

# Contextual Inference in Markets: On the Informational Content of Product Lines

Emir Kamenica\*  
University of Chicago†

July 4, 2007

## Abstract

A large literature demonstrates that contexts and frames influence decisions. This malleability of choice is usually invoked as evidence against the assumption that people maximize a stable preference ordering. In a market equilibrium, however, contexts and frames provide payoff-relevant information to consumers: the information implicit in a firm's decision to offer a particular set of goods allows uninformed consumers to infer from the product line which good is optimal for them. Consequently, these consumers rationally violate naïve formulations of standard choice theoretic principles. I identify informational asymmetries under which apparently anomalous behaviors, namely the compromise effect and choice overload, arise as market equilibria. In addition, I establish that the presence of uninformed consumers may induce firms to reduce the number of varieties they offer or to introduce *premium loss leaders*, i.e., expensive goods of overly high quality that are unprofitable on their own but greatly increase the demand for other products.

---

\*I am extremely grateful to Edward Glaeser and David Laibson for their guidance and intellectual generosity. I am deeply indebted to Dražen Prelec; my interest in this topic grew directly out of conversations with him. Matthew Gentzkow provided particularly useful suggestions. I would also like to thank participants at many seminars and colleagues too numerous to mention individually for helpful comments and suggestions. Karen Bernhardt provided excellent research assistance. I gratefully acknowledge support by the National Science Foundation Graduate Research Fellowship, the National Institute on Aging (Grant # T32-AG00186), the Humane Studies Fellowship, the Institute for Quantitative Social Science Fellowship, and the Chiles Fellowship. All mistakes are mine alone.

†email: emir.kamenica@ChicagoGSB.edu; phone: 773.834.8690

# 1 Introduction

Numerous studies demonstrate that seemingly irrelevant factors influence people’s decisions. Perhaps the best known examples of such influence are *context effects*. A consumer exhibits a context effect if her choice between two alternatives systematically depends on the presence of a third option. An extensive literature demonstrates context effects in laboratory settings. One of the most widely studied context effects is the compromise effect (Simonson 1989).<sup>1</sup> The compromise effect refers to the finding that people tend to choose the middle option. More precisely, when three alternatives are available the middle alternative is chosen more often than when it is paired with only one other option. Figure 1 shows the compromise effect obtained by Simonson (1989). This tendency to avoid extreme options has been credited with affecting phenomena ranging from the demand for wine (McFadden 1999) to voting (Herne 1997) and investing (Benartzi and Thaler 2002). Even more telling of the importance bestowed on the compromise effect is its didactic use in books such as *101 Ways to Increase Sales* (van Eetvelde, Geens, and Harrington 2002) and *Information Rules* (Shapiro and Varian 1999).

Another behavior that is seemingly inconsistent with a well-defined preference ordering is choice overload. In choice overload experiments (e.g., Iyengar and Lepper 2000), customers are less likely to make a purchase if more products are added to the choice set.

More broadly, marketing research reveals that minor changes in the decision-making environment can have a substantial impact on what people buy. For example, North, Hargreaves, and McKendrick (1997) show that market shares react to the type of music played in the store. In their experiment, customers bought more than three times as many bottles of French as German wine when French music was playing, but German wine outsold French by 150% when music was

---

<sup>1</sup>Many of the laboratory experiments reported in this paper utilize hypothetical questions. The vast majority of the results, however, have subsequently been replicated using incentive-compatible procedures with real stakes, occasionally in the field (e.g., Doyle *et al.* 1999).

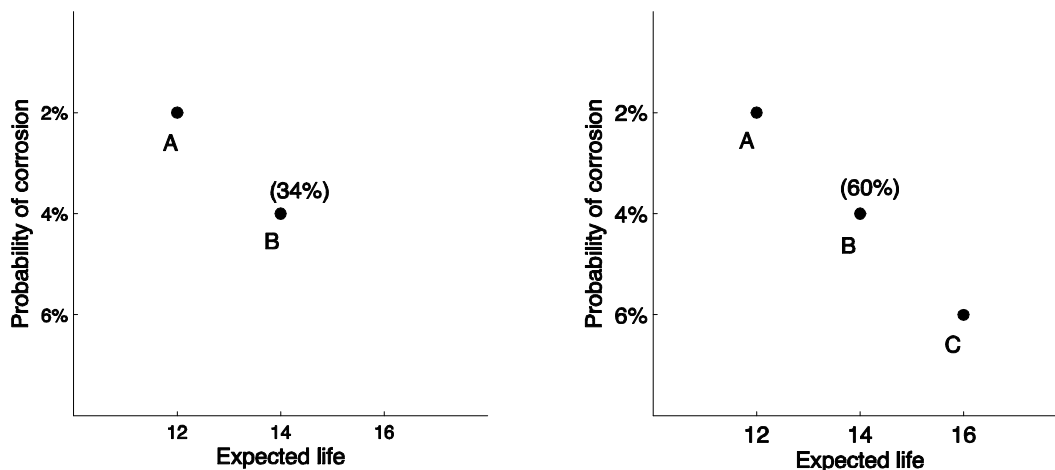


Figure 1: Compromise effect with calculator batteries. Numbers in parentheses indicate percentage of subjects choosing the alternative. The difference is significant at  $p < 0.05$ . Source: Simonson (1989).

German.

This malleability of behavior is usually presented as evidence against stability of preferences and as an invitation to consider alternative, psychologically richer, theories of choice (e.g., Slovic 1995). However, a recognition that *contexts and frames may contain information* suffices to reconcile these apparent anomalies with standard utility-maximizing behavior. In this paper, I develop a model where uninformed consumers learn payoff-relevant information by observing what goods are available. The tendency to select the middle option thus naturally arises when there are consumers who are unsure which option is best for them, but know their tastes are middlebrow. Choice overload comes as no surprise if excessive product lines reduce consumers' information about which varieties are likely to suit them.<sup>2</sup> In short, *contextual inference* parsimoniously explains seemingly disparate behavioral anomalies.

In examining each incarnation of contextual inference as an apparent behavioral anomaly, I first

---

<sup>2</sup>Similarly, French music playing in the store might indicate that the store specializes in French vintages, but this paper will not examine such framing effects.

consider a situation where market context, i.e., the product line,<sup>3</sup> arises without the firm’s attempt to influence consumers’ beliefs. Such a model is appropriate when the number of uninformed consumers is small. The first proposition of the paper identifies the supply-side conditions that are sufficient for the compromise effect to arise as a market equilibrium. The idea is straightforward: in a market setting, a consumer’s knowledge of her relative position in the distribution of tastes is sufficient for identifying the optimal good *if* she can observe the entire product line. When fixed costs exclude some goods from the product line, however, the reduced menu provides worse information and forces the consumer to choose based on her prior. This leads to an inconsistency between choices from a smaller and a larger menu. The analysis behind this proposition not only establishes that the compromise effect can arise in equilibrium; it also makes clear and testable predictions on the *ex post* optimality of the inconsistent choices.

When many consumers are uninformed, the firm may try to manipulate consumers’ beliefs through the set of varieties it offers.<sup>4</sup> In particular, the second proposition establishes that firms may introduce *premium loss leaders* – expensive goods of overly high quality which, though unprofitable on their own, greatly improve the demand for other products. I provide anecdotal evidence that supports the existence of premium loss leaders.

The second half of the paper examines choice overload. I first demonstrate that an uninformed consumer can be better off with a smaller choice set. The logic behind this possibility is as follows. A consumer who does not know which variety she likes must choose randomly among the available varieties. In equilibrium, the most popular varieties are introduced, so the average popularity of the available varieties is decreasing in the breadth of the product line. Consequently, the uninformed

---

<sup>3</sup>In accordance with the prevalent use in the existing literature, I use the word “context” throughout the paper to simply mean the set of alternatives available to the agent, i.e., the choice set in the language of decision theory. I reserve the word “frame” for those aspects of the decision-making environment, including the manner of representing the alternatives available, that do not change the underlying choice set.

<sup>4</sup>Consider a wine column that advises, “If you’re on a tight budget, you can always do what economical diners have done for decades: order the second cheapest wine on the list,” yet warns, “Just be advised that an old restaurant ploy is to slot an overstocked bottle into the second cheapest position on the list” (Oldman 2004).

consumer's surplus is greater when there are fewer options. In response, as the final results in the paper reveal, firms reduce the number of goods they offer in the presence of uninformed consumers. These results on choice overload have implications not only for the theory of product differentiation, but also for the current debates on Social Security and Medicare reform.

The contrast between the compromise effect and choice overload is worth noting. In the case of the compromise effect, the uninformed consumers know their relative position in the distribution of tastes and their equilibrium strategies resemble a rank-order heuristic. In the case of choice overload, the uninformed do not know their relative position in the distribution of tastes (or goods are not ordered in a suitable way), so they cannot do any better than to choose randomly among the available options. The structure of preferences is not the determining factor: both the compromise effect and choice overload can arise whether product differentiation is horizontal or vertical.

Importantly, the interpretation of context- and frame-sensitivity in terms of inference yields a rich set of testable predictions. In Section 4, I discuss existing experimental results that support the inference interpretation of choice overload.

Admittedly, not every instance of context and framing effects is likely a consequence of fully rational behavior. Contextual inference may not be the complete story in some examples of context effects,<sup>5</sup> and certain demonstrations of anchoring<sup>6</sup> reveal a framing effect in a setting where information should not play a role (Tversky and Kahneman 1974; Ariely, Loewenstein, and Prelec 2003). In these anchoring experiments, the authors attempt to make it transparent to the subjects that the anchor has no informational value, yet the subjects seem unable to refrain from reacting as if the frame harbors information.<sup>7</sup>

---

<sup>5</sup>Simonson and Tversky (1992) demonstrate that context matters even when subjects assess qualities before making their decisions (inspect the samples of paper towels).

<sup>6</sup>Anchoring refers to the tendency of judgments and preferences to be affected by irrelevant, randomly generated numbers that are made salient.

<sup>7</sup>For example, Ariely, Loewenstein, and Prelec (2003) demonstrate that asking subjects whether they would be willing to buy a bottle of wine for a dollar figure equal to the last two digits of their social security number makes their subsequent willingness to pay for that bottle sensitive to this number: subjects with a higher social security

This paper relates to several streams of literature. The idea that context effects may stem from rational inference, though largely unexplored, is not new. Luce and Raiffa (1957) and Sen (1993) informally observe that a choice set may contain information. Wernerfelt (1995) develops the idea formally and demonstrates that consumers' ignorance of their absolute, and knowledge of their relative, tastes can lead to the compromise effect.<sup>8</sup> This observation plays the central role in my analysis of the compromise effect and motivates the paper overall. In contrast to Wernerfelt (1995), the uninformed consumers in my paper do not follow a rank-order rule in equilibrium but rather have beliefs that depend on the strategy of the firm. The consequent analysis yields novel intuitions, including that the firm distorts the product line in the attempt to manipulate consumers' beliefs and that the compromise effect remains an equilibrium outcome even when the firm's manipulation reduces the informational content of the product line. I further expand on Wernerfelt (1995) by examining how the quality of uninformed consumers' information varies with the choice set. This consideration yields the novel results on choice overload.

Other papers examine contextual inference in various settings. Anand and Shachar (2004) empirically study how the information implicit in a TV network's decision to air particular shows induces brand loyalty. Bénabou and Tirole (2003) demonstrate that an agent's inference about her tastes from the incentive structure can generate a trade-off between intrinsic and extrinsic motivation. Kalai, Rubinstein, and Spiegel (2002) consider inference more abstractly and establish bounds on the size of the implicit state space that is needed to rationalize specific behaviors.<sup>9</sup>

This paper is also closely related to the marketing literature on context effects (Simonson and Tversky 1992; Tversky and Simonson 1993; Kivetz, Netzer, and Srinivasan 2004; Orhun 2006). The paper in that line of research that is most relevant is Orhun's (2006) concurrent work which embeds

---

number are willing to pay more for the wine.

<sup>8</sup>Prelec, Wernerfelt, and Zettelmeyer (1997) experimentally examine this possibility.

<sup>9</sup>Harrison, Harstad, and Rutström (2004) and Plott and Zeiler (2005) stress the need to consider inference by subjects in design of experiments.

consumers with context-dependent preferences in a market setting and examines the equilibrium product line. Her analysis generates the possibility that a firm will introduce a good of excessively high quality. However, in her paper, as in the remainder of this line of research, agents are exogenously assumed to have preferences that depend on the choice set, while I consider context-dependence that arises endogenously through inference.

The results in this paper also build on the industrial organization literature on the influence of asymmetric information on market structure. The well-known insight that informed consumers can exert a positive externality on the uninformed ones (Salop and Stiglitz 1977; Chan and Leland 1982; Wolinsky 1983; Cooper and Ross 1985) plays a central role in the analysis of the compromise effect. However, the choice overload results reveal a limitation of this intuition and establish that uninformed consumers' surplus can *decrease* as the number of the informed consumers increases.

Finally, this paper relates to the work on behavioral or boundedly rational industrial organization.<sup>10</sup> The last two years have witnessed a profusion of papers that analyze the question of how firms will respond to consumers who exhibit some particular behavioral anomaly (DellaVigna and Malmendier 2004; Schlag 2004; Heidhues and Köszegi 2005a, 2005b; Gabaix and Laibson 2006; Spiegler 2006). In contrast to this line of research, I do not exogenously impose a behavioral bias on consumers but rather derive non-classical behavior as an equilibrium phenomenon that arises under standard preferences.

In that vein, the choice overload section of this paper is closely related to concurrent work by Kuksov and Villas-Boas (2005) who also demonstrate that rational consumers can be better off with fewer options.<sup>11</sup> They consider a setting where agents with horizontally differentiated preferences incur a cost to determine the location of each alternative offered, and demonstrate that

---

<sup>10</sup>See Ellison (2006) for a survey.

<sup>11</sup>In related work, Mirrlees (1987) examines the optimal number of options that a benevolent government should provide when agents' choices are prone to error.

the expected search cost required to attain a particular fit can increase in the breadth of the product line. Consequently, consumers' demand can decrease when the number of alternatives increases.

The remainder of the paper is structured as follows. In Section 2, I develop the general model of contextual inference. Section 3 applies the model to the compromise effect and establishes the possibility of premium loss leaders. Section 4 demonstrates that, under an appropriate informational asymmetry, uninformed consumers obtain a greater surplus from a strictly smaller choice set. Section 5 concludes.

## 2 A Model of Contextual Inference

Suppose there is a continuum of consumers and a single firm. The consumers are indexed by  $i \in [0, 1]$ . Let  $X$  be the set of technologically feasible varieties. Each variety  $x \in X$  is characterized by the utility it yields to the consumers, its marginal cost of production  $c_x$ , and its (possibly stochastic) fixed cost  $K_x$ . The randomness in the fixed costs will provide exogenous variation in the product line.

The utility function is quasi-linear: consumer  $i$  obtains utility  $u(\theta_i, s, x) - p_x + \varepsilon_{ix}$  from purchasing variety  $x$  at price  $p_x$ , where  $\varepsilon_{ix}$  are independent and identically distributed shocks with  $E[\varepsilon_{ix}] = 0$ .<sup>12</sup> Utility from variety  $x$  thus depends on the consumer's individual type,  $\theta_i \in \Theta$ , and the global preference parameter,  $s \in S$ . Each consumer  $i$  has unit demand and an outside option  $x_0$ .

The global preference parameter  $s$  is the key component of the model. The precise interpretation of  $s$  depends on the particular application; in general,  $s$  may capture features of the external world (e.g., the meaning of technical units of quality) or features of internal tastes (e.g., the mapping from

---

<sup>12</sup>These utility shocks are only needed in Subsection 3.2, for the result on premium loss leaders, where they ensure that demand is continuous in beliefs. Each consumer  $i$  knows  $\varepsilon_{ix}$  for all  $x$ .

flavors to preferences). One way to think about  $s$  is as a taste shifter unobserved by a fraction of the population it affects. I will discuss the interpretation of  $s$  in much greater detail later on.

A fraction  $\alpha \in [0, 1)$  of the consumers do not know  $s$ . This fraction is independent of the type. The uninformed share a common prior  $\pi$  over  $S$  and the firm knows the uninformed have this prior.

The monopolist knows  $s$  and chooses a product line  $M \subseteq X$  given its costs. I assume that prices are exogenous. This assumption greatly simplifies the exposition and increases the transparency of the mechanisms that drive the results. An earlier version of this paper (Kamenica 2006) derives the results in a setting with endogenous prices.<sup>13</sup>

The firm’s strategy may depend on  $s$ , so the uninformed consumers rationally update their beliefs about  $s$  based on the firm’s behavior, forming a posterior  $\pi(s|M)$ .<sup>14</sup> The consumers know the distribution, but not the realization of the fixed costs. Also, I assume the uninformed cannot observe the behavior of other consumers.<sup>15</sup>

The solution concept is *Perfect Bayesian Equilibrium* with the *D1* criterion (Banks and Sobel 1987; Cho and Kreps 1987). The *D1* criterion is an equilibrium refinement widely used in signalling games. It requires that if the set of uninformed consumers’ mixed responses that make the firm willing to deviate to some disequilibrium action  $a$  when  $s = s'$  is strictly smaller than set of such responses when  $s = s''$ , then the uninformed consumers believe that the firm is infinitely more likely to deviate to  $a$  when  $s = s''$  than when  $s = s'$ . Without such a restriction, seemingly implausible equilibria built on “threat beliefs” arise. In particular, without *D1* any product line  $M$  can be

---

<sup>13</sup>With endogenous prices an additional element is needed to ensure that the information in prices does not fully reveal  $s$ . Accordingly, the treatment in Kamenica (2006) requires retail cost shocks that reduce the informational content of prices.

<sup>14</sup>Extensive laboratory evidence suggests people make systematic mistakes in their inferences. In particular, the cursed equilibrium model (Eyster and Rabin 2005) or the analogy-based expectation equilibrium model (Jehiel 2005) could be relevant in this setting. Additionally, experimental evidence suggests that, apart from their mistakes in inference, many people exhibit limited “strategic sophistication”: they do not take into account other players’ incentives (Costa-Gomes, Crawford, and Broseta 2001). However, I utilize a standard equilibrium notion to demonstrate that my results do not require any unconventional assumptions.

<sup>15</sup>Previous research has explored learning from others (e.g., McFadden and Train 1996; Bergemann and Välimäki 1999; Bolton and Harris 1999).

supported as an equilibrium outcome by off-equilibrium beliefs that interpret a deviation to any  $M' \neq M$  as evidence that goods in  $M'$  are undesirable.

I can now introduce some of the ideas from the Introduction in formal terms. A consumer engages in *contextual inference* if  $\pi(s|M) \neq \pi(s)$ . To simplify notation, let  $\hat{u}(\theta, x|M)$  denote the average<sup>16</sup> expected utility from purchasing  $x$  for the uninformed consumers of type  $\theta$  given the information that firm introduced  $M$ , i.e.,  $\hat{u}(\theta, x|M) = \int_S u(\theta, s, x) d\pi(s|M) - p_x$ . Note that this notation does *not* imply that utility depends on the choice set: the product line enters expected utility only through its influence on beliefs.

Context effects will arise if the posterior affects the relative valuations of two goods, i.e., if there are  $x$  and  $x'$  such that when they are chosen from some product line  $M$ ,  $x$  is preferred,  $\hat{u}(\theta, x|M) > \hat{u}(\theta, x'|M)$ , but the presence of an additional option,  $y$ , provides information that makes  $x'$  more desirable,  $\hat{u}(\theta, x|M \cup \{y\}) < \hat{u}(\theta, x'|M \cup \{y\})$ .

The compromise effect is a specific example of a context effect. Let  $\succ$  denote a partial ordering on  $\mathbb{R}^2$  defined by  $(a_1, a_2) \succ (a'_1, a'_2)$  if  $a_1 > a'_1$  and  $a_2 > a'_2$ . For example,  $a_1$  might be the quality of a good and  $a_2$  its price; in that case,  $\succ$  provides a natural ordering in the price-quality space. We say that uninformed consumers of type  $\theta$  exhibit the compromise effect if there are  $x_0, x_1, x_2$  in  $\mathbb{R}^2$  such that  $x_0 \succ x_1 \succ x_2$  and  $x_1 = \arg \max_x \hat{u}(\theta, x|\{x_0, x_1, x_2\})$ , but  $\hat{u}(\theta, x_0|\{x_0, x_1\}) > \hat{u}(\theta, x_1|\{x_0, x_1\})$  or  $\hat{u}(\theta, x_2|\{x_1, x_2\}) > \hat{u}(\theta, x_1|\{x_1, x_2\})$ . That is, a good is superior if it is the middle option, but not as a part of a pair. Recall that Figure 1 depicts an example of the compromise effect.<sup>17</sup>

Finally, uninformed consumers of type  $\theta$  engage in rational choice overload if there are two choice sets  $M$  and  $M'$ , with  $M \subsetneq M'$  s.t.  $\max_{x \in M} \hat{u}(\theta, x|M) > \max_{x \in M'} \hat{u}(\theta, x|M')$ .<sup>18</sup> In other words, the maximum obtainable utility from a smaller choice sets is strictly greater than the maximum

<sup>16</sup>The average is over the  $\varepsilon_{ix}$ 's. Recall that  $E[\varepsilon_{ix}] = 0$ .

<sup>17</sup>Note that I define the compromise effect in terms of  $\hat{u}$ , rather than as a violation of regularity in market shares (as in Figure 1). However, unless the variance of  $\varepsilon_{ix}$  is excessive, this definition does imply a violation of regularity.

<sup>18</sup> $M \subsetneq M'$  denotes that  $M$  is a proper subset of  $M'$ , i.e.,  $M \subseteq M'$ , but  $M \neq M'$ .

obtainable utility from the superset. Subsequent sections provide concrete examples of how these phenomena may arise.

### **3 Hedonic Interpretation of Quality: The Compromise Effect and the Premium Loss Leader**

Interpreting technical units of quality can be difficult. How much more, for example, would you be willing to pay for a flashlight that delivers 40 rather than 35 lumens of light?<sup>19</sup> Similarly, in order to optimally choose a personal computer, a consumer may need to know her willingness to pay for megahertz, gigabytes, and numerous other technical measures of quality. How do consumers make choices in the demanding environments of numerical information? In this section, I identify the ways in which informational externalities can ease the task of selecting the optimal variety when there is uncertainty about the hedonic interpretation of quality. In a market setting, a consumer's knowledge of her relative position in the distribution of tastes is often sufficient for identifying the optimal good. Goldilocks may not know how many dollars she is willing to pay for an additional megahertz, but, as long as she knows she is in the middle of the distribution of taste for speed, she will do well purchasing the computer that is neither too slow nor too fast.<sup>20</sup> Extracting information from the set of available options, however, may lead consumers to violate the naïve formulation of the Weak Axiom of Revealed Preference. The first subsection demonstrates how this inference can lead to the compromise effect in a market equilibrium.

Moreover, when consumers rely on context to decide what to purchase, firms may have an incentive to distort their product line in order to increase the demand for their most profitable

---

<sup>19</sup>Knowing that a lumen is “a unit of luminous flux, equal to the flux emitted by a point source of intensity one candela into a solid angle of one steradian” (*Oxford English Dictionary*, 2nd edition), is hardly helpful for understanding the utility equivalent of the additional 5 lumens.

<sup>20</sup>Shapiro and Varian (1999) also refer to firm behavior that exploits the compromise effect as “Goldilocks pricing.”

varieties.<sup>21</sup> In particular, they may introduce an expensive good of overly high quality that is unprofitable on its own but greatly increases the demand for other products. The second subsection demonstrates the possibility of such premium loss leaders.

### 3.1 Goldilocks and the Three Goods: The Compromise Effect

For now, suppose that the uninformed consumers are zero measure. Consequently, the firm will not respond to their presence and the equilibrium product line will be the same as in a standard model of discrete choice. The next subsection introduces more uninformed consumers and analyzes the firm's response.

I begin by imposing some structure on the model from Section 2. There are only three technologically feasible varieties,  $\{x_0, x_1, x_2\} = X$ , defined by their quality  $q_j$ , marginal cost  $c_j$ , stochastic fixed cost  $K_j$ , and price  $p_j$ , with  $q_j < q_k$ ,  $c_j < c_k$ , and  $p_j < p_k$  whenever  $j < k$ .<sup>22</sup> Hence, from the consumers' perspective, the goods have a natural ordering in the price-quality space. The discussion of the compromise effect is with respect to this ordering. As the term 'quality' implies, the varieties are vertically differentiated – all consumers would agree on the ranking of the varieties if they were to have identical prices. There are two types of consumers who differ in the intensity of their taste for quality. In particular, consumer  $i$  obtains utility  $\theta_i s q_j - p_j + \varepsilon_{ij}$  from purchasing a product of quality  $q_j$  for price  $p_j$ , where  $\theta \in \{\theta^l, \theta^h\} = \Theta$  with  $0 < \theta^l < \theta^h$ .<sup>23</sup> Let  $\lambda^t$  denote the fraction of consumers of type  $\theta^t$ . Note that the consumer's type captures the consumer's relative position in the distribution of tastes for quality.<sup>24</sup> Each consumer knows her own type and the

---

<sup>21</sup>Glaeser (2004) argues that knowing that people are sensitive to frames and contexts begs the question of how frames and contexts arise in the real world. In other words, if consumers are context sensitive, we should study the market supply of context.

<sup>22</sup>If prices and qualities were endogenous, the considerations of price discrimination (Mussa and Rosen 1978; Tirole 1988, Chapter 3) would substantially complicate the model in a direction orthogonal to the topic of this paper.

<sup>23</sup>The particular multiplicative functional form is of no consequence and is utilized merely for ease of exposition.

<sup>24</sup>We can also think of a particular person exhibiting a different  $\theta$  on different days. For example, the intensity of taste for wine quality may depend on the occasion.

overall distribution of tastes. The utility shocks,  $\varepsilon_{ij}$ 's, are independently drawn from an atomless distribution on  $[0, \xi]$  where  $\xi > |(\theta s q_k - p_k) - (\theta s q_l - p_l)|$  for any  $\theta, s, k$ , and  $l$ . In other words, a consumer of any type may prefer any product. These utility shocks are not needed for establishing the possibility of the compromise effect, but they ensure that more favorable beliefs about  $s$  increase demand in a continuous fashion, which will be useful in the next subsection.

The fixed costs,  $K_j$ 's, which provide exogenous variation in the product line, are independent and identically distributed with an atomless distribution on  $[0, \bar{K}]$ . Finally, I assume  $\frac{p_2 - p_1}{q_2 - q_1} > \frac{p_1 - p_0}{q_1 - q_0}$ ; otherwise, no consumer would ever prefer  $x_1$  to both  $x_0$  and  $x_2$ .

The global preference parameter  $s$  captures the hedonic value of quality. For example, suppose that the firm is producing flashlights, and that quality,  $q$ , is measured in lumens. A consumer of type  $\theta$  then, would be willing to pay additional  $\$5\theta s$  for a flashlight that delivers 40 instead of 35 lumens of light. The effective hedonic value of a flashlight of quality  $q$  is  $\theta s q$ . With this formulation, we capture uncertainty about the utility interpretation of quality as uncertainty about the value of  $s$ . In the style of high school physics exercises, we can rewrite  $u = \theta s q - p$  with the emphasis on the units:  $u \text{ \$} = \theta \frac{\text{\$}}{\text{brightness}} * s \frac{\text{brightness}}{\text{lumens}} * q \text{ lumens} - p \text{ \$}$  in the case of flashlights, or  $u \text{ \$} = \theta \frac{\text{\$}}{\text{speed}} * s \frac{\text{speed}}{\text{Mhz}} * q \text{ Mhz} - p \text{ \$}$  in the case of computer processors. The global preference parameter  $s$  thus translates *technical units* like lumens and Mhz into *hedonic units* like brightness and speed.

This preference parameter determines which product is optimal for which type. In particular, I assume  $S = \{\underline{s}, \bar{s}\}$ , and when  $s$  is low ( $s = \underline{s}$ ),  $x_1$  is optimal for the high types while the low types prefer  $x_0$ .<sup>25</sup> When  $s$  is high ( $s = \bar{s}$ ),  $x_1$  is optimal for the low types while  $x_2$  is optimal for the high types.<sup>26</sup> Both  $\underline{s}$  and  $\bar{s}$  occur with positive probability.

<sup>25</sup>Of course, in the presence of utility shocks, some consumers will not prefer the variety that is optimal for their type.

<sup>26</sup>Formally,

The firm can produce  $x_1$  and  $x_2$ . The lowest quality good,  $x_0$ , is the outside option for each consumer. We can think of it as a generic brand produced by an unmodelled competitive industry. This outside option is always available to the consumers.<sup>27</sup> I will abuse the notation slightly and include  $x_0$  in the expressions for the posterior, even though it is not introduced by the firm and provides no information about  $s$ .

The firm knows  $s$  and solves

$$\max_M \sum_{j: x_j \in M} D(x_j; M, s)(p_j - c_j) - K_j$$

where  $M$  is the set of varieties the firm offers and  $D(x_j; M, s)$  is the expected demand for  $x_j$  given product line  $M$  and the preference parameter  $s$ .

Now, suppose the following hold:

**(A1)** with positive probability the fixed costs are sufficiently low that the firm introduces surplus-maximizing goods:  $\{x_1, x_2\}$  in  $\bar{s}$ , and  $\{x_1\}$  in  $\underline{s}$ ;

**(A2)** with positive probability the fixed cost for any particular variety is sufficiently high that the firm does not introduce that variety.

while

$$\begin{aligned} \theta_l \underline{s} q_0 - p_0 &> \theta_l \underline{s} q_j - p_j & \forall j \neq 0 \\ \theta_h \underline{s} q_1 - p_1 &> \theta_h \underline{s} q_j - p_j & \forall j \neq 1, \\ \theta_l \bar{s} q_1 - p_1 &> \theta_l \bar{s} q_j - p_j & \forall j \neq 1 \\ \theta_h \bar{s} q_2 - p_2 &> \theta_h \bar{s} q_j - p_j & \forall j \neq 2. \end{aligned}$$

Equivalently,

$$\begin{aligned} \underline{s} &\in \left[ \frac{p_1 - p_0}{\theta_h (q_1 - q_0)}, \min \left\{ \frac{p_1 - p_0}{\theta_l (q_1 - q_0)}, \frac{p_2 - p_1}{\theta_h (q_2 - q_1)} \right\} \right] \\ \bar{s} &\in \left[ \max \left\{ \frac{p_1 - p_0}{\theta_l (q_1 - q_0)}, \frac{p_2 - p_1}{\theta_h (q_2 - q_1)} \right\}, \frac{p_2 - p_1}{\theta_l (q_2 - q_1)} \right]. \end{aligned}$$

The inequality  $\frac{p_2 - p_1}{q_2 - q_1} \geq \frac{p_1 - p_0}{q_1 - q_0}$  guarantees these two intervals are non-empty.

<sup>27</sup>One can also easily construct a version of the model where the firm can produce all the goods. The current version simplifies the demonstration of the possibility of premium loss leaders.

Later in this subsection, I discuss the conditions that guarantee such behavior by the firm. For now, note that A2 is merely an assumption on the support of the distribution of fixed costs. Ensuring A1, however, is more complicated since it is possible, for reasons of price discrimination, that the firm will not introduce a good in  $\bar{s}$  even if its fixed cost is zero.

Finally, I assume that the prior probability of  $\underline{s}$  is sufficiently high that if the firm only introduces  $x_1$ , the expected utility of this product for the low types is inferior to that of the outside option, i.e.,  $\hat{u}(\theta^l, x_0 | \{x_0, x_1\}) > \hat{u}(\theta^l, x_1 | \{x_0, x_1\})$ . This supposition precludes the situation where the low types select the middle option ( $x_1$ ) from  $\{x_0, x_1\}$  on *a priori* grounds.<sup>28</sup> Under these assumptions, we obtain the following proposition:

**Proposition 1.** *In any equilibrium, the uninformed consumers of type  $\theta^l$  exhibit the compromise effect with positive probability.*

All proofs are relegated to the Appendix. The basic intuition behind the result, however, is quite simple. When  $x_0$  and  $x_1$  are the only varieties offered, the uninformed  $\theta^l$  do not know which one is better for them. If  $s = \underline{s}$ ,  $x_0$  is optimal, but if  $s = \bar{s}$ ,  $x_0$  is inferior to  $x_1$ . However, the product line does not reveal whether  $s = \underline{s}$  or  $s = \bar{s}$ :  $x_2$  could be absent because  $s = \underline{s}$  or because  $K_2$  is large. The uninformed  $\theta^l$  thus make their choices based on their prior belief, and select a variety which is not always *ex post* optimal. In particular, since  $\hat{u}(\theta, x | M)$  does not depend on  $s$ ,  $\hat{u}(\theta^l, x_0 | \{x_0, x_1\}) > \hat{u}(\theta^l, x_1 | \{x_0, x_1\})$  whether  $s = \underline{s}$  or  $s = \bar{s}$ . Whenever the uninformed  $\theta^l$  consumers are offered three varieties, however, they know that  $s = \bar{s}$  and that the middle option is optimal. Hence, they exhibit the compromise effect. Importantly, as the next subsection will demonstrate, the result in Proposition 1 does not rely on non-strategic behavior by the firm: even when there are many uninformed consumers, so the firm distorts the product line in order to manipulate their beliefs, the uninformed low types still exhibit the compromise effect.

---

<sup>28</sup>The expression, in terms of the primitives, for this restriction on  $\pi(\underline{s})$  is cumbersome though conceptually simple.

In contrast, the  $\theta^h$  types, by always choosing the highest quality available, never select a variety that is suboptimal, given their taste, to another available variety. The information in the product line always reveals which of the available goods is best for them, so they never exhibit the compromise effect.

Now, consider the assumptions that are needed to ensure condition A1: that the firm will introduce both  $x_1$  and  $x_2$  in  $\bar{s}$  when fixed costs are sufficiently low.<sup>29</sup> This behavior is not immediately guaranteed as there exist prices under which the firm's profit is greater if it excludes a socially optimal good even when its fixed cost is zero. One way to ensure that this does not happen is to presume (i) that the prices maximize firm's profits given that both goods are introduced and (ii) that markups are increasing in quality, i.e.,  $(p_1, p_2) \in \arg \max_{\hat{p}_1, \hat{p}_2} \sum_{j=1}^2 D(x_j; M, \bar{s})(\hat{p}_j - c_j)$  and  $(p_2 - c_2) > (p_1 - c_1)$ .<sup>30</sup>

The analysis behind Proposition 1 reveals several new results. Most importantly, it establishes that information contained in the product line may lead to the compromise effect in a market equilibrium. A similar line of reasoning can be used to explain the attraction effect (Huber, Payne, and Puto 1982).<sup>31</sup> Also, the analysis yields a normative ranking of inconsistent choices in the case of the compromise effect: those choices made within a larger context are the better ones.<sup>32</sup> The prediction here is exactly opposite of that made by Hsee (2000). He argues that consumption always takes place in a separate evaluation mode and that, consequently, choices made with limited comparison are superior *ex post*.

---

<sup>29</sup>As noted earlier, one can easily ensure condition A2, that fixed costs exclude each variety with positive probability, by supposing that  $\bar{K} > (p_j - c_j)$  for all  $j$ . Also, it is trivial that the firm will introduce  $x_1$  in  $\underline{s}$  when  $K_1$  is sufficiently close to zero.

<sup>30</sup>With endogenous prices, it is more difficult to ensure both goods are introduced. Anderson and Dana (2006) provide a relevant discussion.

<sup>31</sup>The attraction effect refers to the finding that, given two multi-attribute alternatives (say A and B), the addition of a third option (C) that is dominated on all attributes by one existing alternative (B) but not the other (A) increases the appeal of the now dominating alternative (B).

<sup>32</sup>This holds in the particular model I have used to generate the compromise effect. More generally, the informational content of a complete product line will be superior to that of a partial one, but it is possible to construct an example with more goods and more types where quality of information is not monotone in the breadth of the product line.

This prediction is testable. For example, measuring subsequent satisfaction with the goods purchased during the experiment (say, by allowing returns or observing use) would reveal whether choices made in richer contexts are in fact more likely to be *ex post* optimal.

### 3.1.1 Interpreting Uncertainty About $s$

Uncertainty about  $s$  plays a crucial role in establishing Proposition 1. As noted above, this uncertainty can be understood in terms of the distinction between technical and hedonic units of quality. This distinction additionally illuminates other behavioral anomalies. Consider, for example, the research on joint-separate evaluation preference reversals (e.g., Bazerman, Loewenstein and White 1992; Lowenthal 1993; Bazerman *et al.* 1994). A joint-separate evaluation preference reversal obtains when an option (A) is generally preferred to its alternative (B) if each is presented separately to two groups of subjects, but B is generally preferred to A if a group of subjects is presented with both options. In a representative experiment, Hsee (2000) asked subjects how much they would be willing to pay for a CD changer. One of the CD changers (A) had THD of .01% and capacity of 20 CDs, while the other (B) had THD of .003% and could hold 5 CDs. All subjects were told that THD stands for total harmonic distortion and that small values of THD imply better sound quality. Some of the subjects were also told that “For most CD changers on the market, THD ratings range from .002% (best) to .012% (worst).” The subjects were assigned to 6 conditions, with 3 evaluation modes (joint evaluation, separate evaluation of A, or separate evaluation of B) by 2 information modes (information about the range of THD values or not). Unsurprisingly, in low information separate evaluation conditions, subjects could not interpret THD values and exhibited a higher willingness to pay for option A, the option that holds more CDs. When context was provided, however, whether through the presence of both A and B or in the form of information about the market distribution of THD values, subjects were able to price

sound quality and CD changer B obtained higher prices.<sup>33</sup> If we think of  $q$  as the THD value, uncertainty about  $s$  neatly captures the intuition behind this experiment.<sup>34</sup> Uncertainty about  $s$  can also be used to interpret results on scope neglect (e.g., Kahneman 1986; Desvousges *et al.* 1992; McFadden and Leonard 1993; Frederick and Fischhoff 1998), and the experiments on “travelling indifference curves” (Drolet, Simonson, and Tversky 2000).

### 3.2 Firm’s Manipulation of Consumers’ Beliefs: The Premium Loss Leader

Since the uninformed consumers’ demand for a particular good can increase with the presence of another good, the firm may manipulate its product line to increase the demand for its more profitable varieties. Smith and Nagle (1995) advise managers to introduce premium products even if they do not sell well, in order to “enhance buyers’ perceptions of lower-priced products in the product line.” Here, I examine the possibility that the firm introduces such a premium loss leader – a good of exceptionally high quality, unprofitable on its own, whose purpose is simply to boost the sales of more moderate varieties. To examine this possibility, let there be a positive measure of uninformed consumers, i.e.,  $\alpha \in (0, 1)$ .<sup>35</sup> With this exception, I maintain the model and the assumptions of the previous subsection.

The mechanism behind the possibility of a premium loss leader is straightforward. The demand by the informed for  $x_2$  is greater when  $s$  is greater, so the introduction of  $x_2$  *credibly* signals a higher  $s$ . Consequently, the demand by the uninformed is greater if  $x_2$  is introduced, which leads the firm to introduce this high quality good even if it is not profitable *per se*. Note that, by assumption of

---

<sup>33</sup>Specifically, in low information separate evaluation conditions, mean WTP values for A and B were \$256 and \$212, respectively ( $p < 0.1$ ), while in low information joint evaluation mode, WTP for A and B were \$204 and \$228, respectively ( $p < 0.01$ ). In high information modes, mean WTP values were \$186 and \$222 ( $p < 0.01$ ) in joint evaluation mode and \$177 and \$222 ( $p < 0.01$ ) in separate evaluation mode.

<sup>34</sup>In the model the goods have a single-dimensional quality and a price, while the experiment utilizes goods with a two-dimensional quality. The more easily interpretable quality dimension, i.e., the CD capacity, plays the role of the price.

<sup>35</sup>It is important to have at least some informed consumers ( $\alpha < 1$ ). Without their presence, the  $D1$  criterion does not eliminate equilibria based on “threat beliefs.”

equilibrium play, the uninformed are fully aware of the fact that the firm is distorting the product line in order to manipulate their beliefs; the increase in their demand induced by the presence of  $x_2$  reflects genuine informational content of the product line.

To demonstrate this formally, let  $\Pi(x_j; M, s)$  denote the firm's *per se* expected profit from selling  $x_j$ , i.e.,  $\Pi(x_j; M, s) = D(x_j; M, s)(p_j - c_j) - K_j$ . Recall that  $D(x_j; M, s)$  is the expected demand for good  $x_j$  given product line  $M$  and preference parameter  $s$ . Then, the following proposition states that the temptation to manipulate the beliefs of the uninformed can lead the firm to introduce  $x_2$  even when its *per se* profit is negative.

**Proposition 2.** *In any equilibrium,  $\exists \hat{\lambda}^l < 1$  s.t. if  $\lambda^l > \hat{\lambda}^l$ , with positive probability the firm introduces the highest quality good even when its *per se* profit is negative.*

It is necessary to assume that a sufficiently high fraction of consumers are of the low type because the high types who switch from buying  $x_1$  to buying  $x_2$  when  $x_2$  is introduced decrease the marginal profit from  $x_2$  relative to the *per se* profit from  $x_2$ . Consequently, in the absence of consumer inference, the *per se* profit from  $x_2$  needs to be *strictly positive* in order for the introduction of  $x_2$  to be profitable. Assuming that  $\lambda^l$  is high reduces the extent of this cannibalization.

Even though the firm's distortion of the product line reduces its informational content (since the firm may introduce  $x_2$  even in  $\underline{s}$ ), it does not eliminate it entirely: the firm is still more likely to introduce  $x_2$  in  $\bar{s}$  than in  $\underline{s}$ . This credibility of  $x_2$  as a signal of  $\bar{s}$  is precisely why Proposition 2 holds even though the uninformed consumers are perfectly aware of the firm's attempt to manipulate their beliefs: the residual informational content of the product line still leads some consumers to switch from  $x_0$  to  $x_1$  when  $x_2$  is introduced. Hence, the main result of the previous subsection holds even when a positive measure of consumers are uninformed.

The presence of the premium loss leader reduces the social surplus without improving the firm's ability to price discriminate, so the firm would wish to commit to introduce  $x_2$  only in  $\bar{s}$ . Such a

commitment, however, would not be credible: if  $s = \underline{s}$  and  $K_2$  is low relative to  $\alpha$ , the firm would increase its profit by introducing  $x_2$  and thus suggesting that  $s = \bar{s}$ .

Anecdotal evidence supports the existence of premium loss leaders. Consider the story, reported in Simonson and Tversky (1992), about Williams-Sonoma, a retail and mail-order company that sells high-end cookware. The company used to offer a single bread-baking appliance for \$275, and then it introduced another, higher quality machine, for \$429. The new item did not sell well, but the demand for the \$275 variety almost doubled! Simonson and Tversky suggest that the company did not anticipate this effect,<sup>36</sup> but the anecdote lends support to the prediction in Proposition 2.<sup>37</sup> Xerox has also been reported to increase the sales of its high-volume copier by introducing an additional, higher quality, version.<sup>38</sup> Rigorously demonstrating these phenomena is a worthwhile challenge for future empirical research.<sup>39</sup>

Contextual inference has substantial implications for the analysis of product differentiation. A large literature in industrial organization examines the determination of the product line in models of discrete choice (see Anderson, de Palma, and Thisse 1992 for a textbook treatment). The results in this section suggest that we could enrich this literature by considering the informational content of product lines. Note that contextual inference may change firms' equilibrium behavior no matter the nature of the competition (e.g., monopoly, duopoly, *etc.*) and no matter the structure of preferences (e.g., vertical or horizontal differentiation).

---

<sup>36</sup>At the time of this paper's writing, Williams-Sonoma offers a single bread-baking appliance for \$150.

<sup>37</sup>The model easily fits the Williams-Sonoma anecdote. We can think of  $x_1$  as the \$275 variety and of  $x_2$  as the \$429 variety. When only the \$275 variety was available, the uninformed customers presumed that  $s = \underline{s}$ , and only the high types bought from the firm. The introduction of the \$429 bread maker, however, led the uninformed to believe that  $s = \bar{s}$  and thus pulled the low types into the market for the \$275 variety.

<sup>38</sup>"The Compromise Effect," *Washington Post*, January 27, 2002.

<sup>39</sup>There is another way in which inference might lead to a premium loss leader: the ability of a firm to produce a good of an extremely high quality might reveal a technological prowess that signals reliability of other products produced by that firm. Note, however, that this mechanism produces distinct observable implications, since it suggests that a high quality good increases demand through market stealing rather than market expansion.

## 4 Choice Overload: Preference for Smaller Choice Sets

One of the simplest choice theoretic principles is that, in non-strategic situations, you cannot be worse off having more options.<sup>40</sup> A burgeoning empirical literature in marketing and economics, however, documents violations of this principle.<sup>41</sup> Iyengar and Lepper (2000) set up a jam tasting booth in an upscale grocery store and varied whether the booth displayed 6 (limited-selection) or 24 (extensive-selection) distinct flavors of jam. They strikingly found that almost 12% of the potential customers in the limited-selection condition purchased a jam, while only 1.65% of those in the extensive-selection condition did so ( $p < 0.001$ ). Boatwright and Nunes (2001) report an experiment run by an online grocery store. The store reduced its product selection by roughly a half<sup>42</sup> for a fraction of its customers (the experimental group)<sup>43</sup> and tracked both their purchases and the purchases of the remaining customers (the control group) for six months prior and five months subsequent to the intervention. Sales in the experimental group were 11% ( $p < 0.0001$ ) higher. Demonstrations of choice overload are not limited to the retail industry. A field experiment by Bertrand *et al.* (2005) reveals that offering a single loan instead of numerous ones increases take-up substantially. Iyengar, Huberman, and Jiang (2004) show that, on average, 75% of employees participate in a company 401(k) plan when there are only 2 funds available, but participation rate falls to roughly 60% when employees must choose between 59 funds. Other demonstrations of preference for smaller choice sets include Tversky and Shafir (1992), Redelmeier and Shafir (1995),

---

<sup>40</sup>A notable exception arises if agents have self-control problems (e.g., Strotz 1955; Laibson 1997; Gul and Pendorfer 2001). I abstract from these issues.

<sup>41</sup>The idea that excessive choice is potentially undesirable has been emphasized in the popular press as well. For a recent example, see “One Nation, With Niches for All,” *New York Times*, June 11, 2005.

<sup>42</sup>Depending on the product category the assortment decreased by between 22% and 82%. The average decrease was close to 50%.

<sup>43</sup>In the article, Boatwright and Nunes (2001) do not specify whether the selection of the experimental group was randomized. In my correspondence with the authors I have learned that they were not involved in the design of the experiment and thus do not know whether the treatments were randomized. I have been unable to obtain contact information for any person at the store who was involved with the experiment.

Dhar(1997), and Chernev (2003).<sup>44</sup>

Iyengar and Lepper (2000) interpret their result as evidence for the hypothesis that smaller choice sets “may be more intrinsically motivating.” Alternatively, however, we can use the idea of contextual inference to interpret the observed effects in a manner that is consistent with standard theories of choice. The basic insight is that smaller choice sets can provide better information: the uninformed know more about which varieties are popular (and are likely to suit them) when they face a smaller product line.

#### 4.1 Contextual Inference Interpretation of Choice Overload

Suppose that there are  $N$  possible flavors of jam,  $X = \{1, 2, \dots, N\}$ , all with the same markup,  $p - c > 0$ , and the same price,  $p$ .<sup>45</sup> Each consumer has a favorite flavor and obtains utility  $\bar{u} > p$  from consuming it. The utility from consuming any flavor other than the favorite is zero. Let  $\lambda_x$  denote the fraction of the consumers whose favorite flavor is  $x$ . If  $\lambda_x > \lambda_{x'}$  we say that  $x$  is *more popular* than  $x'$ . Consumer  $i$  has unit demand and an outside option that yields utility  $u_i(x_0) \stackrel{iid}{\sim} F$ , where  $F$  is an atomless distribution whose support includes  $[-p, \bar{u} - p]$ . The continuous distribution of the outside option along with this assumption on its support ensures that if the uninformed obtain strictly greater expected utility from purchasing a jam, their demand will be strictly greater.

An informed consumer knows which flavor is her favorite. The firm knows how popular each flavor is. An uninformed consumer knows neither which flavor she likes nor which flavors are

---

<sup>44</sup>Schwartz (2004) goes so far as to suggest that the expansion of product lines over the last 30 years has played an important role in increasing the prevalence of depression in the United States.

<sup>45</sup>With endogenous prices, constant marginal costs replace the assumption of constant markups (cf. discussion following Lemma 3), and retail cost shocks replace the assumption of constant prices. Moreover, even with exogenous prices, it is not necessary that prices be constant; the requisite assumption is that prices do not reveal too much information about popularity. Empirically, homogeneous prices are quite common in a variety of imperfectly competitive industries, from yogurts to movie theatres (Orbach and Einav 2006).

popular. Formally, we let  $S$  be the set of permutations of  $\{1, 2, \dots, N\}$  and set

$$u(\theta_i, x, s) = \bar{u}I_{\{\theta_i=s(x)\}},$$

where  $\Theta = \{1, 2, \dots, N\}$  and  $I_{\{\theta_i=s(x)\}}$  is an indicator function equal to 1 if  $\theta_i = s(x)$  and equal to 0 otherwise. In other words, it is as if  $s$  were a label that specifies the covetous type for each flavor. Each consumer knows her own type, but not the distribution of types.<sup>46</sup> Note that the popularity of a given good is a function of  $s$ :  $\lambda_x(s)$ .<sup>47</sup> I assume there are no flavors that nobody likes, that no two flavors are equally popular,<sup>48</sup> and that the elements of  $S$  are equiprobable under the prior. With these assumptions, we obtain the central building block of the analysis in this section:

**Lemma 3.** *In any equilibrium, the firm always introduces the most popular flavors, i.e., if  $M$  is an equilibrium product line when  $s = \hat{s}$ , then  $x \in M$  and  $x' \notin M \Rightarrow \lambda_x(\hat{s}) > \lambda_{x'}(\hat{s})$ .*

This Lemma relies on the homogeneity of markups. If less popular flavors had greater markups and uninformed were many, the firm might strategically introduce a generally undesirable flavor with a high markup. The analysis of such a situation is closely related to the analysis of premium loss leaders in the previous section: the product line would provide less, but still some, information about the popularity of its constituent varieties.

The most important implication of Lemma 3 is that the average popularity of the available flavors is decreasing in the breadth of the product line. Consequently, the uninformed consumers, who can do no better than to choose randomly from the available flavors, prefer smaller choice sets. Let  $D^{\text{unf}}(M)$  be the fraction of uninformed consumers who purchase a jam when the firm offers

---

<sup>46</sup>If some consumers were to know that they have particularly uncommon tastes, they would not participate in the market when only few goods are offered since they would know that none of the popular goods suit them. For choice overload to obtain, it is important that most people think of themselves as typical.

<sup>47</sup>If we denote the fraction of consumers of type  $\theta$  by  $\lambda^\theta$ , then  $\lambda_x(s) = \lambda^{s(x)}$ .

<sup>48</sup>This assumption is generically satisfied. Moreover, even without it the subsequent results still hold, albeit with weak inequalities.

product line  $M$ .

**Proposition 4.** *In any equilibrium, the demand by the uninformed consumers is strictly decreasing in product line breadth. Formally,  $\forall M, M'$  s.t.  $|M| < |M'|$ ,  $D^{unf}(M) > D^{unf}(M')$ .*

Note that  $M$  and  $M'$  are not necessarily equilibrium outcomes: Proposition 4 relates the uninformed demand to product line breadth *within* an equilibrium. However, Lemma 3 also allows us to compare the demand by the uninformed across any two equilibria:

**Proposition 5.** *Let  $M$  and  $M'$  be any two equilibrium product lines. The demand by the uninformed is strictly greater with the smaller product line. Formally, if  $|M| < |M'|$ , then  $D^{unf}(M) > D^{unf}(M')$ .*

Propositions 4 and 5 do have distinct empirical content. Proposition 4 makes a prediction about how the demand by the uninformed consumers would respond if an experimenter manipulated the product line in a fixed equilibrated market, while Proposition 5 makes a prediction about how the demand by the uninformed consumers varies across undisturbed equilibrated markets.

Note that the firm could increase both its profits and social welfare by simply labeling the popularity of the varieties it introduces. At first glance this may seem like an important problem with the model. Choice overload, however, also arises if each variety is produced by a different firm. In this case, “popularity labels” would convey no information in equilibrium since every firm would have an incentive to claim its product is the most popular. Moreover, even when a single firm produces all varieties, heterogenous markups may lead the firm to falsely label a high-margin product as popular.<sup>49</sup> Finally, we often do see retailers, especially reputable ones, provide information about the popularity of the products they sell. For example, Amazon.com provides the sale rank of every product it carries.

---

<sup>49</sup>As noted earlier, such a situation is closely related to the analysis of premium loss leaders.

Propositions 4 and 5 provide a rational explanation for choice overload. Moreover, the suggested mechanism behind the phenomenon yields a testable implication. If the uninformed know their relative position in the distribution of tastes for an ordered, observable attribute (as in Section 3), rational choice overload should not obtain. Hence, the contextual inference interpretation predicts that choice overload is less likely to happen when the available varieties differ along a single, ordered dimension. An experiment by Gourville and Soman (2005) confirms this prediction. Gourville and Soman presented subjects with hypothetical choices of microwaves. Each choice set included  $n$  Sharp microwaves and a single Panasonic option. The experimenters varied  $n$  from one to five. Moreover, in some conditions the Sharp microwaves differed only on capacity and price, while in others they varied on a number of attributes. As the inference interpretation predicts, choice overload obtained in the latter but not in the former conditions.

Salgado (2005) provides a more direct confirmation of the contextual inference mechanism. In her experiments, subjects first made a selection between a large menu of lotteries (with 25 or 50 options) and a smaller menu (with 5 options) and then chose one of the lotteries from the selected menu. The smaller menu was always a subset of the larger one. The subjects were told that the subset was (i) chosen randomly, (ii) chosen by graduate students in economics, or (iii) chosen to include the only 5 undominated lotteries from the larger set. As we would expect under the contextual inference interpretation of choice overload, the fraction of subjects selecting the smaller set was much larger in the latter two conditions.<sup>50</sup>

An alternative way to generate rational choice overload would be to assume that uninformed consumers obtain social capital, and thus a higher utility, from whatever goods the informed are consuming, *à la* Becker and Murphy (2000). In this interpretation, the uninformed do not know from which good they would most benefit precisely because they do not know which good is the most

---

<sup>50</sup>Some subjects chose the smaller choice set even when it was selected randomly. This does not necessarily pose a challenge to the theory, however, since the elicited preferences were not strict.

popular one. This social interactions story, however, does not predict the Gourville and Soman (2005) finding. Nonetheless, a social interactions model of choice overload might be suitable for certain types of goods (e.g., books or music).

The most common alternative hypothesis that attempts to explain choice overload argues that cognitive costs reduce the desirability of excessive choice sets (Huffman and Kahn 1998; Cristol and Sealey 2000; Gourville and Soman 2005). Most treatments of this hypothesis, however, seem not to recognize that a consumer can always randomly select a small choice set out of the large one. Since such a procedure need not entail any thinking, the consumer cannot be worse off with more options simply because of the decision-making costs (unless we allow for a disutility of regret).<sup>51</sup> In order for choice overload to take place, the elements of the smaller choice set must be different in some way from a random selection from the larger set. Contextual inference provides a concrete microfounded difference, namely popularity.

## 4.2 Firm's Response to Choice Overload

In contrast to the uninformed, the informed consumers know which flavors they like. Therefore, they prefer longer product lines since those are more likely to include their preferred flavors: the demand by the informed is increasing in product line breadth. Since the uninformed prefer smaller and the informed larger menus, the firm faces a trade-off between serving the informed and the uninformed. Consequently, the equilibrium product line is decreasing in the measure of the uninformed consumers. To state this result formally, let  $\Pi(M, \alpha, s)$  denote the firm's profit in  $s$  when the product line is  $M$  and fraction  $\alpha$  of consumers are uninformed.

**Proposition 6.** *In any equilibrium, the firm's profit from a smaller product line relative to its profit from a larger product line is strictly increasing in the fraction of the uninformed consumers.*

---

<sup>51</sup>See Irons and Hepburn (2003) and Sarver (2005) for treatments of choice overload under regret.

Formally, if  $M \subsetneq M'$ ,  $\Pi(M, \alpha, s) - \Pi(M', \alpha, s)$  is strictly increasing in  $\alpha$  for all  $s$ .

Proposition 6 immediately implies the following comparative static:

**Corollary 7.** *The equilibrium breadth of the product line is weakly decreasing in the fraction of the uninformed consumers.*

The comparative static is weak only because product line breadth is a discrete variable: as Proposition 6 reveals, the firm's relative profit from a smaller product line is strictly increasing in the size of the uninformed population. A direct consequence of Corollary 7 is that the uninformed consumers' utility, which is decreasing in  $|M|$ , is increasing in  $\alpha$ . In other words, the uninformed are *worse off* when there are more informed consumers in the market. The informed, in turn, prefer a wider choice set, so they suffer from the presence of the uninformed. These externalities are quite similar to the preference externalities that arise when the prevalence of a particular taste induces a product line that provides less surplus for consumers with less common tastes (Waldfogel 2003; George and Waldfogel 2003). Because of these externalities, the consumers would wish to sort into separate stores for the informed and the uninformed. This desire for sorting may be an important factor in the industrial organization of the retail industry.

Choice overload is often invoked as an important consideration in the debate on Social Security reform. Iyengar, Huberman, and Jiang's (2004) study of choice overload was published in a book entitled *Pension Design and Structure*. Cronqvist and Thaler (2004) discuss the Swedish experience with Social Security privatization, emphasizing the seemingly negative effects of numerous fund options. Iyengar and Kamenica (2006) demonstrate that the presence of many funds adversely affects allocation as well as participation decision in 401(k) plans. Finally, the idea that politicians who push for Social Security reform are mistaken because they do not understand choice overload has been put forth in the popular press as well.<sup>52</sup> As the analysis in this section reveals, however, if

---

<sup>52</sup> "Choice Overload Burdens Daily Life," *USA Today*, January 5, 2004.

choice overload stems from contextual inference, the welfare impact of expanding retirement options would crucially depend on whether these options are accompanied by suitable information.

## 5 Conclusion

Characteristics of market equilibria often contain information that allows market participants to make better decisions. The most widely studied aspect of this feature of the market is the fact that prices can aggregate information and thus lead to a more efficient allocation of scarce resources. This paper, in contrast, focuses on the informational content of equilibrium product lines. A firm's decision to offer a particular set of goods may reveal information that helps uninformed consumers make better choices. But, the information revelation is far from perfect, and contextual inference sometimes leads consumers to engage in seemingly anomalous behaviors.

In response to consumer inference, firms may attempt to manipulate the informational content of their product lines and induce supply distortions. Proposition 2 demonstrates that a monopolist may introduce a premium loss leader while Corollary 7 shows that the presence of uninformed consumers can reduce the number of varieties offered. Future theoretical research might consider a dynamic model that allows for the product line to in turn influence what proportion of the consumer population is uninformed. Consumers' information may depend on their consumption in the previous period. Since that consumption depends on the available choice set, the product line in one time period might have an impact on the proportion of the uninformed consumers in the next period.

Contextual inference theory also suggests a number of directions for empirical research. Do firms introduce goods whose purpose is to influence consumers' beliefs? If consumers are aware that the product line is small for reasons unrelated to popularity, does choice overload still obtain? Are consumers with more typical preferences more prone to choice overload? These are but some

of the empirical questions whose answers may help us better understand the role and the scope of contextual inference in markets.

## A Appendix

### A.1 Proof of Proposition 1

*Proof.* The proof is almost by construction. Suppose  $s = \bar{s}$ . Given assumptions A1 and A2 on firm's behavior, we know the consumers sometimes face  $\{x_0, x_1\}$  and that they sometime face  $\{x_0, x_1, x_2\}$ . Moreover, since  $K_2 = 0$  is a zero measure event, the firm will almost surely exclude  $x_2$  in  $\underline{s}$ . Hence,  $\pi(\bar{s} | \{x_0, x_1, x_2\}) = 1$ , which implies

$$\hat{u}(\theta^l, x_1 | \{x_0, x_1, x_2\}) > \max \left\{ \hat{u}(\theta^l, x_0 | \{x_0, x_1, x_2\}), \hat{u}(\theta^l, x_2 | \{x_0, x_1, x_2\}) \right\}.$$

Recall that by assumption  $\hat{u}(\theta^l, x_0 | \{x_0, x_1\}) > \hat{u}(\theta^l, x_1 | \{x_0, x_1\})$ . Hence, uninformed consumers of type  $\theta^l$  exhibit the compromise effect when  $s = \bar{s}$ , which happens with positive probability. ■

### A.2 Proof of Proposition 2

*Proof.* To prove the proposition, we first establish that the uninformed consumers' expectation of  $s$  is strictly greater if  $x_2$  is present than if it is not (STEP 1). Then, the continuity in the distribution of the utility shocks guarantees that, as long as  $\lambda^l$  is sufficiently high, the uninformed consumers' demand for  $x_1$  will be strictly greater if  $x_2$  is introduced (STEP 2). This additional benefit of introducing  $x_2$  means that it will sometimes be profitable to introduce  $x_2$  even if its *per se* profit is somewhat negative (STEP 3).

STEP 1: We begin by demonstrating that the uninformed consumers' expectation of  $s$  is strictly greater if  $x_2$  is present than if it is not. Formally, we want to show that  $\pi(\bar{s} | \{x_0, x_1, x_2\}) > \pi(\bar{s} | \{x_0, x_1\})$  (it is also the case that  $\pi(\bar{s} | \{x_0, x_2\}) > \pi(\bar{s} | \{x_0\})$ , but this inequality does not play a role in the proof). First, we demonstrate the weak inequality: that it cannot be the case that the presence of  $x_2$  leads the uninformed to lower their expectation of  $s$ . Suppose the contrary:

$\pi(\bar{s}|\{x_0, x_1, x_2\}) < \pi(\bar{s}|\{x_0, x_1\})$ . Let  $\mathcal{M}(s, K_1, K_2)$  denote the firm's product line strategy as a function of  $s$  and the realizations of fixed costs. Then, either (i) the firm never introduces  $x_2$  or (ii) there are  $\hat{K}_1$  and  $\hat{K}_2$  such that  $\mathcal{M}(\underline{s}, \hat{K}_1, \hat{K}_2) = \{x_1, x_2\}$  but  $\mathcal{M}(\bar{s}, \hat{K}_1, \hat{K}_2) = \{x_1\}$ . However, if (i) is the case, the off-equilibrium beliefs that imply  $\pi(\bar{s}|\{x_0, x_1, x_2\}) < \pi(\bar{s}|\{x_0, x_1\})$  do not satisfy the  $D1$  criterion. To see this, note that, holding the reaction from the uninformed consumers constant, firm's marginal profit from introducing  $x_2$  is lower in  $\underline{s}$  than in  $\bar{s}$ . Therefore, the set of uninformed reactions that make the introduction of  $x_2$  more profitable than the equilibrium strategy of never introducing it is greater in  $\bar{s}$  than in  $\underline{s}$ . Hence,  $D1$  does not permit off-equilibrium beliefs that suppose  $\pi(\bar{s}|\{x_0, x_1, x_2\}) < \pi(\bar{s}|\{x_0, x_1\})$ . Now, we need to rule out case (ii): that there is some level of fixed costs  $(\hat{K}_1, \hat{K}_2)$  at which  $x_2$  is introduced in  $\underline{s}$  but not in  $\bar{s}$ . Consider the deviation to remove  $x_2$  from  $\mathcal{M}(\underline{s}, \hat{K}_1, \hat{K}_2)$ . For that deviation not to be profitable, it must be the case that the loss of the sales of  $x_2$  outweighs the increased uninformed demand for  $x_1$ , i.e.,

$$(1 - \alpha) \left[ \begin{array}{c} \sum_{j=1}^2 D^{\text{inf}}(x_j; \{x_1, x_2\}, \underline{s})(p_j - c_j) - \\ D^{\text{inf}}(x_1; \{x_1\}, \underline{s})(p_1 - c_1) \end{array} \right] - \hat{K}_2 > \\
\alpha \left[ \begin{array}{c} D^{\text{unf}}(x_1; \{x_1\})(p_1 - c_1) - \\ \sum_{j=1}^2 D^{\text{unf}}(x_j; \{x_1, x_2\})(p_j - c_j) \end{array} \right],$$

where  $D^{\text{inf}}(x_j; M, s)$  is the expected informed demand for  $x_j$  given  $M$  and  $s$  and  $D^{\text{unf}}(x_j; M)$  is the expected uninformed demand for  $x_j$  given  $M$ .

But, the profit *from the informed* from selling  $\{x_1, x_2\}$  relative to selling  $\{x_1\}$  is clearly greater in  $\bar{s}$  than in  $\underline{s}$ :

$$\left[ \begin{array}{c} \sum_{j=1}^2 D^{\text{inf}}(x_j; \{x_1, x_2\}, \bar{s}) (p_j - c_j) - \\ D^{\text{inf}}(x_1; \{x_1\}, \bar{s}) (p_1 - c_1) \end{array} \right] > \left[ \begin{array}{c} \sum_{j=1}^2 D^{\text{inf}}(x_j; \{x_1, x_2\}, \underline{s}) (p_j - c_j) - \\ D^{\text{inf}}(x_1; \{x_1\}, \underline{s}) (p_1 - c_1) \end{array} \right]$$

Therefore, it must be the case that were the firm to add  $x_2$  to  $\mathcal{M}(\bar{s}, \hat{K}_1, \hat{K}_2)$ , the gain from the sales of  $x_2$  would outweigh the decreased uninformed demand for  $x_1$ , i.e.,

$$(1 - \alpha) \left[ \begin{array}{c} \sum_{j=1}^2 D^{\text{inf}}(x_j; \{x_1, x_2\}, \bar{s}) (p_j - c_j) - \\ D^{\text{inf}}(x_1; \{x_1\}, \bar{s}) (p_1 - c_1) \end{array} \right] - \hat{K}_2 > \alpha \left[ \begin{array}{c} D^{\text{unf}}(x_1; \{x_1\}) (p_1 - c_1) - \\ \sum_{j=1}^2 D^{\text{unf}}(x_j; \{x_1, x_2\}) (p_j - c_j) \end{array} \right].$$

Hence, we must have  $x_2 \in \mathcal{M}(\bar{s}, \hat{K}_1, \hat{K}_2)$  and we have reached a contradiction.

We have now established that  $\pi(\bar{s} | \{x_0, x_1, x_2\}) \geq \pi(\bar{s} | \{x_0, x_1\})$ .

Next, we show this inequality is strict. Suppose to the contrary  $\pi(\bar{s} | \{x_0, x_1, x_2\}) = \pi(\bar{s} | \{x_0, x_1\})$ .

If this equality holds because  $x_2$  is never introduced in equilibrium, the firm can profitably deviate by introducing  $x_2$  in  $\bar{s}$  when  $K_2$  is low, as its profits from the informed consumers would increase and the equality implies that there would be no adverse reaction from the uninformed. If the equality holds because the firm is equally likely to introduce  $x_2$  in  $\underline{s}$  and  $\bar{s}$ , then either (i) the firm could profitably deviate by increasing the probability of introduction in  $\bar{s}$  and decreasing it in  $\underline{s}$ , or (ii) the firm introduces  $x_2$  with probability 1 in which case it sometimes introduces it even when its *per se* profit is strictly negative.

STEP 2: We have now established that the uninformed consumers' expected value of  $s$  is strictly greater if  $x_2$  is present than if it is not, i.e.,  $\pi(\bar{s} | \{x_0, x_1, x_2\}) > \pi(\bar{s} | \{x_0, x_1\})$ . Because the utility shocks,  $\varepsilon_{ij}$ 's, are identically and independently drawn from an atomless distribution on  $[0, \xi]$  with  $\xi > |(\theta s q_k - p_k) - (\theta s q_l - p_l)| \forall \theta, s, k, l$ , we know that more favorable beliefs translate into strictly higher demand by the uninformed low types. Hence,

$$\lim_{\lambda^l \rightarrow 1} D^{unf}(x_1; \{x_1, x_2\}) - D^{unf}(x_1; \{x_1\}) > 0.$$

As for the informed, they never buy  $x_2$  in  $\underline{s}$ , so  $D^{\text{inf}}(x_1; \{x_1, x_2\}, \underline{s}) = D^{\text{inf}}(x_1; \{x_1\}, \underline{s})$ . In  $\bar{s}$ , however, the high types switch from  $x_1$  to  $x_2$  when  $x_2$  is introduced. Hence, for any  $\lambda^l < 1$ ,  $D^{\text{inf}}(x_1; \{x_1, x_2\}, \bar{s}) < D^{\text{inf}}(x_1; \{x_1\}, \bar{s})$ . Since this inequality stems from the behavior of high types, it disappears as  $\lambda^l$  goes to 1. Hence, for all  $s$

$$\lim_{\lambda^l \rightarrow 1} D^{\text{inf}}(x_1; \{x_1, x_2\}, s) - D^{\text{inf}}(x_1; \{x_1\}, s) = 0.$$

Therefore, since the difference in demands is continuous in  $\lambda^l$ , for any  $\alpha > 0$ ,  $\exists \hat{\lambda}^l < 1$  s.t. if  $\lambda^l > \hat{\lambda}^l$ ,  $\forall s$ :

$$\begin{aligned} D(x_1; \{x_1, x_2\}, s) &= \\ \alpha D^{unf}(x_1; \{x_1, x_2\}) + (1 - \alpha) D^{\text{inf}}(x_1; \{x_1, x_2\}, s) &> \\ \alpha D^{unf}(x_1; \{x_1\}) + (1 - \alpha) D^{\text{inf}}(x_1; \{x_1\}, s) &= \\ D(x_1; \{x_1\}, s) & . \end{aligned}$$

STEP 3: Since markups are positive and  $K_2$  has an atomless distribution, for all  $s$ , with positive

probability  $K_2$  is realized so that

$$\begin{aligned}
0 &> \\
\Pi(x_2; \{x_1, x_2\}, s) &= \\
D(x_2; \{x_1, x_2\}, s)(p_2 - c_2) - K_2 &> \\
[D(x_1; \{x_1\}, s) - D(x_1; \{x_1, x_2\}, s)](p_1 - c_1) & .
\end{aligned}$$

When these two inequalities hold, the *per se* profit from  $x_2$  is negative but the firm still introduces it. ■

### A.3 Proof of Lemma 3

*Proof.* Suppose to the contrary that, at some  $s = \hat{s}$ , the firm offers some product line  $M$  s.t.  $x \in M$  and  $x' \notin M$  even though  $\lambda_x(\hat{s}) < \lambda_{x'}(\hat{s})$ . Consider a deviation where the firm instead introduces  $M' = M \setminus \{x\} \cup \{x'\}$ . The profit from the informed consumers would clearly be strictly greater under this deviation. Hence, it must be the case that under the off-equilibrium beliefs induced by the introduction of  $M'$ , the average popularity of flavors in  $M'$  is presumed strictly lower than the average popularity of flavors in  $M$ . Such off-equilibrium beliefs, however, do not satisfy the  $D1$  criterion. To see this, let  $\Pi^\delta$  denote the firm's profit from the uninformed consumers when the firm plays the deviation under consideration and the uninformed consumers play the mixed action  $\delta$ . Let  $\Pi^{EQ}(s)$  denote the firm's equilibrium profit in  $s$ . Let  $\Pi^{DEV}(s)$  denote the firm's profit in  $s$  from the informed if the firm plays the deviation under consideration. Finally, let  $T$  denote the subset of  $S$  where  $M$  contains more popular flavors than  $M'$ , i.e.,

$$T \equiv \left\{ s \in S : \sum_{x \in M} \lambda_x(s) > \sum_{x \in M'} \lambda_x(s) \right\}.$$

Note that  $\hat{s} \notin T$ . Fix some  $t \in T$ . Now, define  $A^0(t) \equiv \{\delta : \Pi^\delta \geq \Pi^{EQ}(t) - \Pi^{DEV}(t)\}$  and  $A(\hat{s}) \equiv \{\delta : \Pi^\delta > \Pi^{EQ}(\hat{s}) - \Pi^{DEV}(\hat{s})\}$ . In other words,  $A^0(t)$  is the set of mixed responses by the uninformed consumers that make the deviation to  $M'$  at least as profitable as the equilibrium strategy if  $s = t$ , while  $A(\hat{s})$  is the set of mixed responses by the uninformed consumers that make the deviation to  $M'$  strictly more profitable than the equilibrium strategy if  $s = \hat{s}$ . We need to show that  $A^0(t) \subsetneq A(\hat{s})$ , since that implies that the  $D1$  criterion prohibits the off-equilibrium beliefs under consideration. First, we show that  $\Pi^{EQ}(t) > \Pi^{EQ}(\hat{s})$ . To see why this is the case, note that if the firm were to introduce  $M$  when  $s = t$ , its profit from the uninformed would be the same as in  $\hat{s}$ , but its profit from the informed would be greater than in  $\hat{s}$  (by definition of  $T$ ). Therefore, since  $\Pi^{EQ}(t)$  is at least as high as the profit from introducing  $M$  when  $s = t$ , it is strictly greater than  $\Pi^{EQ}(\hat{s})$ :  $\Pi^{EQ}(t) > \Pi^{EQ}(\hat{s})$ .

Furthermore, since  $\hat{s} \notin T$ , we have  $\Pi^{DEV}(\hat{s}) > \Pi^{DEV}(t)$ . Hence,

$$\Pi^{EQ}(t) - \Pi^{DEV}(t) > \Pi^{EQ}(\hat{s}) - \Pi^{DEV}(\hat{s}),$$

which implies  $A^0(t) \subsetneq A(\hat{s})$ . ■

#### A.4 Proof of Proposition 4

*Proof.* Fix some equilibrium. Suppose  $M$  and  $M'$  are two product lines with  $|M| < |M'|$ . From the proof of Lemma 3, we know that the  $D1$  criterion ensures that the uninformed believe both  $M$  and  $M'$  contain the most popular flavors. Since no two flavors are equally popular, this implies that the average popularity in  $M$  is strictly greater than the average popularity in  $M'$ :

$$E_{\pi(\cdot|M)} \frac{1}{|M|} \sum_{x \in M} \lambda_x(s) > E_{\pi(\cdot|M')} \frac{1}{|M'|} \sum_{x \in M'} \lambda_x(s).$$

Now, since the elements of  $S$  are equiprobable under the prior, the uninformed consumer is indifferent between the available flavors so her expected utility from consuming any flavor is proportional to the average popularity in the menu:

$$\begin{aligned} \max_{x \in M} E_{\pi(\cdot|M)} u(\theta, s, x) &= \left( E_{\pi(\cdot|M)} \frac{1}{|M|} \sum_{x \in M} \lambda_x(s) \right) \bar{u} \\ &> \\ \max_{x \in M'} E_{\pi(\cdot|M')} u(\theta, s, x) &= \left( E_{\pi(\cdot|M')} \frac{1}{|M'|} \sum_{x \in M'} \lambda_x(s) \right) \bar{u}. \end{aligned}$$

Since  $F$ , the distribution of the outside options, is an atomless distribution whose support includes  $[-p, \bar{u} - p]$  the strictly greater expected utility under  $M$  yields strictly greater demand:

$$D^{\text{unf}}(M) > D^{\text{unf}}(M').$$

■

## A.5 Proof of Proposition 5

*Proof.* Let  $M$  and  $M'$  be any two equilibrium product lines. Since  $M$  and  $M'$  are equilibrium product lines, Lemma 3 guarantees they contain the most popular flavors. Hence, the exact same argument as in the proof of the previous proposition establishes  $D^{\text{unf}}(M) > D^{\text{unf}}(M')$ . ■

## A.6 Proof of Proposition 6

*Proof.* Suppose  $M$  and  $M'$  are two product lines with  $M \subsetneq M'$ . Let  $\Pi^{\text{inf}}(\hat{M}, s)$  and  $\Pi^{\text{unf}}(\hat{M}, s)$  respectively denote the profit from an informed and an uninformed consumer, so that

$$\Pi(\hat{M}, \alpha, s) = \alpha \Pi^{\text{unf}}(\hat{M}, s) + (1 - \alpha) \Pi^{\text{inf}}(\hat{M}, s).$$

Now, for any  $\hat{M}$  and  $s$ , we have  $\Pi^{\text{unf}}(\hat{M}, s) = D^{\text{unf}}(\hat{M})(p - c)$ . Hence, by Proposition 4, we have  $\Pi^{\text{unf}}(M, s) > \Pi^{\text{unf}}(M', s)$ . Moreover,

$$\sum_{x \in M'} \lambda_x(s) = \sum_{x \in M} \lambda_x(s) + \sum_{x \in M' \setminus M} \lambda_x(s).$$

Since there are no flavors that nobody likes and  $M' \setminus M$  is nonempty, we have  $\sum_{x \in M' \setminus M} \lambda_x(s) > 0$ , which implies  $\sum_{x \in M'} \lambda_x(s) > \sum_{x \in M} \lambda_x(s)$ . Consequently,  $\Pi^{\text{inf}}(M, s) < \Pi^{\text{inf}}(M', s)$ . Hence,  $\Pi(M, \alpha, s) - \Pi(M', \alpha, s)$  is strictly increasing in  $\alpha$ . ■

## References

- ANAND, B. N., AND R. SHACHAR (2004): “Brands as Beacons: A New Source of Loyalty to Multiproduct Firms,” *Journal of Marketing Research*, 41(2), 135–150.
- ANDERSON, E. T., AND J. DANA (2006): “When Is Price Discrimination Profitable?,” Working Paper.
- ANDERSON, S. P., A. DE PALMA, AND J.-F. THISSE (1992): *Discrete Choice Theory of Product Differentiation*. The MIT Press, Cambridge, MA.
- ARIELY, D., G. LOEWENSTEIN, AND D. PRELEC (2003): ““Coherent Arbitrariness”: Stable Demand Curves Without Stable Preferences,” *Quarterly Journal of Economics*, 118(1), 73–106.
- BANKS, J., AND J. SOBEL (1987): “Equilibrium Selection in Signaling Games,” *Econometrica*, 55(3), 647–662.
- BAZERMAN, M. H., G. F. LOEWENSTEIN, AND S. B. WHITE (1992): “Reversals of Preference in Allocation Decisions: Judging an Alternative Versus Choosing Among Alternatives,” *Administrative Science Quarterly*, 37(2), 220–240.
- BAZERMAN, M. H., H. A. SCHROTH, P. P. SHAH, K. A. DIEKMANN, AND A. E. TENBRUNSEL (1994): “The Inconsistent Role of Comparison Others and Procedural Justice in Reactions to Hypothetical Job Offers: Implications for Job Acceptance Decisions,” *Organizational Behavior and Human Decision Processes*, 60(3), 326–352.
- BECKER, G. S., AND K. M. MURPHY (2000): *Social Economics: Market Behavior in a Social Environment*. The Belknap Press of Harvard University Press, Cambridge, MA.
- BENABOU, R., AND J. TIROLE (2003): “Intrinsic and Extrinsic Motivation,” *Review of Economic Studies*, 70(3), 489–520.
- BENARTZI, S., AND R. H. THALER (2002): “How Much Is Investor Autonomy Worth?,” *Journal of Finance*, 57(4), 1593–1616.
- BERGEMANN, D., AND J. VALIMAKI (1999): “Experimentation in Markets,” Working Paper.
- BERTRAND, M., D. S. KARLAN, S. MULLAINATHAN, E. SHAFIR, AND J. ZINMAN (2005): “What’s Psychology Worth: A Field Experiment in the Consumer Credit Market,” Working Paper.
- BOATWRIGHT, P., AND J. C. NUNES (2001): “Reducing Assortment: An Attribute-Based Approach,” *Journal of Marketing*, 65(3), 50–63.
- BOLTON, P., AND C. HARRIS (1999): “Strategic Experimentation,” *Econometrica*, 67(2), 349–374.
- CHAN, Y.-S., AND H. LELAND (1982): “Prices and Qualities in Markets With Imperfect Information: A Search Model,” *Review of Economic Studies*, 49(4), 499–516.
- CHERNEV, A. (2003): “When More Is Less and Less Is More: The Role of Ideal Point Availability and Assortment in Consumer Choice,” *Journal of Consumer Research*, 30(2), 170–183.
- CHO, I.-K., AND D. KREPS (1987): “Signaling Games and Stable Equilibria,” *Quarterly Journal of Economics*, 102(2), 179–221.

- COOPER, R., AND T. W. ROSS (1985): “Monopoly Provision of Product Quality with Uninformed Buyers,” *International Journal of Industrial Organization*, 3(4), 439–449.
- COSTA-GOMES, M., V. P. CRAWFORD, AND B. BROSETA (2001): “Cognition and Behavior in Normal-Form Games: An Experimental Study,” *Econometrica*, 69(5), 1193–1235.
- CRISTOL, S., AND P. SEALEY (2000): *Simplicity Marketing*. The Free Press, New York.
- CRONQVIST, H., AND R. H. THALER (2004): “Design Choices in Privatized Social-Security Systems: Learning from the Swedish Experience,” *American Economic Review*, 94(2), 424–428.
- DELLAVIGNA, S., AND U. MALMENDIER (2004): “Contract Design and Self-Control: Theory and Evidence,” *Quarterly Journal of Economics*, 119(2), 353–402.
- DESVOUSGES, W. H., F. R. JOHNSON, R. DUNFORD, K. J. BOYLE, S. P. HUSON, AND K. N. WILSON (1992): “Measuring Non-Use Damages Using Contingent Valuation: An Experimental Evaluation of Accuracy,” Research Triangle Institute Monograph 92-1.
- DHAR, R. (1997): “Consumer Preference for a No-Choice Option,” *Journal of Consumer Research*, 24(2), 215–231.
- DOYLE, J. R., D. J. O’CONNOR, G. M. REYNOLDS, AND P. A. BOTTOMLEY (1999): “The Robustness of the Asymmetrically Dominated Effect: Buying Frames, Phantom Alternatives, and In-Store Purchases,” *Psychology and Marketing*, 16(3), 225–243.
- DROLET, A., I. SIMONSON, AND A. TVERSKY (2000): “Indifference Curves That Travel With the Choice Set,” *Marketing Letters*, 11(3), 199–209.
- ELLISON, G. (2006): “Bounded Rationality in Industrial Organization,” in *Advances in Economics and Econometrics: Theory and Applications, Ninth World Congress, Volume II*, ed. by R. Blundell, W. Newey, and T. Persson. Cambridge University Press, Cambridge.
- EYSTER, E., AND M. RABIN (2005): “Cursed Equilibrium,” *Econometrica*, 73(5), 1623–1672.
- FREDERICK, S., AND B. FISCHHOFF (1998): “Scope (In)sensitivity in Elicited Valuations,” *Journal of Risk Decision and Policy*, 3(2), 109–123.
- GABAIX, X., AND D. LAIBSON (2006): “Shrouded Attributes, Consumer Myopia, and Information Suppression in Competitive Markets,” *Quarterly Journal of Economics*, 121(2), 505–540.
- GEORGE, L., AND J. WALDFOGEL (2003): “Who Affects Whom in Daily Newspaper Markets?,” *Journal of Political Economy*, 111(4), 765–84.
- GLAESER, E. L. (2004): “Psychology and the Market,” *American Economic Review*, 94(2), 408–13.
- GOURVILLE, J. T., AND D. SOMAN (2005): “Overchoice and Assortment Type: When and Why Variety Backfires,” *Marketing Science*, 24(3), 382–395.
- GUL, F., AND W. PESENDORFER (2001): “Temptation and Self-Control,” *Econometrica*, 69(6), 1403–1435.
- HARRISON, G. W., R. M. HARSTAD, AND E. E. RUTSTROM (2004): “Experimental Methods and Elicitation of Values,” *Experimental Economics*, 7(2), 123–140.

- HEIDHUES, P., AND B. KOSZEGI (2005a): “The Impact of Consumer Loss Aversion on Pricing,” Working Paper.
- (2005b): “Competition and Price Variation when Consumers are Loss Averse,” Working Paper.
- HERNE, K. (1997): “Decoy Alternatives in Policy Choices: Asymmetric Domination and Compromise Effects,” *European Journal of Political Economy*, 13(3), 575–89.
- HSEE, C. K. (2000): “Attribute Evaluability: Its Implications for Joint-Separate Evaluation Reversals and Beyond,” in *Choices, Values, and Frames*, ed. by D. Kahneman, and A. Tversky, pp. 543–563. Russel Sage Foundation, New York.
- HUBER, J., J. W. PAYNE, AND C. PUTO (1982): “Adding Asymmetrically Dominated Alternatives: Violations of Regularity and the Similarity Hypotheses,” *Journal of Consumer Research*, 9(1), 90–98.
- HUFFMAN, C., AND B. E. KAHN (1998): “Variety for Sale: Mass Customization or Mass Confusion,” *Journal of Retailing*, 74(4), 491–513.
- IRONS, B., AND C. HEPBURN (2003): “Regret Theory and the Tyranny of Choice,” Working Paper.
- IYENGAR, S. S., G. HUBERMAN, AND W. JIANG (2004): “How Much Choice Is Too Much? Contributions to 401(k) Retirement Plans,” in *Pension Design and Structure: New Lessons from Behavioral Finance*, ed. by O. S. Mitchell, and S. P. Utkus, chap. 5. Oxford University Press.
- IYENGAR, S. S., AND E. KAMENICA (2006): “Choice Overload and Simplicity Seeking,” Working Paper.
- IYENGAR, S. S., AND M. LEPPER (2000): “When Choice Is Demotivating: Can One Desire Too Much of a Good Thing?,” *Journal of Personality and Social Psychology*, 79(6), 995–1006.
- JEHIEL, P. (2005): “Analogy-Based Expectation Equilibrium,” *Journal of Economic Theory*, 123(2), 81–104.
- KAHNEMAN, D. (1986): “Comments on the Contingent Valuation Method,” in *Valuing Environmental Goods: An Assessment of the Contingent Valuation Method*, ed. by R. Cummings, D. Brookshire, and W. Schulze, pp. 185–194. Rowman and Allanheld, Totowa, NJ.
- KALAI, G., A. RUBINSTEIN, AND R. SPIEGLER (2002): “Rationalizing Choice Functions by Multiple Rationales,” *Econometrica*, 70(6), 2481–2488.
- KAMENICA, E. (2006): “Contextual Inference in Markets: On the Informational Content of Product Lines,” Working Paper.
- KIVETZ, R., O. NETZER, AND V. SRINIVASAN (2004): “Alternative Models for Capturing the Compromise Effect,” *Journal of Marketing Research*, 41(3), 237–257.
- KUKSOV, D., AND J. M. VILLAS-BOAS (2005): “When More Alternatives Lead to Less Choice,” Working Paper.
- LAIBSON, D. (1997): “Golden Eggs and Hyperbolic Discounting,” *Quarterly Journal of Economics*, 112(2), 443–77.

- LOWENTHAL, D. J. (1993): “Preference Reversals in Candidate Evaluation,” Carnegie Mellon University Working Paper.
- LUCE, D. R., AND H. RAIFFA (1957): *Games and Decisions: Introduction and Critical Survey*. Wiley, New York.
- MC FADDEN, D. L., AND K. E. TRAIN (1996): “Consumers’ Evaluation of New Products: Learning from Self and Others,” *Journal of Political Economy*, 104(4), 683–703.
- MCFADDEN, D. L. (1999): “Rationality for Economists,” *Journal of Risk and Uncertainty*, 19(1-3), 73–105.
- MCFADDEN, D. L., AND G. K. LEONARD (1993): “Issues in the Contingent Valuation of Environmental Goods: Methodologies for Data Collection and Analysis,” in *Contingent Valuation: A Critical Assessment*, ed. by J. A. Hausman, vol. 220 of *Contributions to Economic Analysis*, pp. 165–208. Elsevier Science, New York.
- MIRRLEES, J. A. (1987): “Economic Policy and Nonrational Behavior,” University of California, Berkeley; Working Paper 8728.
- MUSSA, M., AND S. ROSEN (1978): “Monopoly and Product Quality,” *Journal of Economic Theory*, 18(2), 301–317.
- NORTH, A. C., D. J. HARGREAVES, AND J. MCKENDRICK (1997): “In-Store Music Affects Product Choice,” *Nature*, 390(6656), 132.
- OLDMAN, M. (2004): “Don’t Sniff the Cork!,” Uncorked. [www.vault.com](http://www.vault.com).
- ORBACH, B. Y., AND L. EINAV (2006): “Uniform Prices for Differentiated Goods: The Case of the Movie-Theater Industry,” Harvard Law and Economics Discussion Paper No. 337.
- ORHUN, A. Y. (2006): “Optimal Product Line Design When Consumers Exhibit Choice Set Dependent Preferences,” Working Paper.
- PLOTT, C. R., AND K. ZEILER (2005): “Asymmetries in Exchange Behavior Incorrectly Interpreted as Evidence in Prospect Theory,” Social Science Working Paper 1230.
- PRELEC, D., B. WERNERFELT, AND F. ZETTELMEYER (1997): “The Role of Inference in Context Effects: Inferring What You Want from What Is Available,” *Journal of Consumer Research*, 24(1), 118–125.
- REDELMEIER, D. A., AND E. SHAFIR (1995): “Medical Decision Making in Situations That Offer Multiple Alternatives,” *Journal of the American Medical Association*, 273(4), 302–305.
- SALGADO, M. (2005): “Choosing to Have Less Choice,” Working Paper.
- SALOP, S., AND J. E. STIGLITZ (1977): “Bargains and Ripoffs: A Model of Monopolistically Competitive Price Dispersion,” *Review of Economic Studies*, 44(3), 493–510.
- SARVER, T. (2005): “Anticipating Regret: Why Few Options May Be Better,” Working Paper.
- SCHLAG, K. H. (2004): “Competing for Boundedly Rational Consumers,” Working Paper.
- SCHWARTZ, B. (2004): “The Tyranny of Choice,” *Scientific American*, 290(4), 70–75.

- SEN, A. (1993): "Internal Consistency of Choice," *Econometrica*, 61(3), 495–521.
- SHAPIRO, C., AND H. R. VARIAN (1999): *Information Rules*. Harvard Business School Press, Boston, MA.
- SIMONSON, I. (1989): "Choice Based on Reasons: The Case of Attraction and Compromise Effects," *Journal of Consumer Research*, 16(2), 158–174.
- SIMONSON, I., AND A. TVERSKY (1992): "Choice in Context: Tradeoff Contrast and Extremeness Aversion," *Journal of Marketing Research*, 29(3), 281–295.
- SLOVIC, P. (1995): "The Construction of Preference," *American Psychologist*, 50(5), 364–371.
- SMITH, G. E., AND T. T. NAGLE (1995): "Frames of Reference and Buyers' Perception of Price and Value," *California Management Review*, 38(1), 98–116.
- SPIEGLER, R. (2006): "Competition over Agents with Boundedly Rational Expectations," *Theoretical Economics*, 1(2), 207–231.
- STROTZ, R. H. (1955): "Myopia and Inconsistency in Dynamic Utility Maximization," *Review of Economic Studies*, 23(3), 165–180.
- TIROLE, J. (1988): *The Theory of Industrial Organization*. MIT Press, Cambridge, MA.
- TVERSKY, A., AND D. KAHNEMAN (1974): "Judgment under Uncertainty: Heuristics and Biases," *Science*, 185(4157), 1124–1131.
- TVERSKY, A., AND E. SHAFIR (1992): "Choice Under Conflict: The Dynamics of Deferred Decision," *Psychological Science*, 3(6), 358–361.
- TVERSKY, A., AND I. SIMONSON (1993): "Context-Dependent Preferences," *Management Science*, 39(10), 1179–1189.
- VAN EETVELDE, D., C. GEENS, AND P. HARRINGTON (2002): *101 Ways to Increase Sales Indicator*, Ashford, UK.
- WALDFOGEL, J. (2003): "Preference Externalities: An Empirical Study of Who Benefits Whom in Differentiated-Product Markets," *RAND Journal of Economics*, 34(3), 557–68.
- WERNERFELT, B. (1995): "A Rational Reconstruction of the Compromise Effect: Using Market Data to Infer Utilities," *Journal of Consumer Research*, 21(4), 627–633.
- WOLINSKY, A. (1983): "Prices as Signals of Product Quality," *Review of Economic Studies*, 50(4), 647–658.