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 and 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 argue 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 in turn raises the importance of quality in decision-making.

Consumers can be called "discriminating" when they value the differences between alternatives in a market, especially when considering these differences is costly. 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 to 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 their price.

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 (Kuksov and Villas-Boas 2010), negative affect (Dhar 1997; Sagi and Friedland 2007), and 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 uncertain about the importance of quality in a market 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 be more discriminating in their judgments of value. 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, uncertain consumers know their general taste for quality relative to other consumers (for similar treatments, 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 other 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 process implies that a high-quality alternative becomes more valuable while a low-quality alternative becomes less valuable.

The next section surveys two relevant streams of literature. We then describe an analytical framework that captures the intuition outlined above. Our empirical work tests the main predictions of this framework, rules out plausible confounds, and examines one key moderating factor. Overall, we conducted three controlled experiments and observed one natural experiment. Experiment 1 adopted a variant of the Becker-DeGroot-Marschak (BDM; 1964) mechanism to elicit incentive-compatible reservation prices for the same five items presented in a sparse or dense assortment. Experiment 2 introduced a different presentation of quality information and several measures to gauge the range of quality perceived in different assortments. Experiment 3 primed expectations of assortment size to test whether consumer response to product proliferation is a learning effect. Finally, we provide marketplace evidence for the phenomenon in an analysis of auctions conducted by a leading global art business. In these data, the appraisals of experts constitute a quality index and the realized prices reflect 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 initial studies in these domains 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). Finally, several academics have tackled substantive questions associated with the management of product lines, including the risk of cannibalization (Desai 2001), the impact on brand equity (Randall, Ulrich, and Reibstein 1998), the design of channel relations (Villas-Boas 1998), and the decision to invest in research and development (Lauga and Ofek 2009).

We make two observations with respect to this line of work. First, because these articles focus on the strategies of firms rather than the psychology of consumers, standard assumptions are often made concerning the exogenous nature of preferences—which are not affected by the actions of firms (Tirole 1988). However, several authors have argued in favor of a richer approach to the interactions between sellers and buyers (Glaeser 2004; Lancaster 1990), and our work complements research by Guo and Zhang (2010), Orhun (2009), and Kamenica (2008), who examine product line decisions accounting for behavioral phenomena such as loss aversion or the compromise effect.

An important message of this paper is that product line design represents not only an opportunity to better *capture* value, as highlighted in the literature above, but also an opportunity to *shape* value, as revealed by the effect of assortment density on price-quality trade-offs observed in our experiments. This message further reinforces the idea that consumer preferences and engagement form endogenously in response to the commercial activities of firms (Bertini and Wathieu 2008; Guo and Zhang 2010; Wathieu and Bertini 2007).

Second, note that most of the theoretical research on vertical differentiation and product line design views proliferation as an increase in the density of a choice set—i.e., more qualities populating a given quality interval. In contrast, most empirical discussions of product proliferation treat it solely 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 the perception that assortments are crowded within a quality range (the former interpretation). Methodologically, our experiments manipulated density by varying the number of qualities in an interval that was constrained, or at least perceived to be constrained, across conditions.

Choice and Individual Welfare

The present research also joins rich literatures in marketing and 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 too effortful (Dhar 1997; Greenleaf and Lehmann 1995; Iyengar and Lepper 2000; 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 (Diehl and Poynor 2010; Sagi and Friedland 2007). 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).

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 mate selection (Fisman et al. 2006). A second goal is to identify factors that explain or moderate the underlying psychological process (Chernev and Hamilton 2009; Gourville and Soman 2005). Interestingly, these articles tend to focus on the same question of market participation, 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 (Kivetz, Netzer, and Srinivasan 2004; Tversky and Simonson 1993). There are three notable exceptions our work relates to. Iyengar and Kamenica (2010) 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.

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 $\left[\underline{q}, \overline{q}\right]$. We will refer to $d = n / \left(\overline{q} - \underline{q}\right)$ as the assortment's *density*. Note that all consumers would pick the highest available quality if prices were identical. But because prices generally vary among qualities, consumers need to make a trade-off between price *p* and quality *q*. We assume that the preferences of any consumer *i* are captured by the value function $v_i(q, p) = \omega_i q - p$, where weight ω_i represents the consumer's sensitivity to quality. In particular, for a given default interior option (q_0, p_0), a greater sensitivity to quality implies more willingness to pay for high-quality options, e.g., $wtp(\overline{q}) = p_0 + \omega_i(\overline{q} - q_0)$, and less willingness to pay for low quality-options, e.g., $wtp(\underline{q}) = p_0 - \omega_i(q_0 - \underline{q})$.

The novelty of our approach is to posit that sensitivity to quality involves two distinct factors, such that $\omega_i = \gamma\theta_i$, where $\theta_i \in \left[\underline{\theta}, \overline{\theta}\right]$ represents consumer *i*'s taste for quality—probably shaped by individual characteristics such as income and education—and γ is a situational, market-specific importance factor that scales θ_i 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 differences in the market. Consumers treat the importance of quality as an object of learning, represented by adaptive expectation $E_i(\gamma)$. Learning about the importance of quality in a market may come from consumption experience or from communicating with experts, but it is also likely to come from observing market outcomes. Our specific contention is that the observed assortment density informs uncertain consumers about the degree of quality discrimination they should exert in their choices. In other words, we propose the following evaluation model: $v_i(q, p|d) = E_i(\gamma|d)\,\theta_i q - p$.

Why would rational economic agents infer their sensitivity to quality from the density of product assortments? One approach to demonstrate this theory would be to specify a model of supply and demand, and to establish an equilibrium relationship between differentiation strategies and consumer sensitivity to quality (similar to Villas-Boas 2009). We already know that profitable vertical differentiation requires sufficient demand heterogeneity (Champsaur and Rochet 1989), which in our framework would correspond to a stronger importance of quality (i.e., a larger γ). However, density is also associated with supply-side conditions, such as a low cost of introducing new qualities (Kekre and Srinivasan 1990). Ideally, we would like to propose a robust argument that holds true independent of specific assumptions on industrial organization, production cost structures, or distributions of consumer types.

To that effect, consider the premise that consumers need to spend an evaluation cost *c* to compare two offerings involving qualities *q* and *q* + *s* (for similar "cost of thinking" concepts, see Shugan 1980; Villas-Boas 2009; and Wathieu and Bertini 2007). In this case, consumer *i* should simply pick the cheaper alternative *q* unless the quality difference *s* is sufficiently large to warrant scrutiny—i.e., unless $\omega_i q - p(q) \leq \max_{x \in \{q, q+s\}} [\omega_i x - p(x)] - c$. Assuming $p(q) \leq p(q+s)$, this expression implies that a quality difference *s* is certain to be ignored if $\omega_i q > \omega_i (q+s) - c$. Said differently, consumer *i* ignores quality differences that are small relative to the evaluation cost scaled by the sensitivity to quality: $s < c/\omega_i$.

Accounting for this reasoning, and given prior belief about the importance of quality $E_i(\gamma)$ in the market, consumer *i* does not expect even the most sensitive consumer (with parameter $\bar{\theta}$) to value a quality improvement smaller than $\underline{s} = c/E_i(\gamma)\bar{\theta}$. Any assortment with a density greater than $1/\underline{s} = E_i(\gamma)\bar{\theta}/c$ should therefore be surprising or disconfirming, motivating an update in consumer *i*'s prior beliefs about the importance of quality. While learning can take place at lower levels of assortment density, the above analysis proves that there exists a boundary density that causes consumers to think quality is more important than anticipated. Based on this, 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 theoretical relationship between assortment density and willingness to pay. We also propose the following testable hypothesis to capture the moderating role of prior expectations assumed in our theory:

H2: The effect predicted in H1 is moderated by 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 first objective of experiment 1 was to provide evidence for the hypothesis that a more crowded assortment increases willingness to pay for high-quality offerings and decreases willingness to pay for low-quality offerings. The 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.

Upon 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. At this point, participants read a short text explaining the rating system and were given ample time to inspect the assortment. 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 describe the manipulation because the first and last chocolates were identical (same chocolate, same name, and same premium rating) across assortments, thereby fixing the quality interval. The dense assortment was constructed by adding four new chocolates between all consecutive items in the sparse assortment. Participants evaluated the five chocolates (with premium ratings of 19, 37, 55, 73, and 91) that were 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. This number indicated which chocolate could be purchased. Third, participants picked a number from a different urn, which represented the purchase price of the chocolate selected in the first draw. If the purchase price exceeded the stated willingness to pay, no transaction took place. If the purchase price did not exceed the stated willingness to pay, a transaction took place at the selected purchase price. 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 three additional measures. 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”). Finally, they rated how difficult it was to inspect the assortment and to provide five valuations (1 = “not at all difficult,” to 7 = “very difficult”).

Results and Discussion

Our first two tests checked the manipulation of Assortment Density. As intended, participants rated the selection of 21 chocolates as significantly larger than the selection of 5 chocolates: M_{Dense} = 5.22 vs. M_{Sparse} = 3.13; $F(1, 74) = 49.50$, $p < .001$. Moreover, only the mean response in the Dense Assortment condition was significantly higher than the midpoint of the scale ($t(35) = 5.59$, $p < .001$), which confirms this assortment was larger than participants expected.

The next step was to test hypothesis 1. 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 ($F(4, 296) = 7.65$, $p < .001$).

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 a trend analysis of the main effect of Premium Rating in the ANOVA. This particular test yielded significant effects only for the linear ($F(1, 74) = 105.11$, $p < .001$) and quadratic ($F(1, 74) = 23.88$, $p < .001$) terms, which confirmed the expected relationship between quality and willingness to pay.

We then focused on several key contrasts. Consistent with our theory, the difference in willingness to pay between and first and last item in each assortment was greater when participants saw 21 chocolates (M_D = £1.28) than when they saw 5 chocolates (M_S = £0.72, $F(1, 74) = 8.23$, $p = .005$, $\eta^2 = .10$). In fact, the slope between these extreme options, which can be interpreted as an empirical estimate of the average sensitivity to quality $\overline{\varpi_i} = E(E_i(\gamma)\theta_i)$, increased from 1.00 in the Sparse Assortment condition to 1.79 in the Dense Assortment condition. Assuming that individual tastes for quality (θ_i's) remained stable across conditions, these values suggest a 79% increase in the expected importance of quality $\overline{E}(\gamma)$ attributable to the change in density—a result supported by the fact that participants in the Dense Assortment condition were more likely to agree that quality is important in the purchase of chocolate: M_D = 4.97 vs. M_S = 4.10; $F(1, 74) = 6.18$, $p = .015$.

Importantly, as predicted in hypothesis 1, valuations were affected at both ends of the array. While 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; $F(1, 74) = 5.45$, $p = .022$, $\eta^2 = .07$, the opposite was true for the chocolate with the best premium rating (91): M_D = £1.55 vs. M_S = £1.11; $F(1, 74) = 4.69$, $p = .034$, $\eta^2 = .06$.

One concern with the design of experiment 1 is that the densities of the assortments influenced not only the participants' sensitivity to quality, but also their evaluation of quality. We reasoned that premium ratings—a simple, objective measure of quality—would alleviate this problem. But a participant faced with a proliferation of chocolates could simply conclude that the rating system was unreliable or incomplete. There are at least two explanations for this. First, variation in density may cause different perceptions of the distance between endpoints in an assortment, a result akin to the range and frequency effects discussed in the social psychology and marketing literatures (Parducci 1974). Second, consumers may reasonably believe that a denser assortment better represents the underlying distribution of qualities in a 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 exerted greater cognitive effort processing the stimulus than their counterparts in the Sparse Assortment condition, and that this added effort focused judgments on quality information rather than 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 availability of a quality index may have artificially boosted 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 caused by different perceptions of the range of qualities on offer or by a simple demand effect. An additional goal was to test hypothesis 1 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 20-minute online session.

The stimulus described the 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. We reasoned that price rank is a credible quality index because the perceived (positive) correlation between price and wine quality is notoriously strong (Plassmann et al. 2008). 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: $M = 5.58$, $t(15) = 5.44$, $p < .001$.

The 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 the dense assortment was constructed 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 selection in front of them could be grouped into three separate price tiers: cheap (the first three/nine wines in the set), average (the second three/nine wines), and expensive (the last three/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 selling 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 the quality judgments (1 = "not very confident," to 7 = "very confident"). 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 9 wines ($M_{\text{Sparse}} = 4.28$, $F(1, 114) = 14.85$, $p < .001$). Importantly, only the mean response in the Dense Assortment condition was significantly higher than the midpoint of the scale ($t(62) = 7.55$, $p < .001$).

A chi-square 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 on a Sauvignon Blanc picked from the cheapest price tier than their counterparts presented with 9 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 average price tier: M_D = \$23.56 vs. M_S = \$17.89; $F(1, 82) = 7.58$, $p = .007$, $\eta^2 = .09$.

Critically, we observed this variation in willingness to pay despite the absence of an explicit measure of quality or of comparable variation in the estimated selling prices and perceived qualities of these wines. 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, the idea that consumers learn to become more discriminating when confronted with a density of qualities incompatible with their prior beliefs about the importance of quality in a market. 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 inclusion 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 asked participants to imagine they were amateur astronomers interested in purchasing their first pair of specialized binoculars—a product most people readily recognize but are unlikely to have significant exposure to or experience with. Following a brief explanation of how astronomy binoculars differ from general-purpose binoculars, participants were also told that prices typically range from about $100 for a basic model to over $1,000 for an advanced model.

The experimental manipulations followed a 3 (Primed Expectation) × 2 (Assortment Density) full-factorial design. First, we primed participants' expectations 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 an 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 several reputable 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 these two factors is as follows. First, note that participants anticipating a choice of 10 different binoculars should perceive an assortment of 25 or 55 models as surprisingly dense, while participants anticipating a choice of 70 different binoculars should perceive an assortment of 25 or 55 models as surprisingly sparse. 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 experiments 1 and 2.

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

A 3 × 2 full-factorial ANOVA on the participants' impressions of the assortment offered by the online retailer 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 ($F(2, 198) = 2.44$, $p = .090$). As intended, the dense assortment (55 binoculars) was rated significantly larger than the sparse assortment (25 binoculars) by participants primed to expect 40 models ($M_{\text{Dense}|40} = 4.97$ vs. $M_{\text{Sparse}|40} = 3.85$; $F(1, 64) = 10.12$, $p = .002$), but not by participants primed to expect 10 or 70 models ($p = .786$ and $p = .416$, respectively).

Next, we examined the willingness to pay estimates. Overall, a 3 × 2 full-factorial ANOVA on 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 ($F(2, 198) = 7.29$, $p = .001$) 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: $M_{D|40}$ = \$522.03 vs. $M_{S|40}$ = \$325.12; $F(1, 64) = 6.12$, $p = .016$, $\eta^2 = .09$.

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 ($M_{D|40}$ = \$56.73) than in the Sparse Assortment condition ($M_{S|40}$ = \$101.52, $F(1, 64) = 11.15$, $p = .001$, $\eta^2 = .15$) (see figure 3a). Conversely, the maximum price participants were prepared to pay for the Nikon Superior E was higher in the Dense Assortment condition ($M_{D|40}$ = \$578.76) than in the Sparse Assortment condition ($M_{S|40}$ = \$426.64, $F(1, 64) = 3.88$, $p = .053$, $\eta^2 = .06$) (see figure 3b).

Insert figure 3 about here

One of the alternative explanations for hypothesis 1 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. The design of experiment 3, however, allows us to test the role of complexity without resorting to subjective judgments: we can examine the responses of participants faced with the same selection of products but primed with different expectations.

Participants presented with 25 binoculars perceived this assortment to be largest when they anticipated 10 models ($M_{S|10}$ = 4.78 vs. $M_{S|40}$ = 3.85; $t(97) = 2.57$, $p = .012$; and vs. $M_{S|70}$ = 3.86, $t(97) = 2.58$, $p = .011$), whereas participants presented with 55 binoculars perceived this assortment to be smallest when they anticipated 70 models ($M_{D|70}$ = 4.11 vs. $M_{D|40}$ = 4.97; $t(101) = 2.53$, $p = .013$; and vs. $M_{D|10}$ = 4.89, $t(101) = 2.32$, $p = .022$). Did these effects influence willingness to pay? An omnibus test comparing the range of reservation prices across the 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. A data set was provided to us by a leading global art business, covering all (635) sale events conducted between January 2006 and June 2009 at the company's London (UK) locations. In total, 81,245 lots (products) 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.

For each lot sold at auction, our observations included a rich description of the item, information about the sale event (reference number, date and time, location, and department—e.g., books, carpets, furniture, jewelry, photographs, pictures, wines, etc.), 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 ($\rho > .99$). We used the lower bound for our analyses. The realized price is the highest bid or "hammer" price in an ascending-price (English) auction plus the buyer's premium.

Our approach was to treat each sale event as a choice assortment, each expert appraisal as a quality estimate, and each realized price as a representative measure of willingness to pay. Typically, several lots in a sale event shared the same appraisal, and sale events both within and across departments varied significantly in the number of appraisals. For example, the average sale event in the wine department featured 236 lots but only 51.7 different appraisals. The standard deviation of appraisals in that department was 13.7.

Our theory predicts that the density of unique appraisals (i.e., different qualities) in a given sale event is a signal capable of motivating prospective buyers to place greater value on differences in appraisals. We used the following regression model to analyze the data:

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

The assortment density index was calculated by dividing the total number of unique appraisals in a given sale event by the logarithm of the range of these values. This approach was intended to capture density while controlling for fluctuations in the range of appraisals across sale events. According to hypothesis 1, the effect of an increase in assortment density on willingness to pay should be negative for low-quality lots, and positive for high-quality lots. In other words, we expected $\delta \ln(price) / \delta \ln(density) = \beta_2 + \beta_3 \ln(quality)$ to be negative for low appraisals and positive for high appraisals. This requires the existence of an interior critical appraisal level at which price is insensitive to changes in density, defined by $\ln(quality^*) = -\beta_2/\beta_3$ or $quality^* = \exp(-\beta_2/\beta_3)$. Thus, we expected β_2 and β_3 to carry opposite signs. Consistent with the prediction that denser assortments sharpen people's sensitivity to quality, we also expected $\beta_3 > 0$.

As a starting point, we obtained Ordinary Least Squares estimates using the entire set of observations, across all sale events and all departments (*n* = 62,715). Table 1a shows that the signs of the parameter estimates are consistent with our prediction. However, the critical appraisal level implied by these findings is so high that a decrease in density should lower willingness to pay for almost all lots involved. This could be an artifact of aggregation, as the density of appraisals is typically smaller in departments featuring expensive lots.

Insert table 1 about here

Consequently, we focused our second analysis on auctions of wine. The wine department is the largest, with 62 sale events (*n* = 12,587) during the observation period. The signs of the parameter estimates in this context were again consistent with our theory (see Table 1a). Based on these results, we can calculate the critical appraisal level to be exp(-1.3682/0.2125) = £645. Appraisals above (below) this threshold represent 64% (36%) of the sample and are predicted to fetch higher (lower) realized prices in response to an increase in density.

We can also compare the elasticity of realized prices with respect to appraisals across different assortment densities. 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 density of appraisals before they became more discriminating. This critical density index is approximately 4, which corresponds to the typical sale catalog listing 40.6 different appraisals (approximately one standard deviation below the observed mean).

CONCLUSION

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 large assortments also impact the formation of preferences. Contrary to the intuition that greater choice heightens the importance of price as a choice criterion at the expense of product quality (Hsee 1996; Nowlis and Simonson 1997), this paper provides evidence that consumers confronted with a proliferation of options will sharpen their appreciation of quality, making a switch to superior products more enticing and a switch to inferior products less tolerable.

To explain this phenomenon, we proposed a theory of inferred sensitivity to quality differences in which the impact of quality on a consumer's utility includes a known dispositional component (one's personal taste for quality) and a situational component inferred from market equilibrium outcomes (the importance of quality in a market). A proliferation of qualities signals to uncertain consumers that small differences in product quality matter, motivating them to raise their own sensitivity. This mechanism is not purely psychological, as uncertain consumers rationally infer that the presence of product proliferation requires sufficient discriminating consumers. We predicted that a surprisingly dense assortment polarizes willingness to pay such that high-quality (low-quality) options become more (less) valuable (hypothesis 1), and that prior expectations play a significant moderating role (hypothesis 2).

Empirical Findings

We found initial support for hypothesis 1 in an experiment that manipulated the number of quality-ranked products on display. The data showed that participants presented with a dense choice set were prepared to pay 33% less for a low-quality option and 40% more for a high-quality option than their counterparts presented with a sparse assortment. The same participants also reported higher scores on the importance of quality in the purchase decision.

Experiment 2 replicated this result while minimizing the likelihood of a demand effect and ruling out a shift in the perceived range of qualities. In experiment 3 we primed different expectations of assortment size and tested whether these beliefs influenced the relationship between product proliferation and willingness to pay. Finally, an econometric analysis of auction results found that items with low (high) quality estimates realized lower (higher) prices in sale events involving a proliferation of different qualities. For the largest product category, we calculated the critical appraisal level above which proliferation was associated with higher realized prices and the critical density above which bidders became more sensitive to quality.

Implications for Theory

It has long been recognized that price-quality trade-offs are a locus of heterogeneity in consumer types (Blattberg and Wisniewski 1989) and of cognitive and contextual influences

(Tversky and Simonson 1993). In this research, we introduced category-level heterogeneity (and uncertainty) in the importance of product quality and proposed that the density of an assortment is a key input for consumers to draw a contextual inference about the value of alternatives. 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 and basic expectations regarding market mechanisms. Economists have shown that the equilibrium provision of differentiation is determined in part by demand parameters (Champsaur and Rochet 1989). We reversed this relationship by asking how product proliferation can impact a consumer's discrimination among qualities.

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 can shape value as much as capture it. We took a similar approach, placing particular emphasis on understanding how the number of qualities in a market impacts the trade-off consumers make between price and quality.

There is literature on conjoint analysis (Wittink, Krishnamurthi, and Reibstein 1989) suggesting that adding intermediate levels of a product attribute without changing the range of these levels increases the importance (weight) of the attribute in valuation. Our approach here was different in that the objective was to document a behavioral phenomenon rather than to treat a measurement problem. As a result, both of the hypotheses we tested in our experiments fall outside the scope of the research conducted on conjoint methods.

While our analysis concentrated on instances of vertical differentiation, an extension to horizontal differentiation should be relatively straightforward. A crowded set of horizontally-differentiated alternatives suggests that consumers are motivated to make small adjustments towards more personalized or "ideal" options. While consumers who observe dense assortments might believe that barriers to entry are low, it seems equally reasonable to infer that the underlying dimensions of differentiation are highly relevant.

Finally, one could use our theory to provide insight into the mechanisms underlying the de-motivating effect of large choice sets observed in prior research (Iyengar and Lepper 2000). Consumers who become more discriminating when confronted with surprisingly dense assortments are more willing to incur the cost of evaluating any two alternatives. However, exerting additional effort may cause regret, especially when the expected benefits fail to materialize. For consumers who are also unsure of their personal taste for quality, investing this effort may in fact be overwhelming and ultimately reduce commitment to choosing. Conversely, sparse assortments can make consumers less discriminating than they should be, especially in situations where they have a natural tendency to underestimate the utilitarian or hedonic consequences of certain quality dimensions.

Implications for Practice

Implications for practice include the possibility that the effectiveness of price discounts depends not only on product positioning (Bronnenberg and Wathieu 1996), but also on the interaction between positioning and the number of 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.

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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
$2 \leq \ln(ADI) < 3$	3.494	.492	568	.453
$3 \leq \ln(ADI) < 4$	1.350	.828	964	.780
$4 \leq \ln(ADI) < 5$	.423	.965	2,535	.922
$5 \leq \ln(ADI) < 6$	.487	.957	5,406	.930
$6 \leq \ln(ADI) < 7$	.424	.974	2,575	.868
$7 \leq \ln(ADI) < 8$	.667	.915	439	.918

*All parameters with $p < .001$

FIGURE 1

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

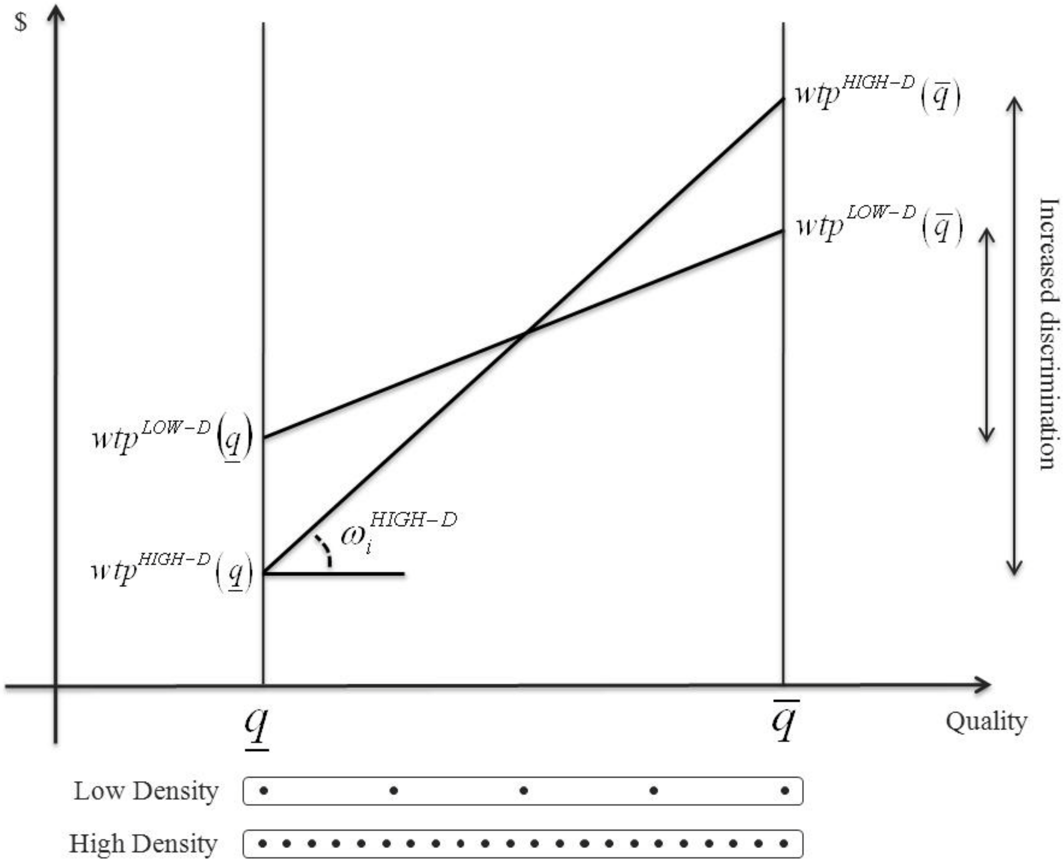

FIGURE 2

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

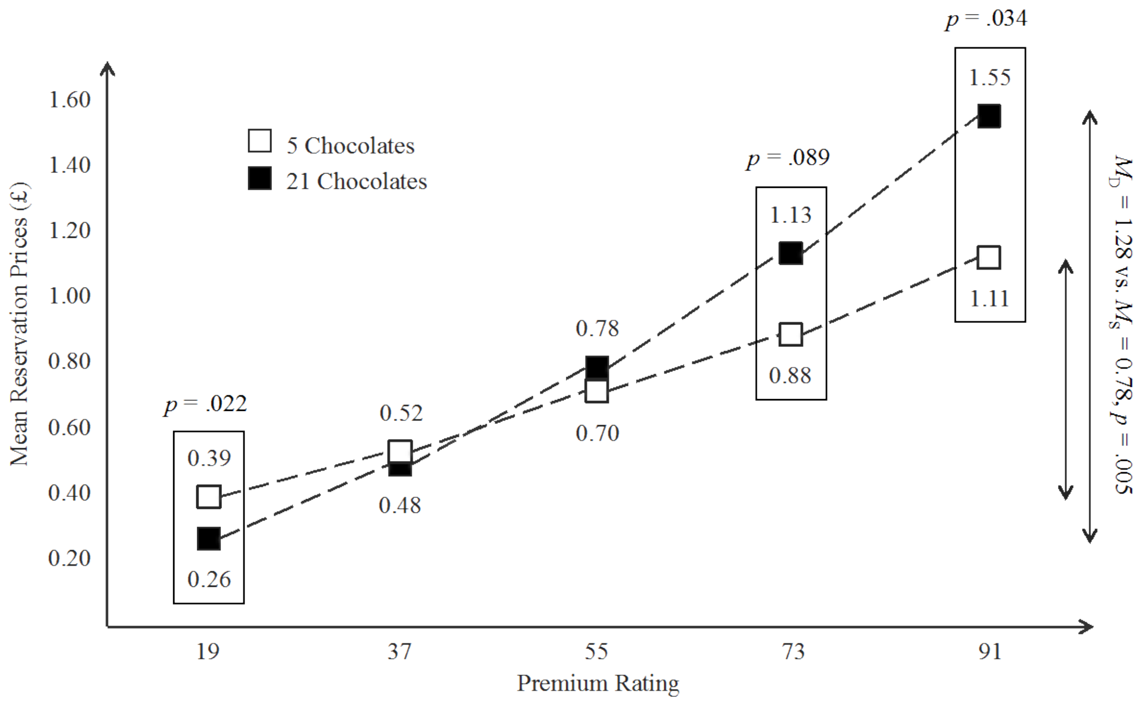

FIGURE 3a

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

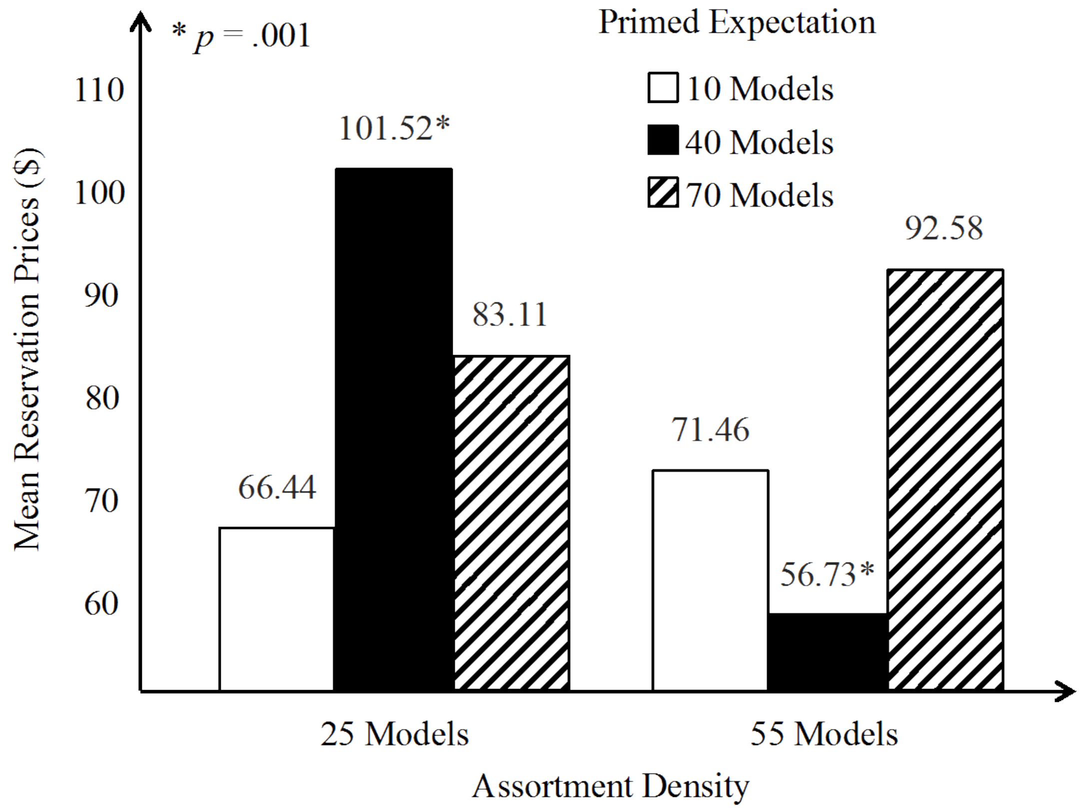

FIGURE 3b

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