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The authors propose that a crowded product space motivates consumers to better discriminate between options of different quality. Specifically, this article 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, the authors 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 in turn, this inference raises the importance of quality in decision making.

Keywords: product proliferation, assortment size, vertical differentiation, willingness to pay, consumer inference

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

Consumers can be considered discriminating when they value the differences between alternatives in a market, especially when inspecting 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 that this tendency causes people to disengage and purchase inferior options simply because they cost less.

Indeed, research in consumer behavior has argued that the proliferation of choice coincides with a certain amount of demotivation among shoppers (Iyengar and Lepper 2000). Academics have traced this effect to a combination of processing 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, several studies suggest that consumers become more price conscious when confronted with many 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 current article illustrates a 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. According to the theory, uncertain consumers know their general taste for quality relative to other consumers (for similar treatments, see Kamenica 2008; Wernerfelt 1995) but use the density of an assortment to assess the absolute importance of quality in the market. A product space more populated than anticipated reveals that other consumers engage in fine price–quality trade-offs, which in turn

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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 and a low-quality alternative becomes less valuable.

In the next section, we survey two relevant literatures. We then describe an analytical framework that captures the intuition outlined previously. Our empirical work tests the main predictions of this theory, rules out plausible confounds, and examines a key moderating factor. Overall, we conducted three controlled experiments and observed one natural experiment. Experiment 1 adopts a variant of the Becker–DeGroot–Marschak (1964), or BDM, mechanism to elicit incentive-compatible reservation prices for the same five items presented in a sparse or dense assortment. Experiment 2 introduces a different presentation of quality information and several measures to gauge the range of quality perceived in different assortments. Experiment 3 primes 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, experts' appraisals 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 LITERATURE

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 examine 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). Subsequent research extends this basic finding in several ways. First, researchers have identified conditions of demand and supply in which a firm may not find it profitable to discriminate (Bayus and Putsis 1999; Kekre and Srinivasan 1990; Salant 1989). Second, other researchers have studied 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, researchers often make standard assumptions regarding the exogenous nature of preferences, which are not affected by firms' actions (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 and the compromise effect.

An important message of the current article is that product line design represents an opportunity not only to better capture value, as highlighted in the literature described previously, but also 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, most of the theoretical research on vertical differentiation and product line design views proliferation as an increase in the density of a choice set—that is, more qualities populating a given quality interval. In contrast, most empirical discussions of product proliferation treat it solely as an increase in variety—that is, 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 manipulate density by varying the number of qualities in an interval that is constrained, or at least is perceived to be constrained, across conditions.

Choice and Individual Welfare

The current research also joins rich literatures in marketing and decision making on the effects of extensive choice on people. As we noted previously, 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 that these hurdles can be overcome, additional studies show that buyers are less satisfied with, less confident in, and more regretful of their eventual decisions (Diehl and Poynor 2010; Sagi and Friedland 2007). These results are intriguing because, in principle, more options 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).

In general, research on choice overload has 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). Notably, 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, which are germane to our work. Iyengar and Kamenica (2010) find 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) find that consumers sidestep the cognitive effort of processing many alternatives by selecting products that are easier to justify. Finally, Berger, Draganska, and Simonson (2007) find 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 $[\underline{q}, \overline{q}]$. We refer to $d = n/(\overline{q} - \underline{q})$ as the assortment's density. Note that all consumers would pick the highest available quality if prices were identical. However, because prices generally vary among qualities, consumers must 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. Beginning from a default quality q_0 included in the interval $[\underline{q}, \overline{q}]$ and its price p_0, consumer i's willingness to pay for the highest and lowest quality levels are defined by $wtp(\overline{q}) = p_0 + \omega_i(\overline{q} - q_0)$ and $wtp(\underline{q}) = p_0 - \omega_i(q_0 - \underline{q})$, respectively. Accordingly, we note that a greater sensitivity to quality results in more willingness to pay for high-quality options and less willingness to pay for low-quality options.

The novelty of our approach is to posit that sensitivity to quality is the product of two distinct factors, such that $\omega_i = \gamma\theta_i$, where $\theta_i \in [\underline{\theta}, \overline{\theta}]$ 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 market.

It can be assumed that consumers know their relative taste for quality in relation to other consumers' tastes (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 communicating with experts, but it is also likely to come from observing market outcomes. We contend 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? A conceivable approach to demonstrate this theory is 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, our goal is to propose a robust theoretical 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 must 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; Wathieu and Bertini 2007). Assuming $p(q) \leq p(q + s)$, consumer i should simply pick the cheaper alternative q and save the evaluation cost unless the quality difference s is sufficiently large to warrant scrutiny—that is, unless

$$\omega_i q - p(q) \leq \max_{x \in \{q, q+s\}} \left[\omega_i x - p(x)\right] - c.$$

This expression implies that a quality difference s will be ignored if $\omega_i q > \omega_i(q + s) - c$. It further implies that consumer i will ignore (has no incentive to notice and evaluate) quality improvements that are too small relative to the evaluation cost scaled by the sensitivity to quality: $s < c/\omega_i$.

Accounting for this reasoning, and given prior belief $E_i(\gamma)$ about the importance of quality in the market, consumer i does not expect even the most sensitive consumer (with parameter $\overline{\theta}$) to value a quality improvement smaller than $\underline{s} = c/E_i(\gamma)\overline{\theta}$. Therefore, observing an assortment with a density greater than $1/\underline{s} = E_i(\gamma)\overline{\theta}/c$ will surprise consumer i because it reveals that there is at least one instance in which a premium is being charged for a quality difference that should be ignored. Such surprise motivates an update in consumer i's prior belief about the importance of quality. Although learning can also take place at lower levels of assortment density, the preceding reasoning proves that we can define a boundary density that provokes consumers to think quality is more important than anticipated. According to the preceding analysis, we articulate the following testable hypothesis:

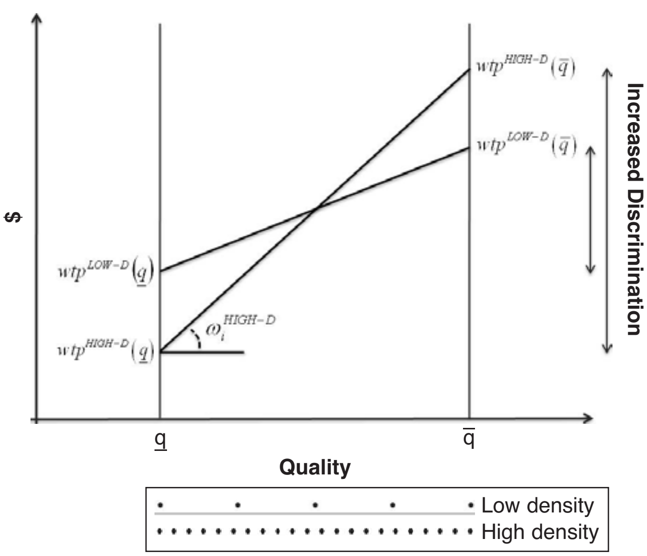
> H_1: Consumers are prepared to pay more for high-quality options and less for low-quality options when confronted with a dense, as opposed to a sparse, set of alternatives.

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:

> H_2: The effect predicted in H_1 is moderated by prior expectations about assortment density and the resulting classification of choice sets as either dense or sparse.

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

Figure 1
PRICE–QUALITY TRADE-OFF AS A FUNCTION OF ASSORTMENT DENSITY



EXPERIMENT 1

The first objective of Experiment 1 is 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 is to document that assortment density affects the perceived importance of product quality in purchase decisions.

Method

Participants (n = 76) were registered members of a subject pool managed by a business school in the United Kingdom. We recruited them by e-mail and assigned them at random to the experimental conditions. At the time of the study, this pool had 5098 active members, 62% of whom were female and 81% were completing undergraduate education. The median age was 24 years. Participation was voluntary, remunerated by the customary £10 payment on 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.

When participants arrived at the laboratory, an experimenter led them to one of two rooms and asked them to approach a table displaying several dark chocolates. The experimenter then explained that the array represented the full range supplied by a local manufacturer and 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 the term "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 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. However, the purchase price 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. To avoid anchoring effects, participants were not informed of the distribution of the potential purchase prices. The numbers in the second urn were distributed uniformly, ranging from £.10 to £5.00 in £.10 increments.

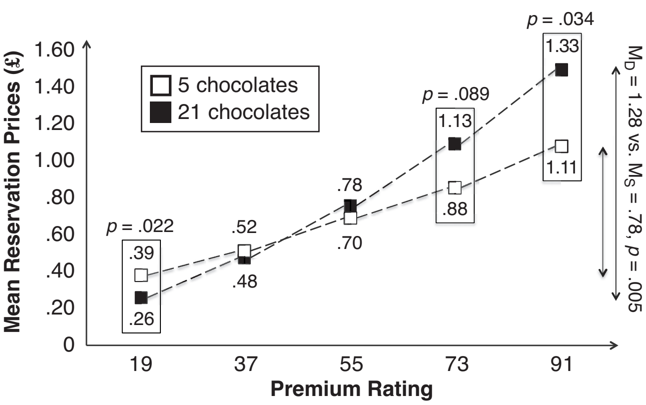
Following this task, we collected three additional measures. Participants first evaluated the following statement: "Buying good quality is always important, but it is particularly important when it comes to chocolate" (1 = "completely disagree," and 7 = "completely agree"). They then judged the size of the assortment produced by this local chocolate manufacturer (1 = "the assortment is very small," and 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," and 7 = "very difficult").

Results and Discussion

Our first two tests checked the manipulation of assortment density. As we 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 H_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 ($F(4, 296) = 7.65$, $p < .001$).

Figure 2
EXPERIMENT 1: MEAN RESERVATION PRICES AS A FUNCTION OF ASSORTMENT DENSITY AND PREMIUM RATING



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 the first and the last item in each assortment was greater when participants saw 21 chocolates (M_D = £1.28) than when they saw 5 chocolates (M_S = £.72; $F(1, 74) = 8.23$, $p = .005$, $\eta^2 = .10$). Indeed, the slope between these extreme options, which can be interpreted as an empirical estimate of the average sensitivity to quality $\overline{\omega}_i = E[E_i(\gamma)\theta_i]$, 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) 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 finding 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 H_1 predicts, 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 = £.26 vs. M_S = £.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. However, 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 therefore they might 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 1998). Note that we found no evidence of a complexity explanation in the participants' subjective evaluations of task difficulty ($p = .769$). However, the process may be subconscious. Indeed, 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 presents 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 conduct 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 H_1 in a different purchase context.

Method

Participants (n = 116) were registered members of a subject pool managed by a business school in the United States. They were recruited through e-mail and assigned at random to the experimental conditions. At the time of the study, this pool had 4223 active members, of whom 58% were female and 87% had completed undergraduate education. The median age was 26 years. 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 on 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 a 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 (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 pretest 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," and 7 = "completely agree"). On average, their responses were 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) 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," and 10 = "very good quality"), and to rate their level of confidence with the quality judgments (1 = "not very confident," and 7 = "very confident"). Finally, participants evaluated the store's selection of sauvignon blanc (1 = "the assortment is very small," and 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 ($M_D = 5.27$) than the assortment of 9 wines ($M_S = 4.28$; 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 H_1, participants presented with 27 alternatives were prepared to spend significantly less on a sauvignon blanc chosen 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, $p = .004$, $\eta^2 = .27$). However, the same group of participants 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

We conducted our third experiment to test H_2, the notion 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. We consider H_2 supported if including these expectations moderates the pattern of results observed in the first two experiments.

Method

Participants (n = 204) were recruited from the same subject pool used in Experiment 2. The task required 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 more than \$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 bricks-and-mortar store carried a stock of 10, 40, or 70 models of astronomy binoculars. Next, we explained that there were no such stores in the local area but that they could purchase a pair of binoculars from an online retailer that offered a selection of 25 or 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, participants anticipating a choice of 10 types of binoculars should perceive an assortment of 25 or 55 models as surprisingly dense, while participants anticipating a choice of 70 types of binoculars should perceive an assortment of 25 or 55 models as surprisingly sparse. The critical condition is when participants anticipate 40 types of 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 H_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," and 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 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 as being significantly larger than the sparse assortment (25 binoculars) by participants primed to expect 40 models ($M_{D|40} = 4.97$ vs. $M_{S|40} = 3.85$; $F(1, 64) = 10.12$, $p = .002$) but not by participants primed to expect 10 or 70 models ($p = .786$, and $p = .416$, respectively).

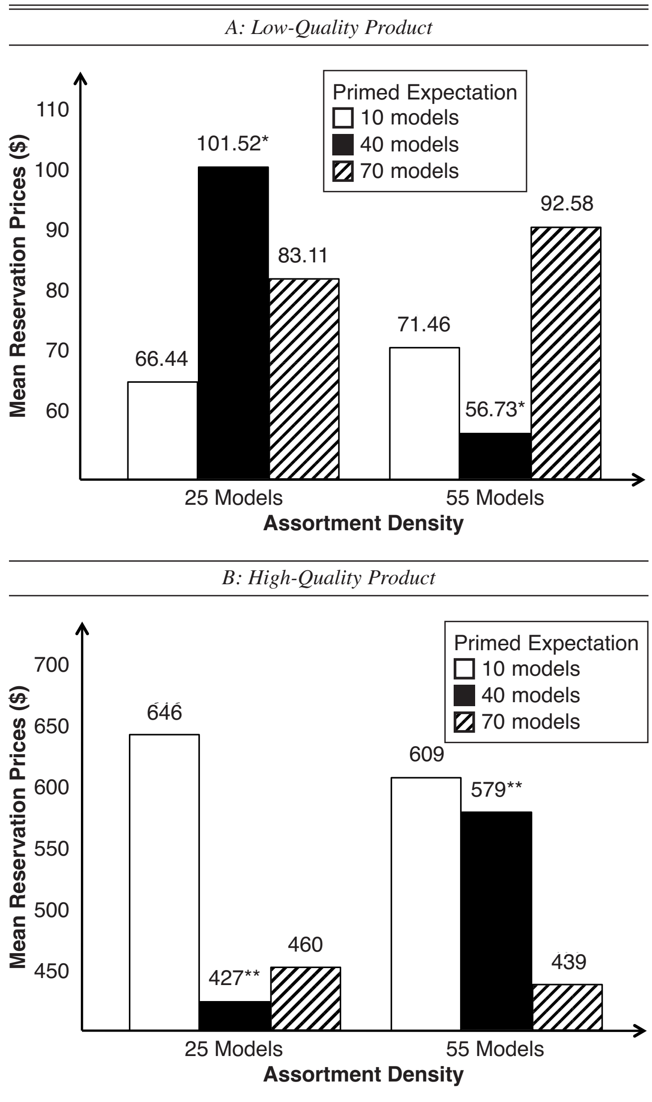
Next, we examined the willingness-to-pay estimates. Overall, a 3 × 2 full-factorial ANOVA on the difference in willingness to pay between the high-quality Nikon Superior E and the low-quality Garrett Gemini LW revealed a main effect of primed expectation ($F(2, 198) = 7.29$, $p = .001$) and the predicted two-way interaction ($F(2, 198) = 3.18$, $p = .044$). In support of H_2, this range varied significantly across assortment density conditions only when participants anticipated a choice of 40 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 in H_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 3, Panel A). 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 3, Panel B).

One of the alternative explanations for H_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. Experiment 1 already indicates some evidence against this reasoning, with participants presented with different densities reporting similar levels of difficulty in completing the task. The design of Experiment 3, however, enables 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. $M_{S|40} = 3.85$; $t(97) = 2.57$, $p = .012$ 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. $M_{D|40} = 4.97$; $t(101) = 2.53$, $p = .013$ 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.

Figure 3
EXPERIMENT 3: MEAN RESERVATION PRICES AS A FUNCTION OF ASSORTMENT DENSITY AND PRIMED EXPECTATION



*$p = .001$.
**$p = .053$.

MARKETPLACE EVIDENCE

To complement our experimental findings, we sought supporting evidence in the field. A leading global art business provided a data set to us, covering all (635) sale events conducted between January 2006 and June 2009 at the company's London 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, because we could not 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), 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 granularity of appraisals. For example, the average sale event in the wine department featured 236 lots but only 51.7 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:

$$\ln(\text{price}) = \beta_0 + \beta_1\ln(\text{quality}) + \beta_2\ln(\text{density}) + \beta_3[\ln(\text{quality}) \times \ln(\text{density})] + \varepsilon.$$

We calculated the assortment density index 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 H_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 $\delta\ln(\text{price})/\delta\ln(\text{density}) = \beta_2 + \beta_3\ln(\text{quality})$ 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 $\ln(\text{quality}^*) = -\beta_2/\beta_3$ or $\text{quality}^* = \exp(-\beta_2/\beta_3)$. Thus, we expected β_2 and β_3 to carry opposite signs. Consistent with the prediction that dense 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 1 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.

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 1). Using these results, we can calculate the critical appraisal level to be exp(–1.3682/.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 according to the assortment density index and estimated the associated relationship between appraisals and realized prices. Table 2 displays the results. It seems 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 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 affect 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 article provides evidence that consumers confronted with a proliferation of options will

Table 1

PARAMETER ESTIMATES OF LINEAR REGRESSION

	All Departments (n = 62,715)*	*Wine Department* (n = 12,587)*
β_0	1.592	2.983
β_1	.900	.590
β_2	–.546	–1.368
β_3	.036	.212
Adjusted R^2	.874	.895

*For all parameters, $p < .001$.

Table 2

RELATIONSHIP BETWEEN REALIZED PRICE AND APPRAISALS AT VARIOUS LEVELS OF ASSORTMENT DENSITY INDEX (WINE DEPARTMENT ONLY)

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	2535	.922
5 ≤ ln(ADI) < 6	.487	.957	5406	.930
6 ≤ ln(ADI) < 7	.424	.974	2575	.868
7 ≤ ln(ADI) < 8	.667	.915	439	.918

*For all parameters, $p < .001$.

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 propose a theory of inferred sensitivity to quality differences in which the impact of quality on a consumer's utility includes a known dispositional component (a person's 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; uncertain consumers rationally infer that the presence of product proliferation requires sufficiently discriminating consumers. We predicted that a surprisingly dense assortment polarizes willingness to pay such that high-quality (low-quality) options become more (less) valuable (H_1) and that prior expectations play a significant moderating role (H_2).

Empirical Findings

We found initial support for H_1 in an experiment that manipulated the number of quality-ranked products on display. The data show 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 replicates 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 introduce category-level heterogeneity (and uncertainty) in the importance of product quality and propose 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 Wernerfelt (1995) and Kamenica (2008) propose.

Consistent with the approach Glaeser (2004) and Villas-Boas (2009) advocate, instead of simply importing cognitive effects into an analysis of economic decision making, we investigate 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 affect 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 take a similar approach, placing particular emphasis on understanding how the number of qualities in a market affects the trade-off consumers make between price and quality.

Literature on conjoint analysis (Wittink, Krishnamurthi, and Reibstein 1989) suggests 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 is different in that the objective was to document a behavioral phenomenon rather than to treat a measurement problem. As a result, both 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 toward 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, our theory could be used to provide insight into the mechanisms underlying the demotivating 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 also unsure of their personal taste for quality, investing this effort may be overwhelming and ultimately reduce commitment to choosing. Conversely, sparse assortments can make consumers less discriminating than they should be, especially in situations in which 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 that a retailer's decision 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 to convey the importance of innovations and features. This finding complements the work of Berger, Draganska, and

Simonson (2007), who show that the variety offered by a manufacturer can add to the power of umbrella brands.

Finally, from a consumer protection point of view, the data could point to 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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