The Discriminating Consumer: Product Proliferation and Willingness to Pay for Quality

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We propose that a crowded product space motivates consumers to better discriminate between choice options of different quality. Specifically, this paper reports evidence from three controlled experiments and one natural experiment that people are prepared to pay more for high-quality products but less for low-quality products when they are considered in the context of a dense, as opposed to a sparse, set of alternatives. To explain this effect, we propose that consumers uncertain about the importance of quality learn from observing market outcomes. Product proliferation reveals that other consumers care to discriminate among similar alternatives, and this inference raises the importance of quality in decision making.

Consumers can be called "discriminating" when they value the differences between objects that belong to the same category, especially when considering these differences is effortful. As firms seek to distinguish themselves from competitors through the superiority of their offerings, they need the custom of discriminating consumers who look beyond price and welcome improvements in quality—no matter how small these improvements might be. Contemporary markets, however, are increasingly characterized by product proliferation and clutter, and practitioners fear this tendency causes people to disengage and purchase inferior options predominantly on the basis of how little they cost.

Research in consumer behavior indeed argues that the proliferation of choice coincides with a certain amount of de-motivation among shoppers (Iyengar and Lepper 2000). Academics have traced this effect to a combination of cognitive effort (Jacoby, Speller, and Kohn 1974; Kuksov and Villas-Boas 2010), negative affect (Carmon, Wertenbroch, and Zeelenberg 2003; Dhar 1997; Sagi and Friedland 2007), or reduced consumer surplus resulting from sharper targeting (Villas-Boas 2009). In addition, a number of studies suggest that consumers become more price conscious when confronted with many choice options because price is presumably more accessible and easier to compare than quality (Hsee 1996; Nowlis and Simonson 1997).

In contrast with these views, the present paper illustrates one mechanism by which a crowded product space can be beneficial to firms striving to compete on quality. The argument is that consumers interpret a surprisingly dense assortment—a large number of options in a given quality interval—as a signal that they are expected, and should themselves expect, to recognize the importance of quality in that market and, as a result, become more discriminating in their evaluations. We capture this idea in a theory of inferred sensitivity to quality differences. The particular form of differentiation we consider assumes that products can be arrayed vertically according to quality. In the theory, consumers know their general taste for quality relative to other consumers (for similar processes, see Kamenica 2008 and Wernerfelt 1995), but use the density of an assortment to assess the absolute importance of quality in the market at hand. A product space more populated than anticipated reveals that informed consumers engage in fine price-quality trade-offs, which in turn motivates uncertain consumers to refine their own sensitivity as they try to find the "right" quality. Critically, this learning process implies that high-quality alternatives become more valuable while low-quality alternatives become less valuable.

We develop and test this theory in the remainder of the paper. The next section surveys two relevant streams of literature. We then describe an analytical framework that captures the intuition outlined above. The empirical work that follows tests the main prediction of this framework in both hypothetical and real purchase settings, rules out plausible confounds, and examines the critical moderating role of consumer expectations. Overall, we conducted three controlled experiments and observed one natural experiment. Experiment 1 adopted a variant of the Becker-DeGroot-Marschak mechanism (BDM; 1964) to elicit incentive-compatible reservation prices for the same products presented either in a sparse or in a dense assortment. Experiment 2 introduced a different purchase setting, a different presentation of quality information, and a series of questions to gauge the participants' perceptions of the range of qualities offered in the assortment. Experiment 3 primed participants with different expectations of assortment size in order to show how consumer response to product proliferation is a learning effect. Finally, we provide marketplace evidence for the phenomenon in an analysis of 635 sale events conducted by a leading global art business. In these data, the expert appraisals published in sale catalogs provide the quality index and the selling prices realized at auction capture willingness to pay. We conclude with a discussion of the theoretical and managerial implications of our findings.

RELEVANT LITERATURES

Vertical Differentiation and Product Line Design

Our work is related to the economics literature on vertical differentiation and to the marketing literature on product line design. The original studies in these areas examined various configurations of second-degree price discrimination. The logic is that different price-quality combinations cause a segmentation of the market that exploits demand heterogeneity to extract more consumer surplus (Moorthy 1984; Mussa and Rosen 1978). Later research extended this basic finding in several ways. One direction was to identify conditions on demand and supply when a firm may not find it profitable to discriminate (Bayus and Putsis 1999; Kekre and Srinivasan 1990; Salant 1989). A second direction was to study the relationship between product proliferation and competitive intensity (Banker, Khosla, and Sinha 1998; Champsaur and Rochet 1989; Jing 2006), as longer product lines can help incumbents crowd out prospective entrants (Bonanno 1987) or protect against proliferating competitors (Gilbert and Matutes 1993). Finally, several academics have tackled substantive questions associated with the management of product lines, including the risk of cannibalization (Desai 2001), the implications for brand equity (Randall, Ulrich, and Reibstein 1998), the design of channel relations (Villas-Boas 1998), and the decisions to invest in advertising (Villas-Boas 2004) or research and development (Lauga and Ofek 2009).

This body of work focuses on the strategies of firms and not on the psychology of consumers (Tirole 1988). Given the objective, standard assumptions are often made concerning the exogenous nature of preferences, which are not affected by the actions of firms. However, researchers have argued that it is problematic to study industrial organization without theories that consider a richer approach to the interactions between consumers and firms (Glaeser 2004; Lancaster 1990; Narasimhan et al. 2005). Progress in this direction includes recent work by Guo and Zhang (2010), Orhun (2009), and Kamenica (2008), who examine firms' product line decisions accounting for established behavioral phenomena such as loss aversion and the compromise effect. Our research is naturally closest to these three studies, though we purposely set aside any question of firm conduct to concentrate instead on consumer behavior.

An important message of this paper is that product line design represents not only an opportunity to better capture value, as highlighted in the literatures above, but also an opportunity to help shape that value. This idea draws on the belief that consumer preferences form endogenously in response to the commercial activities of firms. Support for this claim can be found in research linking decisions on pricing, advertising, and product lines to consumer engagement (Bertini and Wathieu 2008; Guo and Zhang 2010; Kuksov and Lin 2010; Wathieu and Bertini 2007). We take a similar approach to understand how a consumer's price-quality trade-off is affected by the proliferation of alternatives in the market.

Moreover, note that most of the theoretical research on vertical differentiation and product line design, inspired by Hotelling's (1929) problem of the linear city, views proliferation in the same way that we do, as an increase in the density of a choice set—i.e., more qualities populating a given quality interval. Most empirical tests of these models, however, treat proliferation simply as an increase in variety—i.e., more qualities in general. This distinction is important in our research because the type of contextual inference we predict is based on a consumer's perception that assortments are crowded within certain ranges. From a methodological perspective, our experiments manipulated density by varying the number of qualities presented to participants within a quality interval that was either constrained or perceived to remain constant across conditions.

Choice and Individual Welfare

The present research also joins rich literatures in psychology and consumer decision-making on the effects of extensive choice on individuals. As noted in the introduction, the evidence that people are often happier choosing from fewer alternatives is robust. Consumers confronting large assortments may delay or even abandon a purchase because evaluating all the viable options is overwhelming, frustrating, confusing, or simply too effortful (Dhar 1997; Greenleaf and Lehmann 1995; Iyengar and Lepper 2000; Jacoby et al. 1974; Kuksov and Villas-Boas 2010). Even if we assume these hurdles can be overcome, additional studies show that buyers are less satisfied, less confident, and more regretful of their eventual decisions (Chernev 2003; Diehl and Poynor 2010; Sagi and Friedland 2007). All these results are intriguing because, in principle, more choice should not make people worse off. Not only are large choice sets more likely to yield a suitable alternative than small choice sets (Baumol and Ide 1956), but they also provide valuable flexibility when consumers are uncertain or their preferences fluctuate (Kreps 1979; Walsh 1995).

Research on choice overload has generally pursued one of two objectives. One goal is to document the existence of an effect in a new domain. In addition to the classic retail setting

(Boatwright and Nunes 2001), there are now studies ranging from financial investments (Benartzi and Thaler 2002) to charitable giving (Scheibehenne, Greifeneder, and Todd 2009) and even mate selection (Fisman et al. 2006). A second goal is to identify factors that explain or moderate the underlying psychological process (Chernev 2003; Chernev and Hamilton 2009; Gourville and Soman 2005). Interestingly, these articles tend to focus on the same question of market participation or choice deferral, testing only whether the proliferation of choice inhibits decision-making. From a practical standpoint, however, knowing how the preferences of consumers already engaged in product decisions respond to changes in assortments seems equally important.

With regard to this second question, current knowledge is limited to studies on context-dependent preferences that investigate the effects of adding dominated or extreme alternatives to relatively small choice sets (Huber, Payne, and Puto 1982; Kivetz, Netzer, and Srinivasan 2004; Tversky and Simonson 1993). There are three notable exceptions. Iyengar and Kamenica (2010), for instance, found that people allocate more of their savings to simpler financial instruments as the number of retirement options offered to them increases. Sela, Berger, and Liu (2009) found that consumers sidestep the cognitive effort of processing many alternatives by selecting products that are easier to justify. Finally, Berger, Draganska, and Simonson (2007) found that larger assortments trigger brand quality inferences that result in consumers favoring the manufacturer that supplies the greatest product variety. Unlike these articles, however, we are not concerned with specific product choices. Instead, we focus on the readiness of consumers to spend on quality.

The next section develops our theoretical argument linking assortment density to willingness to pay. This argument leads to two formal hypotheses. We then report the results of three controlled experiments and one natural experiment that tested these predictions in several contexts and conditions.

A THEORY OF INFERRED SENSITIVITY TO QUALITY DIFFERENCES

This section formalizes the notion that consumers adjust their price-quality trade-offs in response to the density of encountered assortments. Consider a market assortment with *n* different qualities contained in the interval $[\underline{q}, \bar{q}]$. We will refer to $d = n/(\bar{q} - \underline{q})$ as the assortment's *density*. All consumers would pick the highest available quality if prices were identical. But because prices generally vary among qualities, consumers need to trade price *p* against quality *q*. We assume that the preferences of any consumer *i* is captured by a value function $v_i(q, p) = \omega_i q - p$, where weight ω_i represents the consumer's overall sensitivity to quality. In particular, for a given default option (q_0, p_0), a greater sensitivity to quality implies more willingness to pay for high-quality options, for example, $wtp(\bar{q}) = p_0 + \omega_i(\bar{q} - q_0)$, and less willingness to pay for low quality-options, for example, $wtp(\underline{q}) = p_0 - \omega_i(q_0 - \underline{q})$.

The novelty of our approach is to posit that sensitivity to quality involves two distinct factors, such that $\omega_i = E_i(\gamma)\theta_i$, where $\theta_i \in [\underline{\theta}, \bar{\theta}]$ represents consumer *i*'s taste for quality—probably shaped by individual characteristics such as income and education—and γ is a context-specific importance weight that scales the consumer's taste for quality to reflect precisely how quality differences are experienced in a given market.

It can be assumed that consumers know their relative taste for quality in relation to the tastes of other consumers (Kamenica 2008; Wernerfelt 1995), but they may be uncertain with regard to the importance of quality in the market, which they treat as an object of learning represented by adaptive expectation $E_i(g)$. Learning about the importance of quality in a market may come from consumption experience or from communicating with other consumers, but it is also likely to come from market outcomes. Our contention is that the observed assortment density informs uncertain consumers about the degree of quality discrimination they should exert in their choices. Therefore, we can write: $\omega_i = E_i(\gamma|d)\theta_i$.

While this theory of preference formation can be viewed as a descriptive model that accommodates the empirical findings of our research, it is desirable to root the phenomenon in an economic theory of market behavior. One approach is to specify a prototype model of supply and demand (Villas-Boas 2009), and establish an equilibrium relationship between assortment density and consumer sensitivity to quality. Product proliferation reveals that it is profitable for firms to discriminate through vertical differentiation among consumers of varying sensitivity. As shown by Kekre and Srinivasan (1990), this may relate to supply-side conditions such as the low cost of introducing new quality variants. But it may also relate to demand-side conditions such as the heterogeneity of demand (Chamsaur and Rochet 1989). Therefore, it seems natural that uncertain consumers draw an inference about their own sensitivity to quality when they encounter a surprisingly dense assortment.

Alternatively, we want to propose that our theory holds true independent of assumptions on industrial organization, cost structures, or distributions of consumer types. Consider that consumers need to spend an evaluation cost c to compare two qualities (Shugan 1980; Villas-Boas 2009; Wathieu and Bertini 2007). In the presence of this evaluation cost, consumer i would like to ignore the difference between two qualities q and $q + s$ and simply pick the cheaper of these alternatives when s is small relative to the price premium it entails—that is, when

$$w_i q - p(q) > \max_{x \in \{q, q+s\}} [w_i x - p(x)] - c.$$

A sufficient condition for this to happen is that the inequality holds at arbitrarily small price differences, and in particular in the limit case when $p(q) = p(q+s)$, which means that quality difference are certain to be ignored if $w_i q > w_i (q+s) - c$, i.e., if $c/w_i > s$. Accounting for this reasoning, given prior belief about the importance of quality $E_i(\gamma)$, consumer *i* does not expect anyone to process a quality improvement smaller than $\underline{s} = c/E_i(\gamma)\bar{q}$. In turn, there exists an upper bound on assortment density equal to $1/\underline{s} = E_i(\gamma)\bar{q}/c$ compatible with $E_i(\gamma)$. In the presence of a surprisingly dense assortment, a density superior to that bound, consumer *i* will necessarily update the prior belief about the importance of quality. While this learning process might occur at lower levels of assortment density, the above analysis proves that one can always define a (high) level of assortment density that will cause consumers to think quality is more important than anticipated.

Based on this reasoning, and accounting for the heterogeneity of beliefs and sensitivities to quality present in any market, we can articulate the following testable hypothesis:

H1: Consumers are prepared to pay more for high-quality options and less for low-quality options when confronted with a dense, as opposed to a sparse, set of alternatives.

Figure 1 illustrates this relationship between assortment density and willingness to pay. We also present the following hypothesis to capture the mechanism predicted to cause the effect described in H1:

H2: H1 is conditional on prior expectations about assortment density and the resulting classification of choice sets as either dense or sparse.

Insert figure 1 about here

We now turn our attention to a set of experiments that offer multiple replications and refinements in support of this theory.

EXPERIMENT 1

The main objective of experiment 1 was to provide evidence for the hypothesis that a more crowded assortment increases willingness to pay for high-quality offerings but decrease willingness to pay for low-quality offerings. A second objective of the experiment was to document that assortment density affects the perceived importance of product quality in purchase decisions.

Participants, Design, and Procedure

Participants (n = 76) were registered members of a subject pool managed by a business school in the United Kingdom (UK). They were recruited via e-mail and assigned at random to the experimental conditions. At the time of the study, this pool had 5,098 active members, of which 62% were female and 81% were completing undergraduate education. The median age was 24. Participation was voluntary, remunerated by the customary £10 payment upon completion plus an additional £5, paid up front, to motivate transactions. The experiment was grouped with several unrelated tasks to fill a one-hour session in the laboratory.

After registering their arrival to the laboratory, participants were led by an experimenter to one of two rooms and asked to approach a table displaying several different dark chocolates. The experimenter then explained that the array represented the full range supplied by a local manufacturer. Participants were further told that the chocolates were ordered from left to right according to their "premium rating," a metric commonly used in the industry to gauge quality. Premium ratings could range from 1 to 100, with higher scores representing better quality, and were determined by several factors including the mix and origin of the raw materials plus how the chocolate breaks, melts, and tastes. At this point, participants read a short text explaining these criteria and were given ample time to inspect the various chocolates. A small label indicating name and premium rating accompanied each chocolate.

We manipulated a single factor, Assortment Density, to present either 5 (Sparse Assortment) or 21 (Dense Assortment) chocolates. Note that we use the term "density" rather than "size" to label the manipulation because we fixed the quality interval: the first and last chocolate in each assortment was identical (i.e., same chocolate, same name, and same premium rating) across the two conditions. Note also that we constructed the dense assortment by adding four new chocolates between all consecutive items in the sparse assortment such that the second, third, and fourth chocolate in the sparse assortment corresponded to the sixth, eleventh, and sixteenth chocolate in the dense assortment, respectively. Participants evaluated these five chocolates—with premium ratings of 19, 37, 55, 73, and 91—common to both arrays.

We adopted a variant of the standard BDM mechanism (Becker et al. 1964) to elicit incentive-compatible reservation prices. The experimenter introduced the task as an opportunity for participants to buy one of the five chocolates in the sparse assortment (or one of the corresponding five chocolates in the dense assortment) without spending more than they really wanted. The purchase price, however, was not yet determined. Participants were then guided through the following steps (for a similar protocol, see Wertenbroch and Skiera 2002). First, they wrote down the highest price they were willing to pay for each of the five chocolates. Second, they drew a number from the first urn shown to them. The number drawn indicated which chocolate could be purchased. Third, participants drew a number from a different urn. This second number represented the purchase price of the chocolate selected in the first draw. If the purchase price exceeded the stated willingness to pay, then no transaction took place. If the purchase price did not exceed the stated willingness to pay, then a transaction took place at the selected purchase price. Note that participants were not informed of the distribution of the potential purchase prices to avoid anchoring effects. The numbers in the second urn were distributed uniformly, ranging from £0.10 to £5.00 with £0.10 increments.

Following this task we collected several additional measures, all on seven-point scales. Participants first evaluated the following statement: "Buying good quality is always important, but it is particularly important when it comes to chocolate" (1 = "completely disagree," to 7 = "completely agree"). They then judged the size of the assortment produced by this local chocolate manufacturer (1 = "the assortment is very small," to 7 = "the assortment is very large") and whether the quality of a chocolate can be measured objectively (1 = "not at all," to 7 = "very much"). The final question asked participants to rate how difficult it was to inspect the assortment and articulate five valuations (1 = "not at all difficult," to 7 = "very difficult").

Results and Discussion

Figure 2 plots reservation prices as a function of assortment density and premium rating. As a starting point, we examined these values in a 2 (Assortment Density) × 5 (Premium Rating) mixed-factorial analysis of variance (ANOVA). This analysis resulted in a significant main effect of Premium Rating ($F(4, 296) = 95.60$, $p < .001$) and, importantly, a significant two-way interaction ($F(4, 296) = 7.65$, $p < .001$). The main effect of Assortment Density was not significant ($p = .238$).

Insert figure 2 about here

A basic premise of the experiment is that participants would pay more money for chocolates with better premium ratings. To check this assumption we conducted two tests. First, we analyzed whether participants actually believed that the quality of a chocolate could be measured objectively. As intended, responses in both Assortment Density conditions were, on average, significantly higher than the midpoint of the scale: $M_{\text{Dense}} = 4.60$, $t(35) = 2.97$, $p = .005$; $M_{\text{Sparse}} = 4.78$, $t(39) = 2.31$, $p = .027$. Second, we conducted a trend analysis of the main effect of Premium Rating in the ANOVA. This particular test only produced significant effects for the linear ($F(1, 74) = 105.11$, $p < .001$) and quadratic ($F(1, 74) = 23.88$, $p < .001$) components, which confirms the expected relationship between quality and willingness to pay.

The next step was to test hypothesis 1. We started by searching for evidence that participants were more sensitive to quality in the Dense Assortment condition than in the Sparse Assortment condition. Consistent with our theory, the range of reservation prices (calculated as the difference in willingness to pay between the first and last option in each Assortment Density condition) was greater when participants saw 21 chocolates (M_D = £1.28) than when they saw only 5 chocolates (M_S = £0.72, $F(1, 74) = 8.23$, $p = .005$, $\eta^2 = .10$). As predicted in hypothesis 1, this effect was caused by a shift at both ends of the array. The maximum price participants were prepared to pay for the chocolate with the worst premium rating (19) was significantly lower in the Dense Assortment condition than in the Sparse Assortment condition: M_D = £0.26 vs. M_S = £0.39; $F(1, 74) = 5.45$, $p = .022$, $\eta^2 = .07$. Conversely, the maximum price participants were prepared to pay for the chocolate with the best premium rating (91) was significantly higher in the Dense Assortment condition than in the Sparse Assortment condition: M_D = £1.55 vs. M_S = £1.11; $F(1, 74) = 4.69$, $p = .034$, $\eta^2 = .06$. This pattern of results is consistent with hypothesis 1. Of the three remaining paired comparisons, two failed to reach statistical significance ($p = .630$, $p = .432$) and one, involving the second-highest premium rating we tested (73), resulted in a marginally significant difference in the expected direction: M_D = £1.13 vs. M_S = £0.88; $F(1, 74) = 2.97$, $p = .089$, $\eta^2 = .04$.

We motivated hypothesis 1 by arguing that the density of an assortment affects consumer sensitivity to quality. To provide evidence of this relationship we tested whether the actual densities of the assortments presented to participants matched their perceptions. This is exactly what we found: $M_D = 5.22$vs. $M_S = 3.13$; $F(1, 74) = 49.50$, $p < .001$. Furthermore, the average response of participants in the Dense Assortment condition was significantly higher than the midpoint of the scale ($t(35) = 5.59$, $p < .001$), which suggests that this assortment was perceived as large relative to expectations. (The same test for responses in the Sparse Assortment condition was also significant, but in the opposite direction: $t(39) = 4.31$, $p < .001$.) With these two effects in hand, we then examined the extent to which participants agreed with the statement related to the importance of buying good quality in the context of chocolate. As predicted by our theory, participants presented with 21 options responded more favorably to this question (M_{D} = 4.97) than their counterparts presented with only 5 options (M_{S} = 4.10, $F(1, 74) = 6.18$, p = .015).

One concern with the design of experiment 1 is that the density of an assortment may influence not only sensitivity to quality, but also the subjective perception of quality. Participants were informed about premium ratings—a simple, objective measure of chocolate quality—specifically to avoid this problem. But consumers faced with a surprisingly crowded assortment could simply conclude that the quality index is unreliable or incomplete. We can imagine at least two reasons for this. First, different densities may cause different perceptions of the distance between the endpoints of an assortment, a result akin to the range and frequency effects discussed in the social psychology and marketing literatures (Janiszewski and Lichtenstein 1999; Parducci 1974). Second, consumers may reasonably believe that a denser choice set better represents the underlying distribution of qualities in the market (Greenleaf and Lehmann 1995), and they might therefore expect to find options that are both better and worse in quality. We accounted for this potential perceptual confound in experiment 2 by collecting subjective measures of both product quality and market prices.

A second concern is that participants in the Dense Assortment condition may have exerted greater cognitive effort processing the stimulus than their counterparts in the Sparse Assortment condition, and that this added effort prompted them to rely solely on quality information instead of evoking price-quality trade-offs (Bettman, Luce and Payne 1988). Note that we found no evidence of a complexity explanation in the participants' subjective evaluations of task difficulty (p = .769). But the process may be subconscious. In fact, the stimulus may have facilitated the use of a heuristic with the premium ratings artificially boosting the salience (and therefore importance) of quality to participants under cognitive load. We dealt with this possibility in two ways. First, the scenario in experiment 2 presented quality differences in a less obvious manner. Second, the design of experiment 3 allows for an analysis of willingness to pay when the number of options in the assortment is invariant across conditions.

EXPERIMENT 2

We conducted experiment 2 to rule out the possibility that the relationship between density and willingness to pay is accounted by a shift in the perceived quality of the endpoints in the assortment or by a simple demand effect. An additional goal was to test our theory in a different purchase context.

Participants, Design, and Procedure

Participants (n = 116) were registered members of a subject pool managed by a business school in the United States of America. They were recruited via e-mail and assigned at random to the experimental conditions. At the time of the study, this pool had 4,223 active members, of which 58% were female and 87% had completed undergraduate education. The median age was 26. Participants were informed that the research involved a hypothetical purchase scenario, that there were no right or wrong answers, and that they should only consider their own preferences when answering. Participation was voluntary, remunerated by the customary $5 payment upon completion. The experiment was grouped with several unrelated tasks to fill a twenty-minute online session.

The stimulus described the hypothetical purchase of one bottle of white wine for a dinner party. Participants read that a member of staff at a local liquor store recommended Sauvignon Blanc and pointed out the selection currently in stock. They were further told that this selection was ordered by price, from least expensive on the top left position of the shelf to most expensive on the bottom right position. This last sentence was intended to convey quality information in a less obvious manner than in experiment 1. Note that the perceived (positive) correlation between price and wine quality is notoriously strong (Plassmann et al. 2008), so that price rank is a credible quality index. Our own pre-test confirmed this observation. We asked 16 additional participants to evaluate the statement: "Price is a good indicator of the quality of wine. Generally speaking, wines that cost more are of a better quality than wines that cost less" (1 = "completely disagree," to 7 = "completely agree"). Their responses were, on average, significantly higher than the midpoint of the scale: $M = 5.58$, $t(15) = 5.44$, $p < .001$.

This experiment manipulated a single between-subjects factor, Assortment Density, to present either 9 (Sparse Assortment) or 27 (Dense Assortment) different alternatives. Note that the first and last bottles in each array were identical across conditions, and that we constructed the dense assortment by adding three new wines between all consecutive items in the sparse assortment. Participants were asked to take as much time as needed to inspect an image of the wines. Moreover, they were informed that the array in front of them could be grouped into three separate price tiers: cheap (the first three or nine wines in the set, depending on the condition), average (the second three or nine wines), and expensive (the last three or nine wines).

After reading their respective version of the scenario, participants first selected the price tier they would normally purchase from and then entered the highest amount of money they were willing to pay for any one bottle from that tier. They were also asked to estimate the actual sticker price of both the cheapest and most expensive Sauvignon Blanc in the assortment, to judge the likely quality of the same two wines (1 = "very bad quality," to 10 = "very good quality"), and to rate their level of confidence with these quality judgments (1 = "not very confident," to 7 = "very confident"). We reasoned that these three questions would help us verify that the participants' perceptions of the quality interval did not vary across conditions. Finally, participants evaluated the store's selection of Sauvignon Blanc (1 = "the assortment is very small," to 7 = "the assortment is very large").

Results and Discussion

A comparison of the participants' response to the manipulation check question confirmed that the assortment of 27 wines was perceived to be larger ($M_{\text{Dense}} = 5.27$) than the assortment of nine wines ($M_{\text{Sparse}} = 4.28$, $F(1, 114) = 14.85$, $p < .001$). Importantly, note that the mean response in the Dense Assortment condition was significantly higher than the midpoint of the scale ($t(62) = 7.55$, $p < .001$). The same contrast in the Sparse Assortment condition was not significant ($p = .153$).

We used a chi-square test to analyze the purchase decision. This test revealed that the choice of price tier was comparable across conditions ($p = .160$). Approximately one quarter (25.4%) of participants presented with the dense assortment indicated they would buy from the first (cheap) price tier, while the remainder (74.6%) preferred the second (average) tier. Similarly, 24.5% of participants in the Sparse Assortment condition selected the first price tier, 69.8% selected the second tier, and only 5.7% (three participants) opted for the third (expensive) tier. The remaining analyses exclude these three participants.

Consistent with the outcome of experiment 1, and in support of hypothesis 1, participants presented with 27 alternatives were prepared to spend significantly less money on a Sauvignon Blanc picked from the first price tier than their counterparts presented with only nine alternatives: M_D = \$8.87 vs. M_S = \$14.08; $F(1, 27) = 9.84$, $p = .004$, $\eta^2 = .27$. The same group of participants, however, were prepared to spend significantly more on a Sauvignon Blanc picked from the second price tier: M_D = \$23.56 vs. M_S = \$17.89; $F(1, 82) = 7.58$, $p = .007$, $\eta^2 = .09$.

The key result is that we observed this variation in willingness to pay despite the absence of an explicit measure of quality. Furthermore, participants varied in their valuation of the wines but did not vary in their expectations of sticker prices and of wine quality. Specifically, participants across the two Assortment Density conditions reported similar estimates of price ($p = .090$) and quality ($p = .727$) for the cheapest Sauvignon Blanc, and similar estimates of price ($p = .165$) and quality ($p = .194$) for the most expensive Sauvignon Blanc. There was also no significant difference in their level of confidence in the quality judgments ($p = .616$).

EXPERIMENT 3

Our third experiment was conducted to test hypothesis 2. Central to this hypothesis is the idea that consumers learn to become more discriminating when confronted with a density of qualities incompatible with what their prior beliefs about the importance of quality in that market would suggest. To test this mechanism we added a second manipulation in experiment 3 whereby participants were primed to expect assortments of certain sizes. Hypothesis 2 is supported if the dynamics of these expectations moderate the pattern of results observed in the first two experiments.

Participants, Design, and Procedure

Participants (n = 204) were recruited from the same subject pool used in experiment 2. The task itself asked participants to imagine they were amateur astronomers interested in purchasing their first pair of specialized binoculars. We chose binoculars because most people readily understand what the product does, but are unlikely to have significant exposure to or experience with the category. Following a brief explanation of how astronomy binoculars differ from general-purpose binoculars, participants read that alternatives vary predominantly in size, weight, and magnification power. They were also told that prices range from about $100 for a basic model to over $1,000 for an advanced model.

The experimental manipulations were introduced in the latter part of the stimulus according to a 3 (Primed Expectation) × 2 (Assortment Density) full-factorial design. First, we primed participants' expectations of the assortment they were likely to find by mentioning that the typical brick-and-mortar store carried a stock of 10 (40) (70) different astronomy binoculars. Next, we explained that there were no such stores in the local area but they could purchase a pair of binoculars from a larger online retailer that offered a selection of 25 (55) models. Participants were further told that this retailer ranked all its products according to a proprietary quality rating collated from the latest professional reviews of several independent sources. This rating consisted of a single scale ranging from 1 to 100, with higher values indicating better performance. The average quality for astronomy binoculars was 60, with most models scoring between 40 and 80.

The rationale for crossing the two between-subjects factors is as follows. First, note that participants anticipating a choice of only 10 different binoculars should perceive an assortment of as many as 25 or 55 models as surprisingly dense and, consequently, suggestive that astronomers are unexpectedly discriminant among qualities. Similarly, participants anticipating a choice of as many as 70 different binoculars should perceive an assortment of only 25 or 55 models as surprisingly sparse and, consequently, suggestive that astronomers are unexpectedly discriminant among qualities. The critical condition is when participants anticipate 40 different binoculars. Here, an assortment of 25 models should be perceived as surprisingly sparse, but an assortment of 55 options should be perceived as surprisingly dense. According to hypothesis 2, this is the only scenario that should replicate the outcome of our two previous experiments.

We collected two types of measures. First, we asked participants to inspect the images of three specific models—the Garrett Gemini LW (quality rating of 26), the Fujinon Polaris SX (quality rating of 60), and the Nikon Superior E (quality rating of 94)—and enter the maximum price they were prepared to pay for each. Second, participants reported their impression of the selection of binoculars sold by the online retailer (1 = "the assortment is very small," to 7 = "the assortment is very large").

Results and Discussion

Our analysis of the data started with a manipulation check. The goal was to determine whether our priming manipulation was successful in shifting the participants' perceptions of the assortment offered by the online retailer. To that end, a 3 × 2 full-factorial ANOVA revealed main effects of both Primed Expectation ($F(2, 198) = 6.03$, $p = .003$) and of Assortment Density ($F(1, 198) = 6.01$, $p = .015$). Importantly, these results were qualified by a marginally significant two-way interaction ($F(2, 198) = 2.44$, $p = .090$). We primed participants to expect a choice of either 10, 40, or 70 different astronomy binoculars, but, as intended, the dense assortment (55 binoculars) was rated significantly larger than the sparse assortment (25 binoculars) in the second of these conditions ($M_{\text{Dense}|40}$ = 4.97 vs. $M_{\text{Sparse}|40}$ = 3.85; $F(1, 64) = 10.12$, $p = .002$), but not in the first ($p = .786$) or third ($p = .416$).

Next, we examined the willingness to pay estimates. Overall, a 3 × 2 full-factorial ANOVA on the range of reservation prices (calculated as the difference in willingness to pay between the high-quality Nikon Superior E and the low-quality Garrett Gemini LW) revealed a main effect of Primed Expectation ($F(2, 198) = 7.29$, $p = .001$), no main effect of Assortment Density ($p = .337$), and the predicted two-way interaction ($F(2, 198) = 3.18$, $p = .044$). In support of hypothesis 2, this range varied significantly across Assortment Density conditions only when participants anticipated a choice of 40 different options: $M_{\text{D}|40}$ = \$522.03 vs. $M_{\text{S}|40}$ = \$325.12; $F(1, 64) = 6.12$, $p = .016$, $\eta^2 = .09$. (The p-values of the two other tests were .554 and .690.) Furthermore, we observed the asymmetric effect predicted by hypothesis 1. The maximum price participants were prepared to pay for the Garret Gemini LW was significantly lower in the Dense Assortment condition ($M_{\text{D}|40}$ = \$56.73) than in the Sparse Assortment condition ($M_{\text{S}|40}$ = \$101.52, $F(1, 64) = 11.15$, $p = .001$, $\eta^2 = .15$). Conversely, the maximum price participants were prepared to pay for the Nikon Superior E was higher in the Dense Assortment condition ($M_{\text{D}|40}$ = \$578.76) than in the Sparse Assortment condition ($M_{\text{S}|40}$ = \$426.64, $F(1, 64) = 3.88$, $p = .053$, $\eta^2 = .06$). We observed no significant effect for the average-quality Fujinon Polaris SX ($M_{\text{D}|40}$ = \$212.42 vs. $M_{\text{S}|40}$ = \$268.00; $p = .223$). Figure 3a graphs the mean responses for the Garrett Gemini LW for all Primed Expectation and Assortment Density conditions; figure 3b does the same for the Nikon Superior E.

Insert figure 3 about here

One of the alternative explanations for the effects observed in experiments 1 and 2 is that dense assortments are more complex to process than sparse assortments, and that greater complexity in turn motivates consumers to prioritize quality information as a means to reduce effort and simplify decisions. We already found some evidence against this reasoning in experiment 1, with participants presented with different densities reporting similar levels of difficulty in completing the task. However, the design of experiment 3 allows us to test the role of complexity without resorting to subjective judgments.

Methodologically, this test can be conducted by examining the responses of participants faced with the same selection of astronomy binoculars but primed with different expectations of that assortment. For example, note that participants presented with 25 binoculars perceived this assortment to be larger when they anticipated only 10 models ($M_{S|10} = 4.78$) than when they anticipated 40 ($M_{S|40} = 3.85$, $t(97) = 2.57$, $p = .012$) or as many as 70 ($M_{S|70} = 3.86$, $t(97) = 2.58$, $p = .011$). Note also that participants presented with 55 binoculars perceived this assortment to be smaller when they anticipated as many as 70 models ($M_{D|70} = 4.11$) than when they anticipated 40 ($M_{D|40} = 4.97$, $t(101) = 2.53$, $p = .013$) or as few as 10 ($M_{D|10} = 4.89$, $t(101) = 2.32$, $p = .022$). Did this variance in perceptions influence willingness to pay? An omnibus test comparing the range of reservation prices across the three levels of Primed Expectations yielded a significant effect in the case of a sparse assortment ($M_{S|10}$ = \$579.69 vs. $M_{S|40}$ = 325.12 vs. $M_{S|70}$ = 376.40; $F(2, 97) = 6.17$, $p = .003$, $\eta^2 = .11$) and in the case of a dense assortment (M_{D10} = \$537.66 vs. $M_{D|40}$ = 522.03 vs. $M_{D|70}$ = 346.58; $F(2, 101) = 4.18$, $p = .018$, $\eta^2 = .08$). These two results are sufficient to reject complexity as a plausible alternative to our theory.

MARKETPLACE EVIDENCE

To complement our experimental findings we sought supporting evidence in the field. We reasoned that auction data would be helpful, as the realized price for a lot (product) reflects the eventual buyer's willingness to pay. A data set was provided to us by a leading global art business. These data cover all (635) sales conducted between January 2006 and June 2009 at the London (UK) locations of the company. In total, 81,245 lots were auctioned during this period, 62,944 (77.5%) of which were ultimately sold. We excluded unsold lots from the analysis, as one cannot determine whether a missed sale corresponded to an excessive reservation price, insufficient bids, or a decision by the auction house to take the product off the market for some unrelated reason.

At the lot level, our observations included a description of the item, the sale context (item reference number, sale catalog, department, and sale date), the appraisal provided by an expert (expressed in monetary terms as an interval), and the realized price. The logarithms of the upper and lower bounds of the appraisals were perfectly correlated: $\rho > .99$. The realized price is the highest bid or "hammer" price in an ascending-price (English) auction plus the buyer's premium.

We treated each (thematic) sale catalog as a product assortment in a given department (books, carpets, furniture, jewelry, photographs, pictures, wines, etc.). Furthermore, we assumed that the experts' appraisals represented quality estimates. Note that multiple lots in a sale could share the same appraisal. Some catalogs featured a dense assortment in the sense that they contained a proliferation of appraisals, while other catalogs featured fewer appraisals. Hypothesis 1 predicts that buyers attending a sale with a dense set of appraisals are more motivated to value quality differences than buyers attending a sale with a sparse set of appraisals. This motivation translates to higher bid for high-quality lots and lower bids for low-quality lots.

As a starting point, we obtained Ordinary Least Squares results for a linear regression of the logarithm of realized prices—assumed to reveal the willingness to pay of the second-highest bidder—on the logarithm of the lower bound of the appraisals, on the logarithm of an assortment density index, and on the interaction between these two variables (n = 62,715). The regression model was:

$$\ln(price) = \beta_0 + \beta_1 \ln(quality) + \beta_2 \ln(density) + \beta_3 \left[\ln(quality) \times \ln(density)\right] + \varepsilon.$$

The assortment density index was calculated by dividing the total number of unique appraisals in a given sale by the logarithm of the range of these values—i.e., the difference between the lowest and highest appraisal. We used this index to control for fluctuations in the range of appraisals (i.e., quality estimates) across sales. Hypothesis 1 is supported when $\beta_1 > 0, \beta_2 < 0, \beta_3 > 0$, such that an increase in assortment density has a negative impact on willingness to pay for lots below a certain calculable threshold appraisal equal to $\exp(-\beta_2 / \beta_3)$, and a positive impact on willingness to pay for lots above that threshold. Table 1a shows that the parameter estimates obtained across all auctions support this prediction.

Insert table 1 about here

The second set of analyses was conducted only on sales of wine. We selected the wine department because it accounts for the greatest number of observations. It is also the category most consistent with the notion of a market where some substitutability among qualities can be assumed. We have data for all 62 wine sales that took place during the said period (n = 12,587).

On average, each sale included 236 lots and 51.7 different appraisals (s = 13.7). The mean range of appraisals across these sales was £25,492. Parameter estimates in this restricted context were again consistent with our hypotheses (see Table 1a). Based on these results, we can calculate the threshold appraisal to be $\exp(-1.3682/0.2125)$ = £645. This number represents the quality estimate above which an increase in assortment density was associated with an increase in realized price. In the data, this implies that the bottom 36% of wines sold at auction—i.e., those with the lower bound of the appraisal below £645—suffered from an increase in the number of appraisals, while the remainder benefited.

Alternatively, we can compare the elasticity of realized prices with respect to appraisals across different levels of assortment density. To do this, we split the wine data into seven segments based on the assortment density index and estimated the associated relationship between appraisals and realized prices. The results are displayed in Table 1b. It appears that bidders required a certain proliferation of appraisals before they became more discriminating. In particular, the data suggest a change of regime when the density index rises above 4, which corresponds to the typical sale catalog listing 40.6 different appraisals (approximately one standard deviation below the observed mean).

GENERAL DISCUSSION

One striking aspect of many contemporary markets is the abundance of choice. Beyond the ongoing debate on the implications of product proliferation for market participation, an additional question of both theoretical and practical relevance is whether, conditional on some purchase taking place, large assortments also impact the formation of preferences. Contrary to the logic that greater choice heightens price consciousness at the expense of product quality (Hsee 1996; Nowlis and Simonson 1997), this paper provides evidence that proliferation increases sensitivity to quality. As a result of this increased sensitivity, switching to a high-quality alternative becomes more enticing to consumers while settling for a low-quality alternative becomes less tolerable.

To explain this phenomenon we developed a formal theory of inference under conditions of preference uncertainty and bounded rationality. The preference uncertainty element is an importance weight that scales a consumer's taste for quality to reflect how quality differences are experienced in a specific market. The assumption, therefore, is that the overall impact of quality on decision making varies not only across consumers but also across markets. The bounded rationality element is a cost of comparing two qualities, such that consumers prefer to neglect small differences.

Our approach was not pure psychology in the sense that uncertain consumers understand that proliferation is a market equilibrium outcome that requires the presence of enough discriminating consumers. We showed that initial beliefs about the importance of quality determine the minimum quality difference and, consequently, the maximum number of qualities a market can sustain. The key result is that consumers confronted with a density superior to this upper bound necessarily update their beliefs and become more discriminating between qualities. Hypothesis 1 predicted that surprisingly dense assortments polarize willingness to pay such that high-quality options become more valuable and low-quality options become less valuable. Hypothesis 2 articulated the moderating role of prior expectations of assortment density.

Summary of Findings

Our empirical work included three controlled experiments and one natural experiment. Our objectives were to document the basic effect on willingness to pay across several purchase settings and conditions, to rule out a number of plausible confounds, and to test the predicted learning process.

We found initial support for hypothesis 1 in an experiment that manipulated the number of dark chocolates offered by a local manufacturer. These chocolates varied according to a premium rating that reflected quality differences on multiple dimensions. The data collected using an incentive-compatible mechanism showed that participants presented with a dense choice set were prepared to pay 33% less for a low-quality chocolate and 40% more for a high-quality chocolate than their counterparts presented with a sparse assortment. Overall, the range of reservation prices in the first condition was 78% larger than in the second condition. We also observed that buying good quality chocolate was significantly more important to participants confronted with the dense assortment.

Experiments 2 and 3 built on this result in several ways. Experiment 2 was conducted to rule out potential shifts in the perceived quality of extreme options in the assortment across conditions and to limit the likelihood of a demand effect. We tested a new product category, wine, and replicated the basic phenomenon. In particular, we were able to show that the variation in willingness to pay across assortment density conditions was not mirrored by corresponding changes in subjective judgments of market prices and of product quality. Experiment 3 tested whether priming different expectations of assortment size influenced the relationship between product proliferation and willingness to pay. The results of one analysis showed this to be the case. A second analysis was useful in ruling out variations in complexity across conditions as an additional alternative explanation.

Finally, we also demonstrated the effect of assortment density in an econometric analysis of auction results. The data featured varying number of appraisals (qualities) across 635 sale events. We analyzed all departments available to us as well as wine separately, and found that individual lots of low (high) estimated quality realized lower (higher) prices in sales involving a proliferation of different appraisals. For the wine department we also computed the threshold appraisal amount and the amount of density required before bidders became more discriminating.

Implications for Theory

It has long been recognized that price-quality trade-offs are a locus of heterogeneity between consumers (Blattberg and Wisniewski 1989) and of cognitive and contextual influences (Huber et al. 1982). Beyond these dispositional factors, we introduced category-level heterogeneity that captures the consumer's uncertainty regarding the importance of product quality and proposed that the density of an assortment is a key input for consumers to identify their preferences. The underlying process of contextual inference is in line with those proposed by Wernerfelt (1995) and Kamenica (2008).

Consistent with the approach advocated by Glaeser (2004) and Villas-Boas (2009), instead of simply importing cognitive effects into an analysis of economic decision making we investigated how psychological responses in a market emerge from the combination of cognitive ingredients (such as the effort associated with comparing two qualities) and basic expectations regarding market mechanisms (such as those ruling pricing and product line decisions).

Economists have shown that the equilibrium provision of quality is determined in part by demand parameters (Chamsaur and Rochet 1989). We reversed this relationship by asking how product proliferation can impact a consumer's ability or desire to be discriminating.

Our research also contributes to existing work on how consumer engagement forms endogenously in response to marketing actions (Wathieu and Bertini 2007). Studies in this area take the view that market outcomes—in particular, prices—can shape value as much as capture it. We took a similar conceptual approach, placing particular emphasis on understanding how the number of qualities in a market impacts the fundamental trade-off consumers make between price and quality.

One interesting area for future research would be to test hypothesis 1 in the context of other key consumer attitudes and behaviors. One extension is to study perceptions of posted prices. This angle is useful both for theory and practice. From a theoretical perspective, measuring the attractiveness of an offer at a given price would help further reduce the likelihood of assortment-dependent inferences about price and quality. The benefit from a practical perspective is external validity, as in most commercial settings consumers respond to posted prices rather than provide their own willingness to pay.

To provide insight into this question we conducted a variant of experiment 2. On this occasion, the sparse and dense assortments were reduced to 5 and 21 different bottles of Sauvignon Blanc, respectively. Every other element of the experiment was the same except for the main measure. Rather than elicit monetary values, we quoted sticker prices for the cheapest (£4.30) and most expensive (£50.95) bottle in each assortment (the two wine-price combinations were identical across conditions). We then asked 77 MBA students to rate each offer on a 1 ("a very bad deal") to 7 ("a very good deal") scale. As compared to participants presented with only

5 wine options, participants presented with 21 options reported that paying £4.30 for the cheapest Sauvignon Blanc in the store was a significantly worse deal: M_D = 4.26 vs. M_S = 5.00; $F(1, 75) = 4.68$, $p = .034$, $\eta^2 = .06$. Conversely, they also reported that paying £50.95 for the most expensive Sauvignon Blanc in the store was a significantly better deal: M_D = 3.71 vs. M_S = 2.97; $F(1, 75) = 4.28$, $p = .042$, $\eta^2 = .05$).

Implications for Practice

Implications for practice include the possibility that the effectiveness of price discounts depends not only on product positioning (Blattberg and Wisniewski 1989) but also on the interaction between positioning and the number of differently-priced qualities in a market. If retailers and manufacturers have different agents, our results suggest the decision by retailers to carry a more or less crowded product line may conflict with the manufacturer's ability to compete through pricing and discounting.

From a retailing point of view, while luxury items tend to be presented in isolation for branding reasons, our results suggest that sufficient competition is necessary to underscore the utility difference carried by high-end goods. Thus, marketers might decide to extend their product line in order to convey the importance of innovations and features. This finding complements the work by Berger et al. (2007), who showed that the variety offered by a manufacturer can add to the power of umbrella brands.

Finally, from a consumer protection point of view, one might derive from the data the idea that denser choice sets will concentrate price-based competition on the low end of a market, so that the poor are potentially paying less and the rich are potentially paying more under product proliferation—which may or may not be considered desirable. This paper questions the idea that parsimony and simplicity in consumption is necessarily advantageous across all categories: simplicity can make consumers less discriminating than they should, especially in areas of consumption where they have a natural tendency to underestimate the utilitarian or hedonic consequences of certain quality dimensions.

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TABLE 1a

Parameter Estimates of Linear Regression

	All departments* (n = 62,715)	Wine Department* (n = 12,587)
ß$_0$	1.592	2.983
ß$_1$	.900	.590
ß$_2$	-.546	-1.368
ß$_3$	.036	.212
Adjusted R^2	.874	.895

*All parameters with $p < .001$

TABLE 1b

Relationship between Realized Price and Appraisals at Various Levels of Assortment Density Index (Wine Department)

Assortment Density Index (ADI)	Intercept*	Slope*	n	Adjusted R^2
$\ln(ADI) < 2$	2.953	.575	71	.591
2 £ $\ln(ADI) < 3$	3.494	.492	568	.453
3 £ $\ln(ADI) < 4$	1.350	.828	964	.780
4 £ $\ln(ADI) < 5$	.423	.965	2,535	.922
5 £ $\ln(ADI) < 6$	.487	.957	5,406	.930
6 £ $\ln(ADI) < 7$	.424	.974	2,575	.868
7 £ $\ln(ADI) < 8$	.667	.915	439	.918

*All parameters with $p < .001$

FIGURE 1

Price-Quality Trade-Off as a Function of Assortment Density

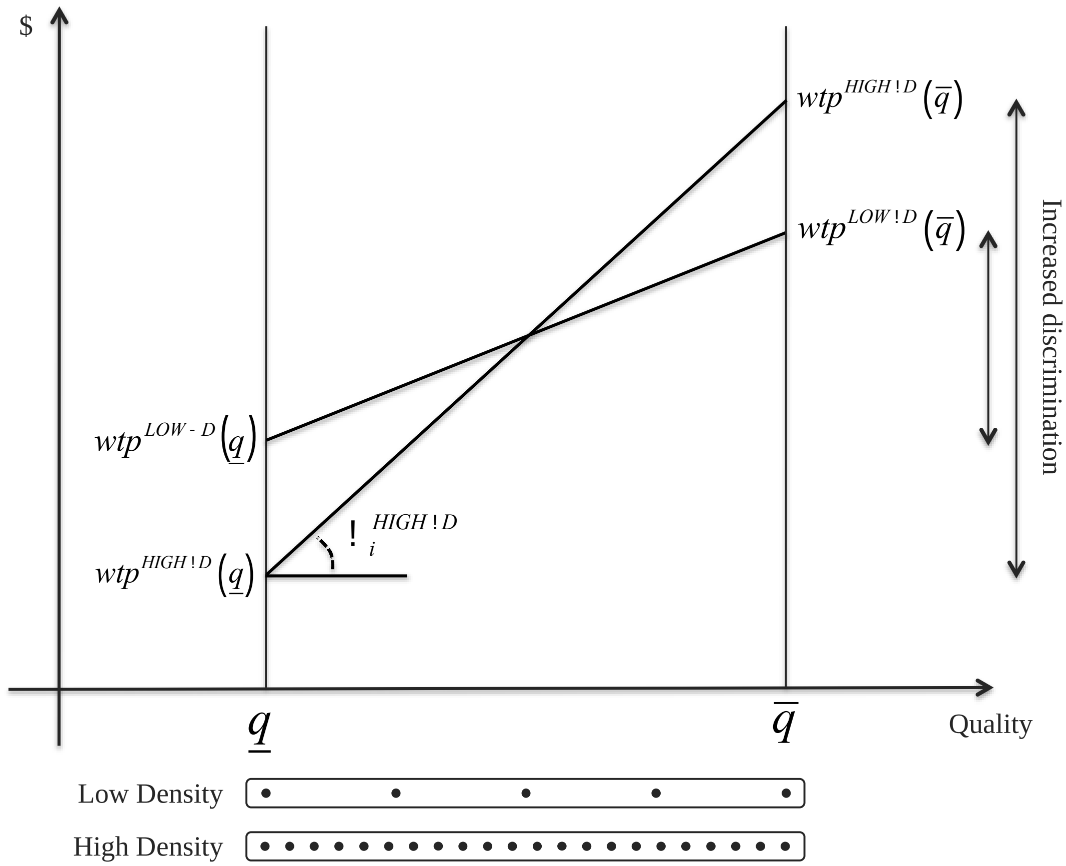

FIGURE 2

Experiment 1: Mean Reservation Prices as a Function of Assortment Density and Premium Rating

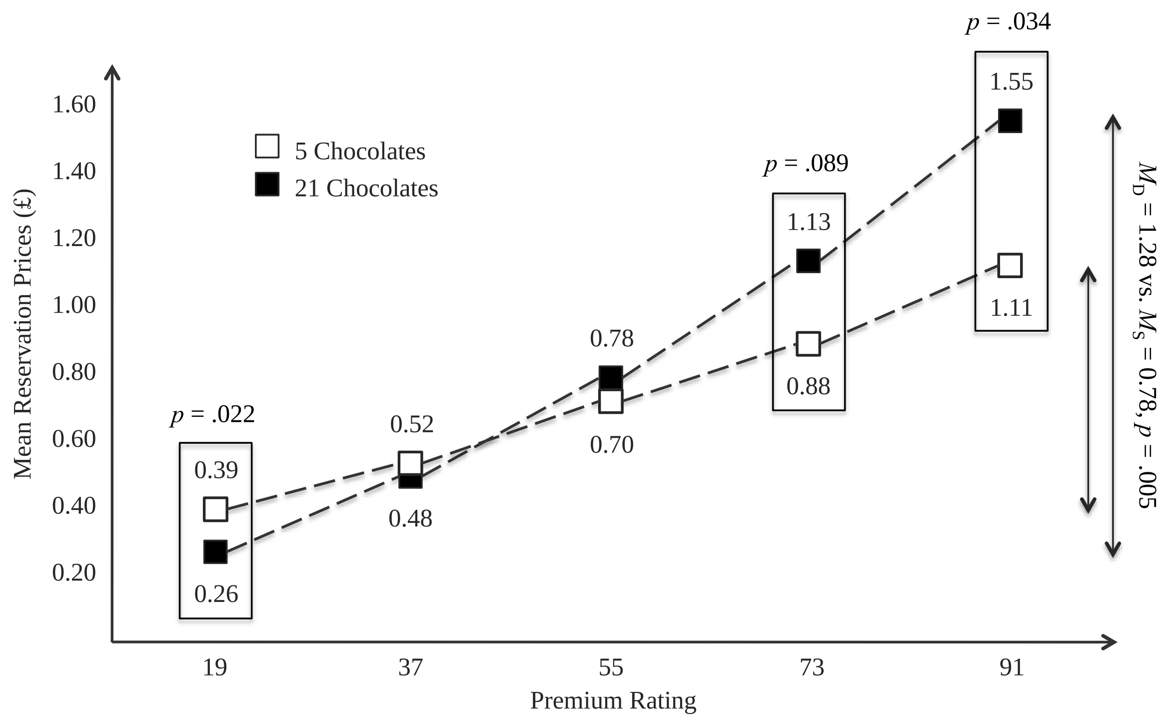

FIGURE 3a

Experiment 3: Mean Reservation Prices as a Function of Assortment Density and Primed Expectation (Low-Quality Product)

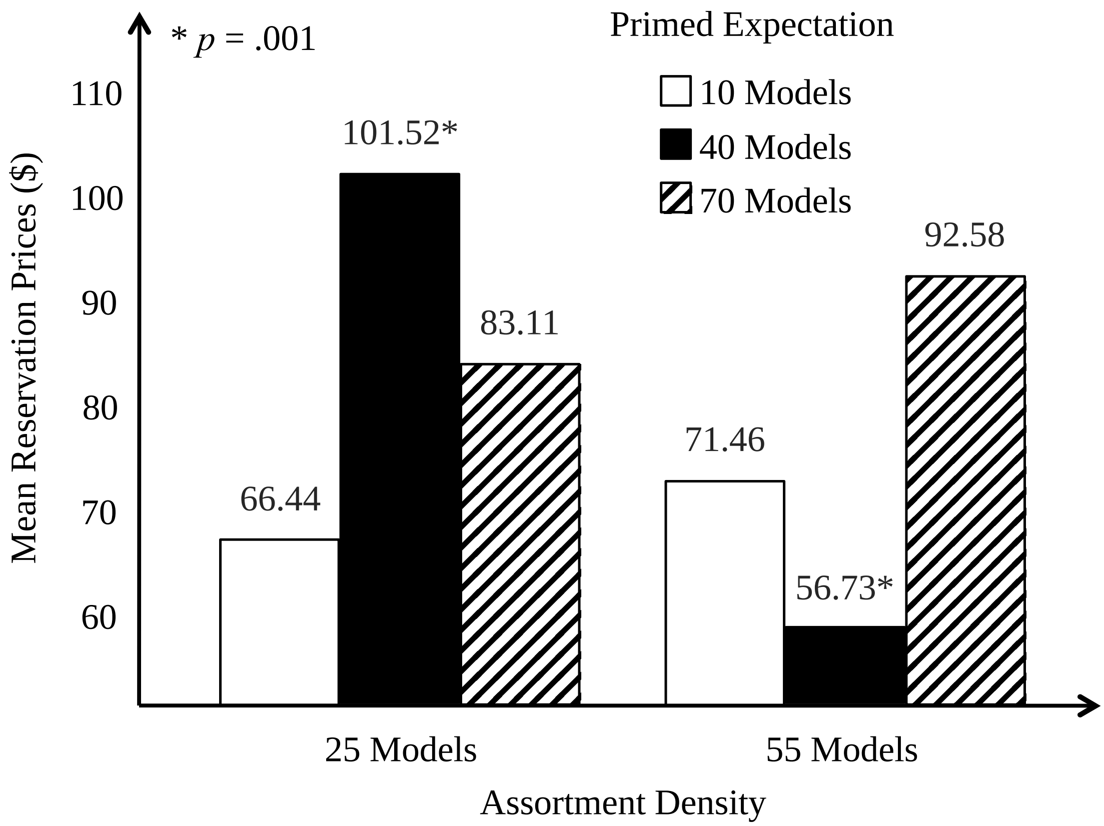

FIGURE 3b

Experiment 3: Mean Reservation Prices as a Function of Assortment Density and Primed Expectation (High-Quality Product)