(A18)\quad W_7 = \alpha_s\beta\left(\tfrac{\beta\lambda}{(1-\alpha_n)(1-\beta)+\beta} + \tfrac{\beta}{1-\alpha_n(1-\beta)} - \tfrac{\beta^2}{2(1-\alpha_n(1-\beta))^2}\right)$$
$$+(1-\alpha_s)\beta\left(\tfrac{\beta}{1-\alpha_n(1-\beta)} - \tfrac{\beta^2}{2(1-\alpha_n(1-\beta))^2}\right) - \tfrac{(1-\alpha_n)(1-\beta)\beta^2}{2(1-\alpha_n(1-\beta))^2}.$$

8. $\{00,11\},\{01,10\}$: Maximizing the welfare function with respect to qualities yields $s_L = \frac{(1-\alpha_s)\beta}{\alpha_n(1-\beta)+(1-\alpha_s)\beta}$ and $s_H = \frac{\alpha_s\beta}{1-\alpha_n(1-\beta)-\beta(1-\alpha_s)}$. Welfare is

$$(A19)\quad W_8 = \alpha_n(1-\beta)\left(\tfrac{(1-\alpha_s)\beta\lambda}{\alpha_n(1-\beta)+(1-\alpha_s)\beta} - \tfrac{(\alpha_s-1)^2\beta^2}{2(\alpha_n\beta-\alpha_n+\alpha_s\beta-\beta)^2}\right)$$
$$+(1-\alpha_s)\beta\left(\tfrac{(\alpha_s-1)\beta}{\alpha_n\beta-\alpha_n+\alpha_s\beta-\beta} - \tfrac{(\alpha_s-1)^2\beta^2}{2(\alpha_n\beta-\alpha_n+\alpha_s\beta-\beta)^2}\right) - \tfrac{(1-\alpha_n)\alpha_s^2(1-\beta)\beta^2}{2(1-\alpha_n(1-\beta)-\beta(1-\alpha_s))^2}$$
$$+\alpha_s\beta\left(\tfrac{\alpha_s\beta\lambda}{(1-\alpha_n)(1-\beta)+\alpha_s\beta} + \tfrac{\alpha_s\beta}{1-\alpha_n(1-\beta)-\beta(1-\alpha_s)} - \tfrac{\alpha_s^2\beta^2}{2(1-\alpha_n(1-\beta)-\beta(1-\alpha_s))^2}\right).$$

Three groups: 9. $\{10\},\{00,01\},\{11\}$: Maximizing the welfare function with respect to qualities yields $s_L = 0$, $s_M = s_H = 1$. Welfare is

$$(A20)\qquad W_9 = \alpha_s\beta\left(\lambda+\frac{1}{2}\right)+\frac{1}{2}(1-\alpha_s)\beta.$$

10. $\{00\},\{01,10\},\{11\}$ (image building): Maximizing welfare with respect to qualities yields $s_L=0$,$s_M=\frac{(1-\alpha_s)\beta}{\alpha_n(1-\beta)+(1-\alpha_s)\beta}$, and $s_H=1$. Welfare is

$$\text{(A21)}\quad W_{10}=\ \alpha_n(1-\beta)\left(\tfrac{(1-\alpha_s)\beta\lambda}{\alpha_n(1-\beta)+(1-\alpha_s)\beta}-\tfrac{(1-\alpha_s)^2\beta^2}{2(\alpha_n(1-\beta)+(1-\alpha_s)\beta)^2}\right)$$
$$+(1-\alpha_s)\beta\left(\tfrac{(1-\alpha_s)\beta}{\alpha_n(1-\beta)+\beta(1-\alpha_s)}-\tfrac{(1-\alpha_s)^2\beta^2}{2(\alpha_n(1-\beta)+(1-\alpha_s)\beta)^2}\right)+\alpha_s\beta\left(\lambda+\tfrac{1}{2}\right).$$

11. $\{01\},\{10,11\},\{00\}$: Maximizing the welfare function with respect to qualities yields $s_L=s_M=0$, $s_H=1$. Welfare is

$$\text{(A22)}\qquad W_{11}=\alpha_s\beta\left(\lambda+\tfrac{1}{2}\right)+\tfrac{1}{2}(1-\alpha_s)\beta.$$

12. $\{10\},\{00,11\},\{01\}$: Maximizing the welfare function with respect to qualities yields $s_L=0$, $s_M=\frac{\alpha_s\beta}{1-\alpha_n(1-\beta)-\beta(1-\alpha_s)}$, $s_H=1$. Welfare is

$$\text{(A23)}\quad W_{12}=\alpha_s\beta\left(-\tfrac{\alpha_s^2\beta^2}{2(\alpha_n\beta-\alpha_n+\alpha_s\beta-\beta+1)^2}+\tfrac{\alpha_s\beta\lambda}{(1-\alpha_n)(1-\beta)+\alpha_s\beta}+\tfrac{\alpha_s\beta}{\alpha_n\beta-\alpha_n+\alpha_s\beta-\beta+1}\right)$$
$$-\tfrac{(1-\alpha_n)\alpha_s^2(1-\beta)\beta^2}{2(\alpha_n\beta-\alpha_n+\alpha_s\beta-\beta+1)^2}+\tfrac{1}{2}(1-\alpha_s)\beta.$$

13. $\{11\},\{10,00\},\{01\}$: Maximizing the welfare function with respect to qualities yields $s_L=0$, $s_M=\frac{(1-\alpha_s)\beta}{1-\alpha_n(1-\beta)-\alpha_s\beta}$, $s_H=1$. Welfare is

$$\text{(A24)}\quad W_{13}=\ -\tfrac{(1-\alpha_n)(1-\alpha_s)^2(1-\beta)\beta^2}{2(1-\alpha_n(1-\beta)-\alpha_s\beta)^2}+\alpha_s\beta\left(\lambda+\tfrac{1}{2}\right)$$
$$+(1-\alpha_s)\beta\left(\tfrac{(1-\alpha_s)\beta}{1-\alpha_n(1-\beta)-\alpha_s\beta}-\tfrac{(1-\alpha_s)^2\beta^2}{2(1-\alpha_n(1-\beta)-\alpha_s\beta)^2}\right).$$

14. $\{10\},\{01,11\},\{00\}$: Maximizing the welfare function with respect to qualities yields $s_L=0$, $s_M=\frac{\alpha_s\beta}{\alpha_n(1-\beta)+\alpha_s\beta}$, $s_H=1$. Welfare is

$$\text{(A25)}\quad W_{14}=\ \alpha_s\beta\left(\tfrac{\alpha_s\beta\lambda}{\alpha_n(1-\beta)+\alpha_s\beta}+\tfrac{\alpha_s\beta}{\alpha_n(1-\beta)+\alpha_s\beta}-\tfrac{\alpha_s^2\beta^2}{2(\alpha_n(1-\beta)+\alpha_s\beta)^2}\right)$$
$$+\alpha_n(1-\beta)\left(\tfrac{\alpha_s\beta\lambda}{\alpha_n(1-\beta)+\alpha_s\beta}-\tfrac{\alpha_s^2\beta^2}{2(\alpha_n(1-\beta)+\alpha_s\beta)^2}\right)+\tfrac{1}{2}(1-\alpha_s)\beta.$$

Four groups: 15. $\{00\},\{01\},\{10\},\{11\}$ (full separation): In this setting, optimal qualities are obviously $s_{00}=0$, $s_{01}=0$, $s_{10}=1$, $s_{11}=1$. Welfare is

$$\text{(A26)}\qquad W_{15}=\beta\left(\alpha_s\lambda+\tfrac{1}{2}\right).$$

Rearranging yields $W_2>W_3$, $W_2>W_{15}$, $W_2>W_6$, $W_2>W_7$, $W_2>W_9$, $W_2>W_{11}$, $W_2>W_{12}$, $W_2>W_{13}$, $W_2>W_{14}$, $W_{10}>W_8$, $W_{10}>W_5>W_1$, and $W_{10}>W_4$. so that the only two candidates for welfare maximization are partitions 2 and 10. Furthermore,

$$\text{(A27)}\qquad W_2>W_{10}\Leftrightarrow\frac{\alpha_n(\alpha_s-1)(\beta-1)\beta(1-2\lambda)}{2\beta(\alpha_n+\alpha_s-1)-2\alpha_n}\Leftrightarrow\lambda>\frac{1}{2}$$

It is straightforward to show that for the given prices, all relevant incentive compatibility and participation constraints are satisfied. □

Proof of Corollary 3

Proof. According to the welfare maximizing allocation, consumers who value either quality or image are provided with $s_L^w = \frac{(1-\alpha_s)\beta}{\alpha_n(1-\beta)+(1-\alpha_s)\beta}$ but the profit-maximizing allocation to these consumers for $\lambda \in [\tilde{\lambda}_m, \tilde{\tilde{\lambda}}_m]$ is, according to the image-building product line, $s_L^m = \frac{(1-\alpha_s)\beta\lambda}{\alpha_n(1-\beta)+(1-\alpha_s)\beta}$. It is $s_L^w > s_L^m \Leftrightarrow \lambda < 1$. For $\lambda > \tilde{\tilde{\lambda}}_m$, the profit-maximizing product line is an exclusive good which allocates $s = 0 < s_L^w$ to consumers who value either quality or image. □

Proof of Corollary 4

Proof. Consider the standard good allocation for $\lambda \leq \frac{1}{2}$. Types 01 and 00 are not willing to pay for quality, do not buy, and obtain an image of zero $R_0 = 0$. Neither of the two can do better by choosing the product with quality $s = 1$ at a price $p = 1$, as utility of type 01 would be utility from image minus the price, i.e., $\lambda - 1 \leq -\frac{1}{2} < 0$, and utility of type 00 would be $-p = -1 < 0$. Type 10 buys (s, p) if $s - p \geq 0$ which clearly holds. Type 11 receive additional image utility and buys too.

Consider now the image-building allocation for $\lambda > \frac{1}{2}$ with $p_L = \min\{R_L, \lambda R_L\}$ and $p_H = p_L + \lambda(R_H - R_L) + s_H - s_L$. First, note that in the candidate allocation, type 00 does not buy and $R_0 = 0$. Moreover, the group of types 10 and 01 receives image $R_L = \frac{\beta(1-\alpha_s)}{(1-\alpha_s)\beta+\alpha_n(1-\beta)}$ and type 11 gets image $R_H = 1$. IC for type 11 holds with equality for the specified price. Downward IC of 10 and 01 holds, because $p_L = \min\{R_L, \lambda R_L\} = \min\{s_L, \lambda R_L\}$ at the welfare-optimal quality level $s_L = R_L$. Upward IC for type 10 requires $s_L - p_L \geq s_H - p_H$ which is equivalent to $\lambda(R_H - R_L) \geq 0$ and holds with strict inequality by construction. Upward IC for type 01 requires $\lambda R_L - p_L \geq \lambda R_H - p_H$ which is equivalent to $s_H - s_L \geq 0$ which again holds with strict inequality for the welfare-optimal quality levels. □

Proof of Proposition 3

Proof. Suppose the monopolist has to obey a MQS of $\underline{s} = 1$. Products in the standard good and the exclusive good are unaffected by the MQS. For the mass market (see Lemma A2) the monopolist then chooses $s = \max\{1, \min\{1, \lambda R\}\} = 1$. Prices are adjusted such that incentive compatibility is fulfilled. The optimal product offer is

$$(s, p) = \begin{cases} (1, \lambda R) & \text{if } \lambda \leq R^{-1} \\ (1, 1) & \text{if } \lambda > R^{-1} \end{cases}$$

For the image building product line (see Lemma A3) the monopolist cannot decrease quality below 1 and chooses $s_L = \max\{1, \min\{1, \lambda R_L\}\} = 1$. Incentive compatibility requires that the price for the high quality product is adjusted upwards. For $\lambda < R^{-1}$, the price for the low quality product lies below its quality since otherwise the purely image-concerned consumer would not buy. This yields the optimal product line as

$$(s_L, p_L) = \begin{cases} (1, \lambda R_L) & \text{if } \lambda \leq R_L^{-1} \\ (1, 1) & \text{if } \lambda > R_L^{-1} \end{cases} \quad (s_H, p_H) = \begin{cases} (1, \lambda) & \text{if } \lambda \leq R_L^{-1} \\ (1, 1 + \lambda(1 - R_L)) & \text{if } \lambda > R_L^{-1} \end{cases}$$

From this I compute profits for each consumer partition. For any set of parameters, the equilibrium with regulation is given by the offer which maximizes profits. Then, I compute consumer surplus for each equilibrium, and also welfare as the sum of consumers surplus and profit. I compare consumer surplus and welfare with regulation with results from Section 2.3. The proof is completed by Examples A1 and A2:

Example A1. *Suppose $\alpha_n = \frac{3}{4}, \alpha_s = \frac{1}{48}, \beta = \frac{13}{64}, \lambda = 3$. With and without regulation, the monopolist offers an image building product line. The introduction of the MQS $\underline{s} = 1$ decreases profits from 0.38484 to 0.20898 but increases consumer surplus from 0.00317 to 0.05414. The former effect is stronger: Welfare is 0.38801 without regulation and only 0.26312 with the MQS.*

Example A2. *Suppose $\alpha_n = \frac{3}{4096}, \alpha_s = \frac{1}{224}, \beta = \frac{1}{4096}, \lambda = 2$. The monopolist offers an image building product line without regulation and an exclusive good in the presence of the MQS $\underline{s} = 1$. Consumer surplus decreases from 5.43230×10^{-7} without regulation to 3.56475×10^{-7} with the MQS. Profit also decreases. Welfare decreases from 0.00037 without regulation to 3.08073×10^{-6} with regulation.*

□

Proof of Lemma 6

Proof. There cannot be a partially pooling equilibrium at another product since purely quality-concerned consumers will always defect to buying $(1, \frac{1}{2})$.

Moreover, for $\lambda < \frac{1}{2}\frac{\alpha_n(1-\beta)+(1-\alpha_s)\beta}{(1-\alpha_s)\beta}$, purely image-concerned consumers must be indifferent between $(1, \frac{1}{2})$ and $(0, 0)$. In equilibrium only a fraction q of the purely image-concerned consumers buy $(1, \frac{1}{2})$. The associated image is then $R(1, \frac{1}{2}, q) = \frac{\beta}{q(1-\beta)\alpha_n+\beta}$. The indifference condition for purely image-concerned consumers pins down its participation probability q and thereby the associated image uniquely:

$$\text{(A28)} \qquad \lambda\frac{\beta}{q(1-\beta)\alpha_n+\beta} = \frac{1}{2} \quad \Leftrightarrow \quad q = (2\lambda - 1)\frac{\beta\alpha_s}{(2-\beta)\alpha_n}$$

Images associated with all other products must be such that no consumer type wants to switch. This is ensured for instance by beliefs $\mu(s', p') = 0$ for all $(s', p') \neq (1, \frac{1}{2})$. □

Proof of Lemma 7

Proof. Suppose two products $(1, \frac{1}{2})$ and $(1, \frac{1}{2} + \eta)$ with $\eta > 0$ constitute a partially separating equilibrium: type 11 buys $(s, \frac{1}{2}s^2 + \eta)$, type 10 buys $(1, \frac{1}{2})$, type 00 chooses $(0, 0)$. Type 01 buys $(1, \frac{1}{2})$ with probability q and chooses $(0, 0)$ with probability $1 - q$, where q is given in equation 6. Images are $R(0, 0) = 0$, $R(1, \frac{1}{2}) = \frac{\beta(1-\alpha_s)}{\beta(1-\alpha_s)+q(1-\beta)\alpha_n}$, and $R(s, \frac{1}{2}s^2 + \eta) = 1$. Suppose out-of-equilibrium beliefs are $\mu(s, p) = 0$ for all other products.

Clearly, type 10 prefers $(1, \frac{1}{2})$ over any other product independent of beliefs.

Type 01 indeed prefers $(1, \frac{1}{2})$ over $(s, \frac{1}{2}s^2 + \eta)$ in the proposed equilibrium if

$$\text{(A29)} \quad U_{01}(1, \frac{1}{2}, R(1, \frac{1}{2})) \geq U_{01}(s, \frac{1}{2}s^2 + \eta, R(s, \frac{1}{2}s^2 + \eta))$$
$$\Leftrightarrow \lambda \frac{\beta(1-\alpha_s)}{\beta(1-\alpha_s) + q(1-\beta)\alpha_n} - \frac{1}{2} \geq \lambda - \frac{1}{2}s^2 - \eta$$
$$\Leftrightarrow \eta \geq \underline{\eta} := \lambda \frac{q(1-\beta)\alpha_n}{\beta(1-\alpha_s) + q(1-\beta)\alpha_n} + \frac{1}{2}(1-s^2)$$

For $\lambda < \frac{1}{2}\frac{(1-\alpha_s)\beta + q\alpha_n(1-\beta)}{(1-\alpha_s)\beta}$, participation of type 01 is partial since the image of the low quality product under full participation is too low to compensate for the price of $\frac{1}{2}$. The participation probability q of type 01 is given in Equation 6.

Consumer type 11 prefers $(s, \frac{1}{2}s^2 + \eta)$ over $(1, \frac{1}{2})$ if

$$\text{(A30)} \quad U_{11}(1, \frac{1}{2}, R(1, \frac{1}{2})) \leq U_{11}(s, \frac{1}{2}s^2 + \eta, R(s, \frac{1}{2}s^2 + \eta)$$
$$\Leftrightarrow 1 + \lambda \frac{\beta(1-\alpha_s)}{\beta(1-\alpha_s) + q(1-\beta)\alpha_n} - \frac{1}{2} \leq s + \lambda - \frac{1}{2}s^2 - \eta$$
$$\Leftrightarrow \eta \leq \bar{\eta} := \lambda \frac{q(1-\beta)\alpha_n}{\beta(1-\alpha_s) + q(1-\beta)\alpha_n} + (s-1) + \frac{1}{2}(1-s^2)$$

It follows from (A29) and (A30) that there is a continuum separating equilibria with two products: $(1, \frac{1}{2})$ is bought by type 10 and type 01, $(s, \frac{1}{2}s^2 + \eta)$ with $s > 1$ and $\eta \in (\underline{\eta}, \bar{\eta})$ is bought by type 11, and type 00 chooses the outside good $(0, 0)$. The following beliefs sustain this as an equilibrium:

$$\mu(s,p) = \begin{cases} 1 & \text{if } (s,p) = (s, \frac{1}{2}s^2 + \eta) \text{ with } s > 1, \quad \eta \in (\underline{\eta}, \bar{\eta}) \\ \frac{\beta(1-\alpha_s)}{\beta(1-\alpha_s) + q(1-\beta)\alpha_n} & \text{if } (s,p) = (1, \frac{1}{2}) \\ 0 & \text{else.} \end{cases}$$

With these beliefs, any other product—associated with zero image—is less attractive to consumer type 11 and 01 than $(1, \frac{1}{2})$.

Suppose now $\eta = 0$ and let us write $s = 1 = \varepsilon$ with $\varepsilon > 0$. Type 01 indeed prefers $(1, \frac{1}{2})$ over $(1+\varepsilon, \frac{(1+\varepsilon)^2}{2})$ in the proposed equilibrium if

$$\text{(A31)} \quad U_{01}(1, \frac{1}{2}, R(1, \frac{1}{2})) > U_{01}(1+\varepsilon, \frac{(1+\varepsilon)^2}{2}, R(1+\varepsilon, \frac{(1+\varepsilon)^2}{2}))$$
$$\Leftrightarrow \lambda \frac{\beta(1-\alpha_s)}{\beta(1-\alpha_s) + q(1-\beta)\alpha_n} - \frac{1}{2} > \lambda - \frac{(1+\varepsilon)^2}{2}$$
$$\Leftrightarrow \varepsilon > \underline{\varepsilon} := \sqrt{1 + 2\lambda \frac{q(1-\beta)\alpha_n}{\beta(1-\alpha_s) + q(1-\beta)\alpha_n}} - 1$$

For $\lambda < \frac{1}{2}\frac{(1-\alpha_s)\beta + q\alpha_n(1-\beta)}{(1-\alpha_s)\beta}$, participation of type 01 is partial since the image of the low quality product under full participation is too low to compensate for the price of $\frac{1}{2}$. The participation probability q of type 01 is

$$q = \begin{cases} (2\lambda - 1)\frac{\beta\alpha_s}{(1-\beta)\alpha_n} & \text{if } \frac{1}{2} < \lambda \leq \frac{1}{2}\frac{(1-\alpha_s)\beta + q\alpha_n(1-\beta)}{(1-\alpha_s)\beta} \\ 1 & \text{if } \lambda > \frac{1}{2}\frac{(1-\alpha_s)\beta + q\alpha_n(1-\beta)}{(1-\alpha_s)\beta} \end{cases}$$

Consumer type 11 prefers $(1+\varepsilon, \frac{(1+\varepsilon)^2}{2})$ over $(1, \frac{1}{2})$ if

$$\text{(A32)} \quad U_{11}(1, \frac{1}{2}, R(1, \frac{1}{2})) < U_{11}(1+\varepsilon, \frac{(1+\varepsilon)^2}{2}, R(1+\varepsilon, \frac{(1+\varepsilon)^2}{2}))$$
$$\Leftrightarrow 1 + \lambda \frac{\beta(1-\alpha_s)}{\beta(1-\alpha_s) + q(1-\beta)\alpha_n} - \frac{1}{2} < 1 + \varepsilon + \lambda - \frac{(1+\varepsilon)^2}{2}$$
$$\Leftrightarrow \varepsilon < \bar{\varepsilon} := \sqrt{2\lambda \frac{q(1-\beta)\alpha_n}{\beta(1-\alpha_s) + q(1-\beta)\alpha_n}}$$

It follows from (A31) and (A32) that there is a continuum of separating equilibria $(1+\varepsilon, \frac{(1+\varepsilon)^2}{2})$ such that $\varepsilon \in [\underline{\varepsilon}, \bar{\varepsilon}]$. The following beliefs sustain $(1, \frac{[1}{2}), (1+\varepsilon, \frac{(1+\varepsilon)^2}{2})$ as an equilibrium:

$$\mu(s,p) = \begin{cases} 1 & \text{if } (s,p) = (1+\varepsilon, \frac{(1+\varepsilon)^2}{2}) \\ \frac{\beta(1-\alpha_s)}{\beta(1-\alpha_s)+q(1-\beta)\alpha_n} & \text{if } (s,p) = (1, \frac{1}{2}) \\ 0 & \text{else.} \end{cases}$$

With these beliefs, any other product—associated with zero image—is less attractive to consumer type 11 and 01 than $(1, \frac{1}{2})$. □

Proof of Proposition 4

Proof. For the second part, suppose $\lambda > \frac{1}{2}$. I first show that among the separating equilibria a unique one is consistent with the Intuitive Criterion (IC). In this separating equilibrium $\varepsilon = \underline{\varepsilon}$. Then, I show that no pooling equilibrium is consistent with IC.

(i) The proof is by contradiction. Assume there is a separating equilibrium as derived in Lemma 7 with $\varepsilon > \underline{\varepsilon}$ (see equation A31). Sustaining this equilibrium would require the belief on $(1+\underline{\varepsilon}, \frac{1+\underline{\varepsilon}}{2})$ to be sufficiently low. A necessary condition for "sufficiently low" is $\mu(1+\underline{\varepsilon}, \frac{1+\underline{\varepsilon}}{2}) < 1$. However, type 00 would do worse by buying $(1+\underline{\varepsilon}, \frac{1+\underline{\varepsilon}}{2})$ instead of choosing $(0,0)$ for any belief. Type 01 cannot profit from deviating to $(1+\underline{\varepsilon}, \frac{1+\underline{\varepsilon}}{2})$ for any belief $R(1+\underline{\varepsilon}, \frac{1+\underline{\varepsilon}}{2}) \in [0,1]$ by definition of $\underline{\varepsilon}$ (see the proof of Lemma 7, in particular Equation A32). Also type 10 is better off buying $(1, \frac{1}{2})$ than anything else, independent of beliefs. Only type 11 can strictly profit from deviating from $(1+\varepsilon, \frac{1+\varepsilon}{2})$ to $(1+\underline{\varepsilon}, \frac{1+\underline{\varepsilon}}{2})$. Thus, the only belief consistent with the Intuitive Criterion is $\mu(1+\underline{\varepsilon}, \frac{1+\underline{\varepsilon}}{2}) = 1$ for which type 11 is better off buying $(1+\underline{\varepsilon}, \frac{1+\underline{\varepsilon}}{2})$ than $(1+\varepsilon, \frac{1+\varepsilon}{2})$.

The same argument goes through for all potentially separating equilibria, where $s = 1+\varepsilon$ and $p > \frac{1+\varepsilon}{2}$. The only separating equilibrium, which remains is $(1, \frac{1}{2})$ and $(1+\underline{\varepsilon}, \frac{(1+\varepsilon)^2}{2})$ with participation behavior and beliefs as defined in Lemma 7.

(ii) Consider a pooling equilibrium where type 01 buys $(1, \frac{1}{2})$ with probability q as defined in Equation 5 and with probability $1-q$ type 01 choose $(0,0)$ so that $R(1, \frac{1}{2}) = \frac{\beta}{q(1-\beta)\alpha_n + \beta}$. I show in the following that there always exists $\varepsilon > 0$ such that type 11 profits from deviating to product $(1+\varepsilon, \frac{(1+\varepsilon)^2}{2})$ if he beliefs this to be associated with $R = 1$, while type 01 cannot profit from deviating for any belief. But then, according to the Intuitive Criterion, $R(1+\varepsilon, \frac{(1+\varepsilon)^2}{2}) = 1$ since for $R(1+\varepsilon, \frac{(1+\varepsilon)^2}{2}) < 1$ we would assign positive probability to a type who would never gain from choosing this product.

Choose $\varepsilon > 0$ such that $\frac{\varepsilon}{2} < \lambda(1 - \frac{q(1-\beta)\alpha_n}{\beta(1-\alpha_s)+q(1-\beta)\alpha_n}) < \varepsilon + \frac{\varepsilon}{2}$. Then, for the product $(1+\varepsilon, \frac{(1+\varepsilon)^2}{2})$ the following holds:

(a) For the most favorable belief $R(1+\varepsilon, \frac{(1+\varepsilon)^2}{2}) = 1$, type 11 gains from separating:

$$U_{11}(1, \tfrac{1}{2}, R(1, \tfrac{1}{2})) < U_{11}(1+\varepsilon, \tfrac{(1+\varepsilon)^2}{2}, R = 1) \Leftrightarrow \tfrac{\varepsilon}{2} < \lambda(1 - \tfrac{q(1-\beta)\alpha_n}{\beta(1-\alpha_s)+q(1-\beta)\alpha_n}) \tag{A33}$$

(b) Type 01 cannot gain from deviating to $(1+\varepsilon, \frac{(1+\varepsilon)^2}{2})$ even for the most favorable belief $R(1+\varepsilon, \frac{(1+\varepsilon)^2}{2}) = 1$:

$$U_{01}(1+\varepsilon, \tfrac{(1+\varepsilon)^2}{2}, \mu = 1) < U_{01}(1, \tfrac{1}{2}, R(1, \tfrac{1}{2})) \Leftrightarrow \lambda(1 - \tfrac{q(1-\beta)\alpha_n}{\beta(1-\alpha_s)+q(1-\beta)\alpha_n}) < \varepsilon + \tfrac{\varepsilon}{2} \tag{A34}$$

□

Proof of Corollary 6

Proof. The first part is obvious from Propositions 2 and 4. Suppose that $\lambda > \frac{1}{2}$. In the competitive allocation, consumers who value either quality or image purchase a product with $s_L^c = 1$. The welfare-maximizing allocation is $s_L^w = \frac{(1-\alpha_s)\beta}{\alpha_n(1-\beta)+(1-\alpha_s)\beta} < 1$. Consumers who care about both image and quality purchase a product with $s_H^c > 1 = s_H^w$. □

Proof of Proposition 5

Proof. The proof is by example.

Example A3. *Suppose $\lambda = 1$, $\beta = 0.5$, $\alpha_n = 0.5$, and $\alpha_s = 0.5$, put verbally, half of the population values quality, half is concerned with their image, the image concern is independent of the taste for quality, and image and quality are weighed equally in the utility function. Then $\tilde{\lambda}_m = .5 < \lambda < 6 = \tilde{\tilde{\lambda}}_m$. Welfare in monopoly, which yields image building, is 0.5625 whereas welfare in competition, which yields functional excuse, is 0.478553.*

Welfare in monopoly is continuous in λ for $\lambda \notin \{\tilde{\lambda}_m, \tilde{\tilde{\lambda}}_m\}$ and in competition for $\lambda \neq \frac{1}{2}$. Thus, we find parameter constellations close to the example such that welfare with monopoly is still higher than welfare with competition. □

Proof of Corollary 7

Proof. Purely image-concerned consumers either buy quality s at price $p = s$ or choose $(0, 0)$ in monopoly. Both yield zero surplus, whereas they receive surplus $\frac{1}{2}$ in competition from buying $(1, \frac{1}{2})$ for all λ.

For consumers who value image and quality, surplus in monopoly is

$$\text{(A35)} \qquad \mathrm{CS}_{11}^{\mathrm{mon}} = \begin{cases} \lambda & \text{if } \lambda < \tilde{\lambda}_m \\ \lambda \frac{(1-\alpha_s)\beta}{(1-\alpha_s)\beta+\alpha_n(1-\beta)} & \text{if } \tilde{\lambda}_m < \lambda < \tilde{\tilde{\lambda}}_m \\ \lambda \frac{(1-\alpha_s)\beta}{(1-\alpha_s)\beta+1-\beta} & \text{if } \lambda > \tilde{\tilde{\lambda}}_m \end{cases}$$

In competition, surplus to consumers who value image and quality is

$$\text{(A36)} \qquad \mathrm{CS}_{11}^{\mathrm{comp}} = \begin{cases} \lambda + \frac{1}{2} & \text{if } \lambda \leq \frac{1}{2} \\ \lambda + (s - \frac{s^2}{2}) \text{ with } s = \sqrt{1 + 2\lambda \frac{(1-\beta)\alpha_n}{(1-\beta)\alpha_n+\beta(1-\alpha_s)}} & \text{if } \lambda > \frac{1}{2} \end{cases}$$

Thus, for type 11 consumers monopoly surplus is highest in image building and competitive surplus is lowest in functional excuse with full participation of types 01. Therefore, I only evaluate this most extreme case.

$$\text{(A37)} \qquad \mathrm{CS}_{11}^{\mathrm{mon}} - \mathrm{CS}_{11}^{\mathrm{comp}} = \frac{1}{2} - \sqrt{1 + 2\lambda \frac{\alpha_n(1-\beta)\lambda}{(1-\alpha_s)\beta + \alpha_n(1-\beta)}} \leq 0 \text{ for all } \lambda > 0$$

Even in this case, competition yields higher surplus to types 11. So they are always better off with competition.

Consumers who value only image can be worse off under competition as demonstrated by the following example. Apart from jump points at $\lambda \in \{\tilde{\lambda}_m, \tilde{\tilde{\lambda}}_m, \frac{\alpha_n(1-\beta)+(1-\alpha_s)\beta}{(1-\alpha_s)\beta}\}$, the surplus to consumers who value only image, is continuous in λ and is continuous in other parameters. Thus, the example is generic.

Example A4. *Suppose $\alpha_s = 0.625, \alpha_n = 0.25, \beta = 0.625$, and $\lambda = 1.5$. Then, surplus to purely image-concerned consumers is 0.576923 in monopoly, which yields an exclusive good. The surplus purely image-concerned consumers is only 0.571429 in competition, where functional excuse obtains.*

□

Proof of Corollary 8

Proof. Consumers who value neither image nor quality obtain a surplus of 0 in either case. Consumers who value quality profit from competition as proven in Corollary 7.

For consumers who value only image obtain, surplus in monopoly is

$$\mathrm{CS}_{01}^{\mathrm{mon}} = \begin{cases} 0 & \text{if } \lambda < \tilde{\lambda}_m \\ 0 & \text{if } \tilde{\lambda}_m < \lambda < \tilde{\tilde{\lambda}}_m \text{ and } \lambda \leq \lambda_1 \\ \lambda \frac{((1-\alpha_s)\beta)}{\alpha_n(1-\beta)+(1-\alpha_s)\beta} - 1 & \text{if } \tilde{\lambda}_m < \lambda < \tilde{\tilde{\lambda}}_m \text{ and } \lambda > \lambda_1 \\ \lambda \frac{((1-\alpha_s)\beta)}{1-\alpha_s\beta} & \text{if } \lambda > \tilde{\tilde{\lambda}}_m \end{cases}$$

In competition, surplus to this consumer type is

$$\mathrm{CS}_{01}^{\mathrm{comp}} = \begin{cases} 0 & \text{if } \lambda \leq \frac{1}{2} \\ \lambda \frac{((1-\alpha_s)\beta)}{\alpha_n(1-\beta)+(1-\alpha_s)\beta} - \frac{1}{2} & \text{if } \lambda > \frac{1}{2} \end{cases}$$

If image building would give positive surplus to consumers who value only image, competition leads to the functional excuse equilibrium:

$$\text{(A38)} \qquad \lambda \frac{((1-\alpha_s)\beta)}{\alpha_n(1-\beta)+(1-\alpha_s)\beta} > 1$$

$$\text{(A39)} \qquad \Leftrightarrow \qquad \lambda > \frac{\alpha_n(1-\beta)+(1-\alpha_s)\beta}{(1-\alpha_s)\beta} > \frac{1}{2}$$

For $\lambda \leq \lambda_1$, image building yields zero surplus to consumers who value only image so that functional excuse does clearly better. Also for $\lambda > \lambda_1$, surplus to purely image-concerned consumers from image building is always lower than that from functional excuse: $\mathrm{CS}_{01}^{\mathrm{mon}} - \mathrm{CS}_{01}^{\mathrm{comp}} = -\frac{1}{2}$.

□

Proof of Proposition 6

Proof. Any single-product equilibrium features $s = 1$ and is unaffected. Suppose we are in a two-product equilibrium. By Proposition 4 the product chosen by type 11 in this equilibrium is characterized by $\tilde{s} = \sqrt{1 + \frac{2\alpha_n(1-\beta)\lambda}{\alpha_n(1-\beta)+(1-\alpha_s)\beta}} > 1$. $MC(\tilde{s}) = \frac{1}{2} + \frac{\alpha_n(1-\beta)\lambda}{\alpha_n(1-\beta)+(1-\alpha_s)\beta}$ is just high enough to ensure that type 01 prefers to buy $(1, \frac{1}{2})$.

Choose $0 < \varepsilon < \sqrt{1 + \frac{2\alpha_n(1-\beta)\lambda}{\alpha_n(1-\beta)+(1-\alpha_s)\beta}} - 1$. For each product (s, p) set the tax to

$$\text{(A40)} \qquad t(s,p) = \begin{cases} 0 & \text{if } s \leq 1 \\ \lambda \frac{\alpha_n(1-\beta)}{\alpha_n(1-\beta)+(1-\alpha_s)\beta} & \text{if } s > 1 \text{ and } s \neq 1+\varepsilon \\ \lambda \frac{\alpha_n(1-\beta)}{\alpha_n(1-\beta)+(1-\alpha_s)\beta} - \varepsilon^2 & \text{if } s = 1+\varepsilon \end{cases}$$

Then, type 11 is best off choosing $(1+\varepsilon, MC(1+\varepsilon))$ and paying the associated tax. Assuming separation holds, his utility is then $U_{11}(1+\varepsilon, MC(1+\varepsilon), t) = \frac{1}{2} + \lambda \frac{(1-\alpha_s)\beta}{\alpha_n(1-\beta)+(1-\alpha_s)\beta} + \frac{1}{2}\varepsilon^2$. This is greater than utility would be from choosing $(1, \frac{1}{2})$ which equals $\frac{1}{2} + \lambda \frac{(1-\alpha_s)\beta}{\alpha_n(1-\beta)+(1-\alpha_s)\beta}$. Moreover, for any other quality level $s > 1$, $s - \frac{1}{2}s^2 < \frac{1}{2}$ and type 11 derives strictly lower utility $U_{11}(s, MC(s), t) = \frac{1}{2} + \lambda \frac{(1-\alpha_s)\beta}{\alpha_n(1-\beta)+(1-\alpha_s)\beta} + s - \frac{1}{2}s^2 - \frac{1}{2}$ from choosing it than from choosing $(1, \frac{1}{2})$. Type 01 does not want to mimic type 11 since $U_{01}(1, \frac{1}{2}) = \lambda \frac{(1-\alpha_s)\beta}{\alpha_n(1-\beta)+(1-\alpha_s)\beta} - \frac{1}{2} > \lambda \frac{(1-\alpha_s)\beta}{\alpha_n(1-\beta)+(1-\alpha_s)\beta} - \frac{1}{2} + \frac{1}{2}\varepsilon^2 - \varepsilon = U_{01}(1+\varepsilon, MC(1+\varepsilon), t)$. Thus, separation indeed holds.

Since separation is unchanged, the allocation of image remains the same and welfare increases by the increased efficiency in production because the quality which type 11 chooses now $1+\varepsilon$ is smaller than $\tilde{s}$ by construction.

The tax income does not directly affect welfare but is a transit item since it is subtracted from surplus of type 11 consumers. Thus, it can be seen that there always exists a welfare improving tax scheme. However, not necessarily everyone is better off. The tax does not affect choices by types 00, 01, and 10 and thereby does not affect their surplus either. Type 11 is affected, though. If the functional excuse $\tilde{s}$ is relatively small, $\tilde{s} < 3$, type 11 is hurt by the luxury tax even though welfare increases. The reason is that the tax can be larger than the per unit increase in net surplus. Since taxes cancel out in welfare this implies an increase in aggregate welfare but consumers of type 11 are still worse off so that the tax does not constitute a Pareto improvement.

In the absence of the tax, type 11 would choose $\tilde{s} = \sqrt{1 + \frac{2\alpha_n(1-\beta)\lambda}{\alpha_n(1-\beta)+(1-\alpha_s)\beta}} > 1$ at a price $p = MC(\tilde{s}) = \frac{1}{2} + \frac{\alpha_n(1-\beta)\lambda}{\alpha_n(1-\beta)+(1-\alpha_s)\beta}$ which yields utility $U_{11}(\tilde{s}, MC(\tilde{s})) = \tilde{s} + \lambda - \frac{1}{2}\tilde{s}^2$. Utility with taxation is higher if the following holds:

$$\frac{1}{2} + \lambda \frac{(1-\alpha_s)\beta}{\alpha_n(1-\beta)+(1-\alpha_s)\beta} + \frac{1}{2}\varepsilon^2 > \tilde{s} + \lambda - \frac{1}{2}\tilde{s}^2$$

From the definition of $\tilde{s}$ we know that $\lambda - \frac{1}{2}\tilde{s}^2 = \lambda\frac{(1-\alpha_s)\beta}{\alpha_n(1-\beta)+(1-\alpha_s)\beta} - \frac{1}{2}$ so that the former is equivalent to $\varepsilon^2 > 2(\tilde{s}-1)$ which is only true if $\varepsilon > \sqrt{2(\tilde{s}-1)} > 0$. This requirement on ε can be fulfilled whenever

$$\sqrt{2(\tilde{s}-1)} < \tilde{s} - 1 \Rightarrow 2\tilde{s} - 2 < \tilde{s}^2 - 2\tilde{s} + 1 \Leftrightarrow \tilde{s}^2 - 4\tilde{s} + 3 > 0$$

Given $\tilde{s} > 1$ by definition, this inequality is fulfilled for all $\tilde{s} > 3$. Thus, a welfare-improving tax that also constitutes a Pareto improvement exists, whenever $\tilde{s} > 3$.

To ensure that consumer surplus remains unchanged but choices are unaffected or increases, a more complicated tax scheme has to be put in place which redistributes the tax income to all consumers in a lumpsum way. It is not clear that such a scheme always exists. □

Supplementary material

Further supplementary material is available online at https://janafriedrichsen.wordpress.com/research/. This includes, Part B containing the analysis of the monopoly problem when consumers may randomize, part C with additional results, and Part D with further robustness checks.