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Contextual Deliberation and Preference Construction

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Choices can be context dependent. This empirical finding is usually invoked to suggest that preferences are constructive and susceptible to decision environment. Yet preference construction can be systematic and endogenous. This paper develops the theory of contextual deliberation as a potential explanation for behavioral phenomena of preference construction. When preference ordering in a choice set is ex ante unknown and state dependent, decision makers can engage in information acquisition activities (i.e., deliberation) before choice to improve knowledge about the state-dependent preference ordering. Choice context can thus influence ex post preference ordering through affecting the incentive to deliberate. Consequently, contextual deliberation may lead to preference construction and give rise to seemingly irrational behavioral phenomena such as the compromise effect and the choice overload effect. The theory of contextual deliberation also yields predictions that can be empirically tested to identify from other alternative explanations.

Keywords: choice overload; compromise effect; context-dependent preference; context effect; deliberation; preference construction
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1. Introduction

Classical theories of individual decision making assume that choices are rational: preferences among options can be completely rank ordered and the highest-ranked option is selected as the optimal choice. The rationality assumption implies the property of *independence of irrelevant alternatives* (IIA): preference ranking between any pair of options is not influenced by the choice context. Consequently, a nonpreferred option cannot become preferred in a larger choice set. With respect to aggregate choice behavior, this gives rise to the *regularity* property: the proportion of decision makers who prefer an option (i.e., the choice share) cannot be increased by adding more options to the choice set. Furthermore, standard choice theories typically view preferences as inherently well defined, insusceptible to external stimuli, and amiable to memory storage and retrieval.

However, the rationality assumption has been increasingly challenged. Numerous carefully crafted examples (mainly in lab settings) accumulate to demonstrate violations of the properties of rational choice. These violations suggest that preferences are not necessarily independent of choice context. One of the most cited examples of context-dependent choice behavior is the *compromise effect*, referring to the finding that an option can be more likely to be chosen when it is positioned in the middle of some physical attribute space (e.g., quality, price) relative to other options in the choice set (e.g., Simonson 1989, Simonson and Tversky 1992). Another notable evidence of context-dependent preference is the *choice overload effect*; i.e., decision makers can be less likely to make a choice (i.e., more likely to select the outside option) if the choice set is expanded to include more options (e.g., Iyengar and Lepper 2000). Extrapolating from these (and many other) examples, some researchers (mainly in the behavioral/psychological literature) suggest that preferences can be constructed only when decisions are made and are susceptible to influence by factors such as choice context, preference elicitation methods, transient affect, and framing of options (e.g., Bettman et al. 1998, Kahneman and Tversky 2000, Lichtenstein and Slovic 2006).[1]

My major objective in this paper is to reconcile these seemingly disparate views of choice. I extend the classical choice theories to develop a two-stage decision-making theory of *contextual deliberation* that endogenizes the dependence of preferences on choice context. The premise of the proposed theory is that preference ordering among options is ex ante uncertain and state dependent. Nevertheless, decisions makers can engage in prechoice information-gathering activities (i.e., deliberation) to partially resolve the uncertainty. For example, they can retrieve preference cues from memory, reflect on personal needs, process relevant information, inspect product specifications, and forecast future consumptions. Conditional on the

[1] Some people question the meaning and existence of preference (Tversky et al. 1988, Slovic 1995).

information gained through deliberation, choices are made in a rational manner as in the standard theories. The value of the gained information stems only from the potential improvement in the subsequent choice task, and as a result, the deliberation decision is endogenously influenced by the options in the choice set. Therefore, even though preferences per se (conditional on information) are context independent, contextual deliberation can make (unconditional) preferences appear to be constructed during the decision-making process and observed choice behavior be context sensitive.[2]

I apply the theory of contextual deliberation to explain some well-known examples of seemingly constructed preferences. I first illustrate why the middle alternative in a three-option choice set may be chosen by more experiment participants than when it is paired with only one of the other two options. The idea is simple: the addition of a third option to a two-option set can increase the value of gathering preference-relevant information and hence boost the incentive to deliberate. Choice share can then be increasingly reallocated from the ex ante preferred option to other options that are ex ante not preferred. If the middle option turns out not to be ex ante preferred under the prior belief, it can benefit from the addition of another option because it will be more likely to be ex post preferred. As a result, the analysis not only confirms that the compromise effect can arise even with conventional preference structure but also yields unique predictions that can be empirically tested. In particular, it is highlighted that deliberation can mediate the effect of choice set expansion on the choice share of the middle option. In addition, the compromise effect can emerge only when the cost of deliberation is neither too high nor too low, because otherwise expanding the choice set cannot lead to substantial increase in optimal deliberation. Similar nonmonotonic moderating effects are also derived for the options' relative attribute values.

The compromise effect is also documented in other experiments in which the middle option varies across choice sets. For instance, an alternative design involves expanding the two-option set along both directions of the attribute space. To demonstrate the violation of the regularity property in both directions, I construct an example in which decision makers differ both in the ex ante preferred option and in the extent to which their deliberation is influenced by different choice set expansions. In particular, some decision makers ex ante prefer an option of relatively high quality and are induced to deliberate more by a low-quality extension but not by a high-quality extension, whereas the opposite is true for other decision makers. Consequently, either extension of the choice set can lead some decision makers to deliberate more without changing other decision makers' behavior, thus increasing the choice share of the corresponding middle option.

Moreover, contextual deliberation can lead to choice overload, in the same vein as the compromise effect: adding more options to a choice set can increase the level of deliberation and hence benefit the options that are not ex ante preferred under the prior belief. If the outside option of no choice turns out to be ex ante not preferred over other options, expanding the choice set can thus increase the likelihood that the outside option is ex post preferred. In addition, the interpretation of choice overload as resulting from contextual deliberation yields testable predictions, with respect to the mediating/moderating effects of deliberation, that are similar to those for the compromise effect. Therefore, the theory of contextual deliberation as the mediator of endogenous preference construction can lend a parsimonious explanation to seemingly disparate behavioral phenomena.

This paper is related to several streams of research. First, it contributes to the well-established literature in economics, marketing, and psychology that empirically documents behavioral violations of rational choice. These behavioral phenomena are typically viewed as arising from biases or decision mistakes. By contrast, the theory of contextual deliberation presents a mechanism whereby preferences can be endogenously and systematically context dependent, which can be employed to explain other context effects such as, e.g., asymmetric dominance, enhancement, detraction, and polarization (Huber et al. 1982, Simonson and Tversky 1992, Tversky and Simonson 1993).

This paper adds to the recent literature on contextual inference (e.g., Wernerfelt 1995, Kamenica 2008, Kuksov and Villas-Boas 2010). The basic idea is that consumers can derive choice-related information from choice sets that are endogenously supplied by markets (Villas-Boas 2009). Similarly, the theory of contextual deliberation recognizes that choice sets may systematically influence decision makers' information structure. However, what choice context may influence is not information per se but the decision maker's incentive to retrieve/process information that is by itself independent of the choice set.

[2] Ergin and Sarver (2010) study preferences over menus of lotteries where, as in this paper, a decision maker can engage in costly contemplation to learn about her tastes before choosing an option from a menu. The observables in their preference representation are choices *over* menus but are choices of options *in* menus in the current paper. Their focus is to characterize preferences over menus as being represented by costly contemplation, whereas I concentrate on how context-dependent preferences over options can be rationalized. Another related work is Hauser and Wernerfelt (1990), who show that evaluation costs can lead to the emergence of consideration sets.

Therefore, contextual deliberation constitutes a simple, purely demand-side rationalization of context effects.[3]

Moreover, this paper can help resolve the ongoing debate on inherent versus constructed preferences (Simonson 2008). In particular, revealed preferences can be inherently constructed: decision makers may be endowed with a preference structure that is well defined, enduring, and stable across choice scenarios, whereas the retrieval/revelation of this preference structure in a particular choice task can be structurally influenced by the characteristics of the choice environment. This reconciliation can not only permit the incorporation of empirical regularities into standard theories of rational choice but also offer a falsifiable microfoundation for the behavioral effects.

The analysis presented here can shed light on the rising literature, mostly in industrial organization, on market responses to behavioral anomalies. The past decade has seen an accumulation of studies that investigate how firms react to "abnormal" consumer behavior or bounded rationality. Typically, consumers are exogenously assumed to have certain preferences that reflect the observed behavior (e.g., DellaVigna and Malmendier 2004, Gabaix and Laibson 2006, Heidhues and Kőszegi 2008, Orhun 2009, Guo 2015). An alternative approach would be to model the interaction between firms and consumers with conventional preferences while allowing nonstandard consumer behavior to emerge endogenously in equilibrium (e.g., Guo and Zhang 2012).[4]

The rest of the paper is organized as follows. In §2 I develop the theory of contextual deliberation to endogenize context-dependent preferences. The model is applied to explain the compromise effect in §3 and the choice overload effect in §4. I also derive some testable predictions on the mediating/moderating effects of deliberation and discuss how to identify contextual deliberation from alternative explanations. Section 5 discusses how to extend the model to accommodate other types of preference construction and concludes the paper.

2. The Theory of Contextual Deliberation

In this section I develop the theory of contextual deliberation to account for endogenous preference construction. The building block of the theory rests on a two-stage sequential decision process, which is elaborated below.

Consider a representative decision maker, indexed by i, from a sample of subjects. Let S be the set of feasible choice options. Each option $s \in S$ is characterized by a vector of physical attributes (e.g., quality, price), $x_s \in X \subset \mathbf{R}^k$. The decision maker's utility of option s is $u(\theta_i, x_s)$, where $\theta_i \in \Theta$ is an individual-specific preference parameter. The interpretation of θ will be discussed in greater detail later. The decision maker has a one-unit demand. The outside option s_0 (e.g., choosing none of the available varieties) may or may not be contained in the feasible choice set S.

The following assumptions on the utility $u(\theta, x_s)$ are made. First, the decision maker is ex ante uncertain about the preference parameter θ. The probability function for the decision maker's prior belief is $f(\theta)$, $\theta \in \Theta$. Therefore, even when the values of the physical attributes x_s are known, the decision maker may not ex ante know the exact value of the utility $u(\theta, x_s)$. For example, the technical specifications of digital cameras (e.g., memory size) can be perfectly known, but a decision maker may still be unsure about her willingness to pay for the technical attributes.

Second, the uncertainty over θ can be (partially) resolved during the decision-making process through costly deliberation. The deliberation over the preference parameter can take the form of information retrieval/processing, introspection, retrospection, anticipation, etc.[5] For instance, the decision maker can recall past photo-taking experience, reflect on her need for delicate photo quality, study supplier-provided instructions, inspect product features, project future consumption scenarios, and thus get a better sense about her valuation for digital cameras with different quality levels (e.g., memory size). These deliberation processes are normally costly because they are time consuming and can lead to the depletion of cognitive resources (Shugan 1980, Guo and Zhang 2012). It is important to note that deliberation can embrace scenarios in which the decision maker knows about her preference parameter θ, but she needs to spend time and/or cognitive resources to retrieve such information from memory to make the choice decision.

Consider the following simple setup on how deliberation may resolve the uncertainty about θ. Let $\alpha \geq 0$ be the level of deliberation (e.g., the time spent on reflecting over preferences). As a result of deliberation, there are two possible states regarding the decision maker's ex post knowledge about θ: she may

[3] Kalai et al. (2002) rationalize choices violating IIA by multiple rationales, where it is exogenous which rationale should be applied to a particular choice problem. In this paper the state-dependent preference orderings can be interpreted as different rationales, and it is contextual deliberation that (stochastically) determines which rationale should be endogenously invoked.

[4] Bar-Isaac et al. (2010) study optimal firm strategies in response to consumers who can gather information before making a purchase.

[5] The scope of deliberation can also be extended, in a market setting, to include other prechoice preference-learning activities such as search, consulting, and forecasting.

maintain the prior belief f or become fully informed of θ.[6] Conditional on α, the decision maker can resolve the uncertainty about θ with probability $\pi(\alpha)$; the decision maker remains uninformed of θ with probability $1-\pi(\alpha)$. Assume $\pi'(\cdot)>0$, $\pi''(\cdot)<0$, $\pi'(+\infty)=0$, $\pi(0)=0$, and $\pi(+\infty)=1$. Thus, deliberation can probabilistically increase the chance that the decision maker becomes informed of her preference, the marginal impact of deliberation on resolving uncertainty is decreasing, and the prior uncertainty is unchanged (resolved) when the level of deliberation is zero (infinite). The marginal cost of deliberation is $c>0$.

The decision maker follows a two-stage sequential decision process when she is presented with the problem of choosing one option from the choice set $M \subseteq S$. The first stage involves deciding on how much costly deliberation to invest in order to resolve the uncertainty over θ. Next, in the second stage of the decision process, conditional on whether the decision maker has resolved her utility uncertainty in the first stage, she chooses the alternative with the highest (expected) utility. Thus the rationality assumption is retained in the choice stage.

To characterize the decision maker's problem, let us start with the second-stage decision. Consider first the state when the decision maker fails to resolve the preference uncertainty. She maintains the prior belief and chooses the option with the highest expected utility. Denote the optimal option as $\bar{s}(M)$, such that $\int_\Theta u(\theta, x_{\bar{s}})\,df(\theta) \geq \int_\Theta u(\theta, x_s)\,df(\theta)$ for all $s \in M$. The expected utility for the chosen option is

$$\bar{u}_M = \max_{s\in M} \int_\Theta u(\theta, x_s)\,df(\theta). \tag{1}$$

In the alternative state when the preference uncertainty is resolved, the decision maker can make the choice based on the ex post learned value of θ. Denote the optimal option, conditional on θ, as $\hat{s}(\theta, M)$, such that $u(\theta, x_{\hat{s}}) \geq u(\theta, x_s)$ for all $s \in M$.[7] Define the support of θ over which an option $s \in M$ is preferred as $\Theta(s, M) \subseteq \Theta \cup \varnothing$, where $\varnothing$ denotes the empty set. The conditional expected utility for this informed state (prior to learning the value of θ) is then

$$\hat{u}_M = \int_\Theta \max_{s\in M} u(\theta, x_s)\,df(\theta). \tag{2}$$

It is evident that $\hat{u}_M \geq \bar{u}_M$; i.e., the expected utility when the decision maker is better informed of her preference is (weakly) higher than that under the prior belief. Moreover, $\hat{u}_M > \bar{u}_M$ if and only if $\hat{s}(\theta, M) \neq \bar{s}(M)$ for some $\theta \in \Theta$. That is, information gathering through deliberation can strictly increase the expected utility when and only when the ex post preferred option may deviate from the ex ante preferred one under the prior belief. Intuitively, informed decisions can lead to a higher expected utility than uninformed ones.

Therefore, the first-stage deliberation problem solves

$$\max_{\alpha\geq 0}\{\pi(\alpha)\hat{u}_M + [1-\pi(\alpha)]\bar{u}_M - c\alpha\}. \tag{3}$$

The optimal solution for deliberation is unique. The first-order condition is $\pi'(\alpha)(\hat{u}_M - \bar{u}_M) - c = 0$. Let the inverse function of $\pi'(\cdot)$ be $\dot{\pi}(\cdot)$. The optimal level of deliberation is then given by $\alpha^*_M = \dot{\pi}(\min\{c/(\hat{u}_M - \bar{u}_M), \pi'(0)\})$.[8] As the value of preference information (i.e., $\hat{u}_M - \bar{u}_M$) increases, it is more desirable to invest more efforts on deliberation. More importantly, to the extent that the value of preference information is endogenously dependent on the choice set under consideration, the optimal level of deliberation can also be sensitive to the choice context. A decision maker is engaged in *contextual deliberation* if α^*_M is not independent of M.

If the decision maker follows the above decision process, the observed choice behavior would be characterized by the ex ante probability that an option s is chosen from the choice set M:

$$p(s, M) = \pi(\alpha^*_M)\int_{\Theta(s,M)} df(\theta) + [1-\pi(\alpha^*_M)]\mathbf{1}_{\{s=\bar{s}(M)\}}, \quad \forall s \in M, \tag{4}$$

where $\mathbf{1}_{\{s=\bar{s}(M)\}}$ is an indicator function that equals 1 if the condition in the bracket is satisfied and 0 otherwise.

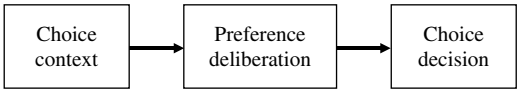
This model extends standard choice theories by accommodating contextual deliberation. In the absence of the endogeneity of contextual deliberation, the rationality assumption would yield predictions that are difficult to reconcile with empirical findings (e.g., Simonson and Tversky 1992, Tversky and Simonson 1993, Iyengar and Lepper 2000). In particular, conditional on the prior belief over θ, the choice function $\bar{s}(M)$ satisfies the IIA property; i.e., if $s = \bar{s}(M)$ and $s \in N \subset M$, then $s = \bar{s}(N)$. In other words, an option that is not optimal cannot become optimal when additional options are added to the choice set. Additionally, the aggregate choice probability when the preference information is (exogenously) available,

[6] It is not a necessary assumption that the decision maker's preference uncertainty can be completely resolved by deliberation. In cases where residual uncertainty may persist, θ can be redefined as the expectation of the (true) preference parameter, conditional on the information gained through deliberation.

[7] For simplicity, assume that the elements in the choice functions, $\bar{s}(M)$ and $\hat{s}(\theta, M)$, include no ties.

[8] When $c/(\hat{u}_M - \bar{u}_M) > \pi'(0)$, the optimal deliberation is at the boundary solution; i.e., $\alpha^*_M = 0$.

Figure 1 The Mediation of Deliberation Between Context and Choice



$\hat{p}(s, M) = \int_{\Theta(s,M)} df(\theta)$, satisfies the regularity property: $s \in N \subset M$ implies $\hat{p}(s, N) \geq \hat{p}(s, M)$. That is, enlarging the choice set cannot increase the probability that an option is chosen.

However, even with the rationality assumption, these (conditional) properties do not necessarily translate into the (unconditional) observed choice behavior if the decision maker can endogenously reflect over her preference prior to making a choice. This is because choice is conditional on deliberation, and the optimal deliberation decision, α^*_M, can be context dependent. Figure 1 depicts the mediation of preference deliberation between the choice context and the final choice decision. Therefore, even though the utility $u(\theta, x_s)$ per se is context independent, the observed choice behavior $p(s, M)$ can be sensitive to the choice context, as long as deliberation optimally varies with the choice context and influences subsequent choice. As will be elaborated, contextual deliberation can lead to endogenous preference construction and thus reconcile the rationality assumption with some seemingly abnormal choice behavior. In particular, I will show how contextual deliberation can explain the compromise effect as well as the choice overload effect, which are otherwise inconsistent with the IIA and the regularity properties.

The theory of contextual deliberation does not imply that choice context carries information. Instead, it captures the notion that consumers can acquire more information about preference through deliberation and that this information acquisition is endogenously influenced by choice context. Therefore, choice context may affect choice behavior only through its influence on prechoice deliberation. This is distinguished from the context-dependent preference models in which utility is directly conditional on context (e.g., Tversky and Simonson 1993, Kivetz et al. 2004). It also differs from the contextual inference models in which choice set per se may convey preference-relevant information (e.g., Wernerfelt 1995, Kamenica 2008, Kuksov and Villas-Boas 2010). I will discuss how these alternative explanations can be empirically separated.

3. Preference Construction for Forced Choices: The Compromise Effect

The compromise effect is among the most widely studied phenomena of preference construction. It refers to the finding that the choice measure of an option can be greater in a choice set when it is a middle option than in a choice set when it is not a middle option. The empirical documentation of this effect is typically through manipulated experiments in which the choice set is varied across subjects.[9] In these demonstrations, the choice set generally does not include the outside option (i.e., forced choices), and the available options can be ranked on their physical attributes.

In particular, the compromise effect is normally demonstrated with choice sets of the following features. The choice alternatives can be characterized by two attributes; i.e., $X = (x_1, x_2)$. Preferences over attribute values are monotonic. For example, the attributes can represent the quality and the price of alternative products. Following Tversky and Simonson (1993), define the betweenness relation among the options as $s_1 \mid s_2 \mid s_3$ if and only if $x_{js_1} \geq x_{js_2} \geq x_{js_3}$ or $x_{js_1} \leq x_{js_2} \leq x_{js_3}$, $j = 1, 2$, for any $s_1, s_2, s_3 \in S$. In addition, denote $P(s, M)$ as the proportion of subjects who prefer option s in the choice set $M \subseteq S$ and write $P(s_1; s_2)$ for $P(s_1, \{s_1, s_2\})$ and $P(s_1; s_2, s_3)$ for $P(s_1, \{s_1, s_2, s_3\})$. Define the choice share of option s_1 relative to that of s_2 in the choice set $\{s_1, s_2, s_3\}$ as $P_{s_3}(s_1; s_2) = P(s_1; s_2, s_3)/(P(s_1; s_2, s_3) + P(s_2; s_1, s_3))$.

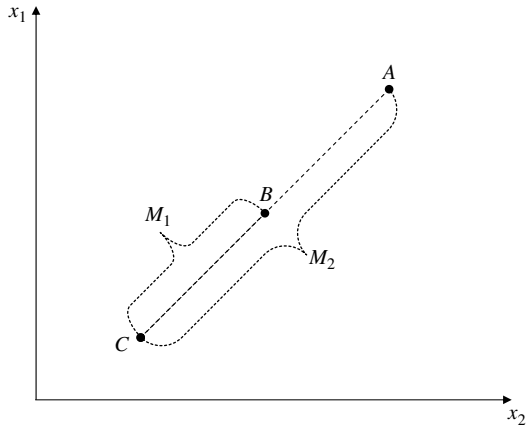
The literature offers two types of experiment design to demonstrate the compromise effect. In the basic design, the middle option, if any, remains the same across choice sets. The compromise effect has also been demonstrated by experiments in which the middle option can differ across choice sets. In this section I show how contextual deliberation may lead to the compromise effect in various experiment designs. Some testable implications are derived regarding how the compromise effect may be influenced by deliberation cost and by the choice options' attribute values. I also discuss how to empirically identify contextual deliberation from other explanations.

3.1. Single Middle Option

In the first type of experiment design, the middle option, if any, does not change across choice sets. The simplest design involves presenting subjects with either a two-option choice set or a choice set in which a third, extreme option is added. For example, consider options $A \mid B \mid C$. As in Figure 2, one group of subjects are presented with $M_1 = \{B, C\}$ and another group with $M_2 = \{A, B, C\}$. The compromise effect would arise if $P_A(B; C) > P(B; C)$. That is, the addition

[9] Subjects can exhibit preference for compromise options in categories ranging from cameras, calculator batteries, mouthwashes, portable PCs, speakers, investment portfolios, to apartments (e.g., Lehmann and Pan 1994, Simonson and Nowlis 2000, Benartzi and Thaler 2002, Dhar and Simonson 2003). The magnitude of the compromise effect can be quite substantial. For instance, the relative choice share of a middle option can increase on average by about 18% (Simonson 1989).

Figure 2 The Compromise Effect with Single Middle Option



of the extreme option A to the two-option choice set increases the relative choice share of the compromise option B. According to Tversky and Simonson (1993), this empirical phenomenon is inconsistent with the prediction in standard choice theory. Moreover, a stronger demonstration of the compromise effect is also documented in which the regularity property is violated: $P(B; A, C) > P(B; C)$.

I now employ the theory of contextual deliberation presented in §2 to explain the compromise effect. I will present sufficient conditions under which subjects engaged in contextual deliberation may exhibit choice behavior as characterized by the compromise effect. For simplicity, let the attributes represent the quality q_s and the price p_s of the options: $u(\theta, x_s) = v(\theta, q_s, p_s)$.[10] The support of the prior belief is $\theta \in [\underline{\theta}, \bar{\theta}]$. Assume $\partial v/\partial q > 0$, $\partial v/\partial p < 0$, $\partial v/\partial \theta > 0$, and $\partial^2 v/\partial q \partial \theta > 0$. Let the indifferent point of θ such that $u(\theta, x_{s_1}) = u(\theta, x_{s_2})$ be $\theta_{s_1 s_2}$ for any $s_1, s_2 \in S$. It follows that $u(\theta, x_{s_1}) > u(\theta, x_{s_2})$, where $q_{s_1} > q_{s_2}$ if and only if $\theta > \theta_{s_1 s_2}$.

Consider a homogeneous group of subjects and the following conditions:

A1. option C is preferred under the prior belief, i.e., $C = \bar{s}(M_2)$; and

A2. for any $s \in M_2$, the set of θ over which s is ex post preferred is nonempty, i.e., $\Theta(s, M_2) \neq \varnothing$.

It follows from the rationality assumption and A1 that $C = \bar{s}(M_1)$. Under the prior belief, the preferred option in the larger choice set M_2 is also preferred in the smaller choice set M_1. The condition A2 means that, even in the larger choice set M_2, no option is always ex post dominated. This in turn implies that $\underline{\theta} < \theta_{BC} < \theta_{AC} < \theta_{AB} < \bar{\theta}$.[11] Therefore, conditional on θ, the addition of option A to the choice set M_1 simply cannibalizes the share of choice for option B, but does not reduce that of option C. This captures the notion that an option is more likely to draw choice share from an option that is adjacent in the attribute space than from a disadjacent option.

The subjects' choice probabilities for the options B and C under M_l, $l = 1, 2$, are

$$P(B, M_l) = \pi(\alpha^*_{M_l})\hat{p}(B, M_l),$$
$$P(C, M_l) = \pi(\alpha^*_{M_l})\hat{p}(C, M_l) + [1 - \pi(\alpha^*_{M_l})].$$

It follows from $\theta_{BC} < \theta_{AC} < \theta_{AB}$ that $\hat{p}(B, M_1) > \hat{p}(B, M_2)$ and $\hat{p}(C, M_1) = \hat{p}(C, M_2)$. Holding deliberation unchanged, the expansion of the choice set from M_1 to M_2 reduces the probability that B is preferred relative to that of C. This is referred to as the *similarity* effect whereby the presence of an additional option cannibalizes the choice of similar options more than that of dissimilar ones.[12]

However, the change in the choice set may also influence the optimal level of deliberation. In particular, given A1 and A2, the addition of the option A strictly increases the value of preference information; i.e., $\hat{u}_{M_1} - \bar{u}_{M_1} < \hat{u}_{M_2} - \bar{u}_{M_2}$. This in turn implies that it may be optimal to invest more efforts on deliberation under the choice set M_2 than under M_1; i.e., $\alpha^*_{M_1} \leq \alpha^*_{M_2}$. It then follows that $P(C, M_1) \geq P(C, M_2)$. As the subjects deliberate more, they are more likely to switch to choose the alternative options (A or B) other than the one that is optimal under the prior belief (C). This decreases the choice probability for C. Conversely, the increasing deliberation under M_2 can exert a positive effect on the likelihood that B is preferred. Whether the choice share of B becomes higher in the expanded choice set depends on the relative importance of the deliberation effect versus the similarity effect, i.e., $\pi(\alpha^*_{M_2})/\pi(\alpha^*_{M_1})$ versus $\hat{p}(B, M_1)/\hat{p}(B, M_2)$.

Proposition 1. *The regularity property is violated for option B when the choice set is changed from M_1 to M_2, i.e., $P(B, M_2) > P(B, M_1)$, if the following condition is met*:

$$\pi'(0)\int_{\theta_{BC}}^{\bar{\theta}} [u(\theta, x_B) - u(\theta, x_C)]\, df(\theta) < c < \pi'(0) \cdot \left\{ \int_{\theta_{BC}}^{\bar{\theta}} [u(\theta, x_B) - u(\theta, x_C)]\, df(\theta) + \int_{\theta_{AB}}^{\bar{\theta}} [u(\theta, x_A) - u(\theta, x_B)]\, df(\theta) \right\}.$$

[10] The analysis is qualitatively similar for cases in which the utility is increasing in both attributes and/or there are more than two attributes.

[11] As shown in the appendix, because $\partial^2 v/\partial q \partial \theta > 0$, there can only be three possible rankings of the indifference points of θ: $\theta_{BC} < \theta_{AC} < \theta_{AB}$, $\theta_{AB} < \theta_{AC} < \theta_{BC}$, or $\theta_{AB} = \theta_{AC} = \theta_{BC}$. Condition A2 rules out the last two possibilities, under which the compromise effect would not arise.

[12] This is termed the *betweenness inequality* property by Tversky and Simonson (1993).

This proposition presents a sufficient condition for the regularity property to be violated. The basic intuition behind the result is straightforward. The first part of the condition in Proposition 1 ensures that the marginal value of information from deliberating over the choice set M_1 is sufficiently low relative to the marginal cost. As a result, the optimal deliberation level is at the minimum (i.e., $\alpha^*_{M_1} = 0$), the prior belief is retained, and option B is chosen with zero probability. However, when the choice set is expanded to include an additional option A that may be ex post preferred for some θ, the marginal value of preference information would be increased. Given the second part of the condition in the proposition, the optimal level of deliberation under the expanded choice set M_2 is strictly positive. This leads to a higher probability that option B is chosen than that under M_1.

In this proposition the deliberation effect is strong enough to counteract the similarity effect such that the middle option's choice share is strictly increased in the enlarged choice set. Other examples can be constructed for the compromise effect to emerge where the optimal deliberation is positive even under the smaller choice set M_1. Note also that, even when the deliberation effect is not dominant enough, and as a result the middle option B's choice share is lower with the addition of option A, the compromise effect can still arise if the choice share of the disadjacent option C is reduced even more. This can happen because the deliberation effect can negatively influence, whereas the similarity effect does not increase, the choice share of option C.

Consider the following example. The utility is quasilinear in quality and price: $u(\theta, x_s) = \theta q_s - p_s$. The prior belief is $f(\theta) = 0.4$ for $\theta = 0.5$, and $f(\theta) = 0.4\theta + 0.2$ for $\theta \in (0.5, 2]$. Assume also $\pi(\alpha) = 1 - e^{-\alpha}$, which implies that $\pi(\alpha^*_M) = \max\{1 - c/(\hat{u}_M - \bar{u}_M), 0\}$. Consider the following attribute values of the options: $(q_A, p_A) = (2.0, 1.75)$, $(q_B, p_B) = (1.5, 1.0)$, and $(q_C, p_C) = (1.0, 0.5)$. The indifference points would be $\theta_{AB} = 1.5$ and $\theta_{BC} = 1.0$. The optimal choice under the prior belief is option C, because the expected value of θ under the prior belief (i.e., 0.95) is less than θ_{BC}. The aggregate choice probabilities for the state when θ is known are $\hat{p}(B, M_1) = 0.4$, $\hat{p}(C, M_1) = 0.6$, $\hat{p}(A, M_2) = \hat{p}(B, M_2) = 0.2$, and $\hat{p}(C, M_2) = 0.6$, respectively. In addition, it can be readily verified that $\hat{u}_{M_1} - \bar{u}_{M_1} = 0.1$ and $\hat{u}_{M_2} - \bar{u}_{M_2} = 0.125$. Therefore, according to Proposition 1, when $0.1 < c < 0.125$, the optimal levels of deliberation are such that $\pi(\alpha^*_{M_1}) = 0$ and $\pi(\alpha^*_{M_2}) = 1 - c/0.125 > 0$. This confirms that $P(B, M_2) = \pi(\alpha^*_{M_2}) \cdot \hat{p}(B, M_2) > P(B, M_1) = \pi(\alpha^*_{M_1}) \cdot \hat{p}(B, M_1) = 0$. Moreover, when $c < 0.1$ such that $\alpha^*_{M_1} > 0$, it can be verified that $P(B, M_2) = \pi(\alpha^*_{M_2}) \cdot \hat{p}(B, M_2) = (1 - c/0.125) \cdot 0.2 > P(B, M_1) = \pi(\alpha^*_{M_1}) \cdot \hat{p}(B, M_1) = (1 - c/0.1) \cdot 0.4$ if $c > 1/12$. This shows that the regularity property is violated if $1/12 < c < 0.125$.

The analysis uncovers several important points. First, it confirms that the mediation of endogenous deliberation between context and choice can lead to the compromise effect. Second, the compromise effect may arise not necessarily because of an increasing utility for the middle option but because expanding the choice set may enhance the incentive for deliberation and thus facilitate the reallocation of choice share from the ex ante preferred option to other options. In other words, the expansion of the choice set may benefit an option that is ex ante not preferred under the prior belief, no matter it is a middle option or not in the expanded choice set. For example, consider adding the middle option B to the choice set $\{A, C\}$. If the ex ante preferred option is C, the choice probability of A can be increased, either strictly or relative to that of C, and vice versa.

I now derive several predictions on the compromise effect that can be empirically tested. I will focus on predictions that are inevitable to emerge if the construction of preference from contextual deliberation is indeed the driving force underlying the compromise effect. These predictions, as presented in Table 1, would permit falsification tests of the theory of contextual deliberation.

First, it is through increasing the incentive to deliberate that the expansion of the choice set may lead to a higher choice probability for the middle option. This implies that, as in Figure 1, deliberation can mediate the effect of choice set expansion on the choice share of the middle option.[13] To test this mediating effect, as shown in the first column of Table 1, deliberation can be measured by the amount of time spent on each choice task (i.e., response time).[14] This measure can be readily recorded in controlled lab experiments. Spontaneously measuring response time can also minimize any potential contamination on the decision-making process.

However, it is important to clarify that it is not generally true that expanding the choice set always enhances the incentive for deliberation. For example, the optimal deliberation would be lower if the added option is sufficiently dominant (e.g., with high quality but low price). Similarly, it is not always the case that

[13] Using think-aloud protocols, Simonson (1989) finds that subjects engage in longer, more complex, and more elaborate thought processes when they choose compromise options than noncompromise options. This can be interpreted as empirical evidence for the mediating role of deliberation in the compromise effect.

[14] Incentive-compatible procedures can be used to reduce the randomness in both the choice decision and the response time. Complementary instruments can also be employed to indirectly measure deliberation efforts exerted during the decision process (e.g., perceived involvement, recall of decision-relevant information).

Table 1 Empirical Predictions of Explanations of the Compromise Effect

Explanation (reference)	Response time	Deliberation cost	Attribute value (e.g., p_A)	Background context
Contextual deliberation (this paper)	+	Inverted U	Inverted U	Nil
Effort-reducing heuristic (Simonson 1989)	−	+	?	?
Context-dependent utility (Tversky and Simonson 1993) (Kivetz et al. 2004)	+	−	+	−
Contextual inference (Wernerfelt 1995) (Kamenica 2008)	?	?	+	−

Notes. The effect of response time represents the mediation effect of response time between the expansion of choice set and the choice probability for the middle option. The other predictions represent the moderating effects on the compromise effect. "+" means positive effect. "−" means negative effect. "Inverted U" means that as the value of the moderating variable increases, the predicted effect is first positive and then negative. "Nil" means that the predicted effect is zero. "?" means that no prediction is made.

a higher level of deliberation inevitably increases the choice probability for the middle option. For instance, if the ex ante preferred option is the middle one, its choice share would decrease with deliberation.[15] This means that the positive mediation of deliberation between choice set expansion and the increasing preference for the middle option is not an inevitable empirical observation, and neither is the compromise effect itself. Nevertheless, the prediction here is that when the compromise effect emerges in a particular experiment, the mediating effect of deliberation would necessarily be observed unless contextual deliberation is not the underlying driving mechanism.

The second falsification test is about the influence of the cost of deliberation on the magnitude of the compromise effect.

Proposition 2. *The compromise effect cannot arise when c is too large or too small; i.e., $P(B; A, C) \le P(B; C)$ as $c \to +\infty$ or $c \to 0$.*

This proposition suggests that the deliberation cost can moderate the compromise effect and that the moderating effect is nonmonotonic. In particular, when deliberation becomes extremely costly or perfectly costless, the compromise effect would not emerge. Intuitively, if the cost of deliberation is too high, deliberation will be suppressed even for the expanded choice set. Conversely, if the cost of deliberation becomes too low, the subjects would readily exert sufficient cognitive resources to resolve preference uncertainty even when the choice set includes a small number of options. In either case, the optimal amount of deliberation would not be different enough across choice sets. As a result, the compromise effect would become insignificant. Nevertheless, as shown in Proposition 1, the compromise effect may obtain when the cost of deliberation is intermediate. Consequently, as shown in Table 1, the theory of contextual deliberation predicts that the cost of deliberation can exhibit an "inverted-U" impact on the compromise effect.

Some empirical findings in the literature can be seen as support for the prediction that the deliberation cost may moderate the compromise effect. For example, using the experiment design in Figure 2, Dhar et al. (2000) demonstrate across several product categories that the compromise effect is mitigated when decisions are made under time pressure than when no time limit is imposed. This is consistent with the prediction that a prohibitively high deliberation cost may reduce the compromise effect. Future research can further investigate whether the significance of the compromise effect can also be reduced by a lower deliberation cost or by a lower need for deliberation. For example, if preference-relevant information is provided/elicited before presenting the choice tasks, the compromise effect may become less significant.

Another set of falsifiable predictions pertains to how the compromise effect can be influenced by the options' attribute values. Consider, for example, varying the price of option A: would the compromise effect become more or less significant as p_A increases?

Proposition 3. *The compromise effect cannot arise when $p_A \to +\infty$ or $p_A \to p_B$.*

The change in the price of option A has a nonmonotonic influence on the compromise effect. This is because increasing p_A is a "two-edged sword" in terms of its impacts on the middle option B's choice share. That is, a higher p_A can reduce both the deliberation and the similarity effects. On the one hand, the relative attractiveness of option A becomes lower as p_A increases. This means that the set of θ over which option A is ex post preferred, $\Theta(A, M_2)$, is smaller. This may in turn reduce the subjects' incentive to deliberate. As a result, when p_A is sufficiently high such that option A is almost never preferred, expanding the choice set by adding A cannot lead to substantial increase in deliberation (i.e., $\alpha^*_{M_2}$ converges to $\alpha^*_{M_1}$) and thus cannot significantly increase the choice share of the middle option B. On the other hand, however, a higher p_A can mitigate the similarity effect and, holding deliberation constant, increase

[15] This suggests that the compromise effect would not arise for homogeneous decision makers if the middle option is the ex ante preferred option. Nevertheless, it is shown in §3.2 that the compromise effect can still emerge even when the middle option is ex ante preferred by some (but not all) decision makers.

the set of θ over which option B is ex post preferred over A; i.e., $\Theta(B, M_2)$ is enlarged. Therefore, when p_A is too low, even though deliberation can be increased in the expanded choice set M_2, the similarity effect would become dominant and thus the likelihood that B is ex post preferred would be sufficiently mitigated. This implies that the compromise effect may arise only when p_A is intermediate.[16] Consequently, as shown in Table 1, the theory of contextual deliberation predicts that the value of p_A can exhibit an inverted-U impact on the compromise effect.

In the same vein, the compromise effect will not emerge if the quality of option A becomes overly high or overly low. Similarly, it is only when the quality and price of option B are neither exceptionally high nor exceptionally low relative to those of options A and C that the compromise effect may obtain. These results establish boundary conditions for the compromise effect: the options must be neither too close nor too different from each other in the attribute space.

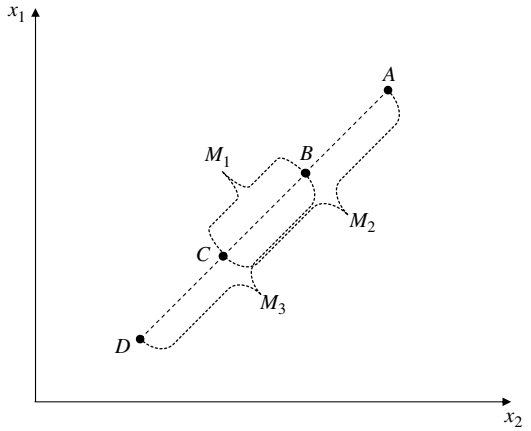
3.2. Varying Middle Options

Another set of experiments demonstrate the compromise effect by including multiple middle options that may vary across choice sets. For example, consider four options, $A \mid B \mid C \mid D$. One experiment design involves three manipulation conditions. As in Figure 3, one group of subjects is presented with $M_1 = \{B, C\}$, one group with $M_2 = \{A, B, C\}$, and another group with $M_3 = \{B, C, D\}$. The expanded choice sets, M_2 and M_3, represent the high-quality and the low-quality extensions, respectively. The compromise effect may arise for both $P_A(B; C) > P(B; C)$ and $P_D(C; B) > P(C; B)$. That is, the addition of an extreme option to the two-option choice set increases the relative choice share of the middle option, B or C, for either the high- or the low-quality extension. Clearly, this is a stronger demonstration of the compromise effect than in the basic design in which the two-option choice set is extended along only one direction.

To show that contextual deliberation may lead to the compromise effect for both high- and low-quality extensions, consider a sample of two types of subjects, $i \in \{1, 2\}$, the proportion of which is γ and $1-\gamma$, respectively. For both types, the utility is similar to that in the basic case: $u(\theta_i, x_s) = v(\theta_i, q_s, p_s)$. For subject

[16] The compromise effect yields the managerial advice to introduce premium loss leaders—products with overly high quality and price that do not sell well on their own but are intended to boost sales of products with moderate quality and price in the product line. See, for example, Simonson and Tversky (1992) and Smith and Nagle (1995) on anecdotal evidence for the existence of premium loss leaders. The analysis presented here offers not only a microfoundation for the rationale of the premium loss leadership but also provides further guidance on the boundary conditions for its existence.

Figure 3 The Compromise Effect with Varying Middle Options



type i, the prior belief is that θ_i is (independently) distributed with density f_i over $[\underline{\theta}_i, \bar{\theta}_i]$. Similarly, consider the following conditions:

A1′. option B is preferred by type 1 and option C is preferred by type 2 under the prior belief, i.e., $B = \bar{s}_1(M)$ and $C = \bar{s}_2(M)$, where $M = \{A, B, C, D\}$; and

A2′. for any $s \in M = \{A, B, C, D\}$, the set of θ over which s is ex post preferred is nonempty for either subject type, i.e., $\Theta_i(s, M) \neq \varnothing$, $i = 1, 2$.

It follows from A2′ that $\underline{\theta}_i < \theta_{CD} < \theta_{BD} < \theta_{BC} < \theta_{AC} < \theta_{AB} < \bar{\theta}_i$ and $\theta_{BD} < \theta_{AD} < \theta_{AC}$. This implies that, conditional on θ, the added extreme option in M_2 or M_3 simply cannibalizes the share of choice for the respective middle option but does not reduce that of the other extreme option.

The subjects' choice probabilities for the options B and C under M_l, $l = 1, 2, 3$, are

$$\begin{aligned} P(B, M_l) &= \gamma\{\pi(\alpha^*_{1M_l})\hat{p}_1(B, M_l) + [1 - \pi(\alpha^*_{1M_l})]\} \\ &\quad + (1-\gamma)\pi(\alpha^*_{2M_l})\hat{p}_2(B, M_l), \\ P(C, M_l) &= \gamma\pi(\alpha^*_{1M_l})\hat{p}_1(C, M_l) \\ &\quad + (1-\gamma)\{\pi(\alpha^*_{2M_l})\hat{p}_2(C, M_l) + [1 - \pi(\alpha^*_{2M_l})]\}. \end{aligned}$$

I can now present sufficient conditions for the regularity property to be violated for both high- and low-quality extensions.

Proposition 4. *The regularity property is violated for option B when M_1 is extended to M_2 and for option C when M_1 is extended to M_3, i.e., $P(B, M_2) > P(B, M_1)$ and $P(C, M_3) > P(C, M_1)$, if the following conditions are met*:

(i) $\bar{\theta}_1 \to \theta_{AB}$;

(ii) $\underline{\theta}_2 \to \theta_{CD}$;

(iii) $$\pi'(0)\int_{\theta_{BC}}^{\bar{\theta}_2}[u(\theta, x_B) - u(\theta, x_C)]\, df_2(\theta) < c < \pi'(0) \cdot \left\{\int_{\theta_{BC}}^{\bar{\theta}_2}[u(\theta, x_B) - u(\theta, x_C)]\, df_2(\theta) + \int_{\theta_{AB}}^{\bar{\theta}_2}[u(\theta, x_A) - u(\theta, x_B)]\, df_2(\theta)\right\};$$

(iv) $$\pi'(0)\int_{\underline{\theta}_1}^{\theta_{BC}}[u(\theta,x_C)-u(\theta,x_B)]\,df_1(\theta)<c<\pi'(0)\cdot\left\{\int_{\underline{\theta}_1}^{\theta_{BC}}[u(\theta,x_C)-u(\theta,x_B)]\,df_1(\theta)+\int_{\underline{\theta}_1}^{\theta_{CD}}[u(\theta,x_D)-u(\theta,x_C)]\,df_1(\theta)\right\}.$$

This proposition constructs an example in which extending the choice set along either direction of the attribute space leads to violation of the regularity property. The key to the example is the subjects' heterogeneity in both the preferred option under the prior belief and how the incentive to deliberate may be differentially influenced by alternative choice set extensions. For type 1 subjects, the ex ante preferred option is B, and given condition (i), the high-quality extension does not enhance the incentive to deliberate. By contrast, type 2 subjects ex ante prefer option C, and condition (ii) ensures that the low-quality extension does not increase optimal deliberation. Therefore, when A is added to the choice set M_1, the choice behavior of type 1 subjects does not change, whereas, given condition (iii), type 2 subjects will strictly deliberate more and thus increase the likelihood of choosing option B. Conversely, the low-quality extension from M_1 to M_3 does not modify the options' relative choice share for type 2 subjects but type 1 subjects will respond by exerting more deliberation efforts and hence ex post reallocating more choice share from B to C.

Other experimental demonstrations of the compromise effect involve choice sets of same size with overlapping options (e.g., M_2 and M_3). In these cases, it is the locus of the middle option, but not the size of the choice set, that is varied across manipulation conditions (e.g., Kivetz et al. 2004, Pocheptsova et al. 2009). Even though the experiment design is different, a corollary following Proposition 4 readily shows that contextual deliberation can explain the emergence of the compromise effect in these scenarios.

Consider the following example. The utility and the deliberation functions of both type of subjects are the same as those in §3.1. The prior belief of type 2 subjects is also the same as the representative decision maker there, whereas that of type 1 subjects is $f_1(\theta)=0.4\theta$ for $\theta\in[0,1.5)$ and $f_1(\theta)=1$ for $\theta=1.5$. The attribute values of the options A, B, and C are the same as well, and the additional option D has the following attributes: $(q_D,p_D)=(0.5,0.25)$. Thus the indifference points are $\theta_{AB}=1.5$, $\theta_{BC}=1.0$, and $\theta_{CD}=0.5$. Note that the optimal choice of type 2 subjects under the prior belief continues to be option C. The ex ante preferred option for type 1 subjects is B, because their expected value of θ under the prior belief (i.e., 1.05) is between θ_{BC} and θ_{AB}. Note also that $\bar{\theta}_1=1.5=\theta_{AB}$ and $\underline{\theta}_2=0.5=\theta_{CD}$, satisfying the conditions (i) and (ii) in Proposition 4. This means that type 1 subjects do not change their choice behavior in response to the high-quality extension from M_1 to M_2, and type 2 subjects are unresponsive to the low-quality extension from M_1 to M_3. Recall that if $1/12<c<0.125$, the response of type 2 subjects to the high-quality extension is to deliberate more and to increase the likelihood of choosing option B. Similarly, it can be readily verified that, as the choice set M_1 is extended to M_3, type 1 subjects would have a higher level of deliberation and strictly increase the choice probability for option C if $1/12<c<0.125$. This demonstrates that the regularity property can be violated for both the high- and the low-quality extensions.

Which predictions in the previous section can be tested under these alternative experiment designs? Because experiment designs involving both high- and low-quality extensions predict variations in the level of optimal deliberation across choice sets, they can be used to test the mediating effect of contextual deliberation. However, if the considered choice sets include an equal number of options (e.g., M_2 and M_3), the aggregate deliberation level may not vary across choice sets. As a result, between-subjects designs would not constitute a clean setup to test the mediating effect.

Furthermore, the moderating effects of deliberation cost and attribute values on the compromise effect, as predicted in Propositions 2 and 3, can be tested in the designs here with varying middle options. For instance, as shown by Pocheptsova et al. (2009) in experiments involving M_2 and M_3, subjects are less likely to choose intermediate options when their cognitive resources are depleted than when the cognitive resources are not depleted. Similar to Dhar et al. (2000), this finding lends additional support for the prediction that the cost of deliberation can moderate the compromise effect.

3.3. Identification from Alternative Explanations of the Compromise Effect

There are alternative explanations for the compromise effect. In this section I briefly survey these explanations and discuss empirical strategies to distinguish them from contextual deliberation. The first potential explanation views the compromise effect as arising from the use of decision heuristics. That is, when it becomes difficult to make attribute trade-offs across choice options, people may use some precoded decision rules to reduce the efforts of choice. For example, there is a reason-based explanation that suggests that compromise options are easier to justify (either to oneself or to others) and can help simplify decision tasks (e.g., Simonson 1989). Nevertheless, this type of

psychological explanation is ad hoc and does not a priori specify why noncompromise options are necessarily more difficult to justify.[17]

One stream of studies attempts to accommodate the compromise effect by assuming context-dependent utility such that the observed choice behavior exhibits preference for intermediate options. For example, Tversky and Simonson (1993) propose a componential context model in which the overall value of an option is influenced by its relative advantages and disadvantages, across all attributes, in comparison to all other options in the choice set. Thus, the preference ordering of options in a choice set is context dependent. They further assume that decision makers are more sensitive to disadvantages than to advantages (i.e., disadvantage aversion). They demonstrate that choice behavior, as captured by this componential context model, leads to the compromise effect. Along the same line, Kivetz et al. (2004) introduce several other context-dependent models to capture the compromise effect.[18]

Another stream of research considers the role of the supply side in rationalizing the compromise effect. For example, Wernerfelt (1995) proposes an interesting explanation based on rational consumers making inference from market offerings. He posits that consumers may have more knowledge about their valuation relative to the general population than about their absolute valuation. Nevertheless, given that firms may design and market their product lines by taking into account the distribution of consumer valuations, the uninformed consumers can rationally infer their absolute valuation from the products that are actually offered in the market. Consumers may then form a rank-order decision rule and choose the product that corresponds to their relative valuation rank, which can be proved to be completely rational. As a result, if the rank-order decision heuristic that the consumers develop in the marketplace is brought into the experiment setting, the subjects may exhibit context-dependent choice behavior.[19] Kamenica (2008) further shows that *contextual inference*, i.e., belief updating based on information gained from choice context, can be rational even when firms may endogenously manipulate consumers' beliefs.

The falsification tests discussed in §3.1 can be used to separate contextual deliberation from these alternative explanations. This is because these alternative explanations may make different predictions on these tests. For example, as presented in the first column of Table 1, testing whether the compromise effect is mediated by response time can identify the explanation of contextual deliberation from that of effort-reducing heuristic or contextual inference. Recall that if the compromise effect is driven by contextual deliberation, the expansion of the choice set would lead to a longer response time, which in turn increases the choice for the middle option.[20] By contrast, as the choice set expands, the heuristic explanation would predict that the response time is shorter, whereas the theory of contextual inference may make no prediction on the role of response time.

The moderating effects of deliberation cost and of attribute value can also be employed to test which of the explanations is the driving force. As presented in column (2) of Table 1, as the cost of deliberation increases, the compromise effect may become stronger as predicted by the heuristic explanation, become weaker by the theory of context-dependent utility, and remain unchanged by the contextual inference theory. These predictions are all different from the nonmonotonic effect derived from the theory of contextual deliberation. Similarly, as the high-end option's price (i.e., p_A) increases, the influence on the compromise effect would be different across these explanations. Even though decisions based on heuristic may be unresponsive, models of context-dependent utility and contextual inference would predict that the compromise effect is stronger because of the mitigation of the similarity effect. Again, these predictions differ from the inverted-U moderating effect that can be derived from the interaction of the deliberation and the similarity effects.

Moreover, the other explanations can yield unique predictions that can be tested to examine whether they can account for the existence of the compromise effect. For example, both the theory of context-dependent

[17] In this regard, the other explanations, including the one based on contextual deliberation, attempt to specify the underlying reason/mechanism on why middle options are "easier to justify." See also Syam et al. (2008) on how regret and product customization may increase the preference for middle options.

[18] In this school of research, the compromise effect is generally viewed as arising from behavioral bias or decision mistake. However, it is difficult to conceive that decision makers err by making effortful, complex comparisons across choice options, which is posited by these studies, and that decision makers cannot reduce the errors by simplifying the valuation process. Indeed, although Dhar et al. (2000) advocate the compromise effect as evidence for irrational behavior, they hesitate to claim that the mitigation of the compromise effect (e.g., under time pressure) implies reduction in decision error. On the other hand, these models still assume optimization as in standard choice theories: decision makers choose the option with the highest context-dependent value.

[19] Prelec et al. (1997) find that subjects' perceptions about product attribute positions are context sensitive. They show that the fit between subjects' ideal attribute positions and perceived product positions, if the rank-order decision rule is used, can predict context-dependent choice behavior.

[20] Nevertheless, the positive mediation effect of response time can also be consistent with the explanation based on context-dependent utility.

utility and contextual inference may posit that if the same choice options are presented (as background context) to the subjects in both the small and the large choice sets, the compromise effect would be mitigated. This is because the dependence of utility on the context, either directly under the former theory or indirectly under the latter one, is driven by the exposure to the context (e.g., Tversky and Simonson 1993). In addition, one major implication of contextual inference is that choice behavior would not be context dependent if the subjects believe that the experimental procedure on the assignment of choice sets is indeed random and uninformative. However, as long as the actual choice options remain different, the subjects may still engage in contextual deliberation because the value of acquiring preference information is endogenously influenced by the options contained in the choice set but not by those in the context only. Therefore, as presented in the last column of Table 1, the background context can be manipulated to identify these alternative mechanisms.

4. Preference Construction with Outside Option: The Choice Overload Effect

The choice overload effect captures another phenomenon of preference construction. It suggests that an overabundance of options to choose from may lead to less choice relative to an outside option.[21] The regularity property is violated for the choice overload effect whereby the outside option is more preferred in an expanded choice set.[22] Iyengar and Lepper (2000) demonstrate this effect in a series of experiments. They set up a tasting table at an upscale grocery store that displayed either a 6-variety or a 24-variety assortment of exotic jams. More consumers were attracted to the tasting table when the displayed assortment included more varieties. However, only 3% of consumers who saw the large assortment actually purchased one of the jams, whereas 30% of those who were presented with the small assortment did so.[23]

In this section I will discuss how contextual deliberation may yield the choice overload effect even with standard utility.[24] Some testable implications and empirical strategies to separate contextual deliberation from other explanations are also discussed.

4.1. Contextual Deliberation Interpretation of Choice Overload

Consider a small assortment with $N1$ varieties and a large assortment with $N2$ varieties, where $N1 < N2$. Suppose it is feasible not to choose any of the available varieties; i.e., an outside option s_0 is allowed. Thus, the choice sets can be represented as $M_{N1} = \{s_0, s_1, \ldots, s_{N1}\}$ and $M_{N2} = \{s_0, s_1, \ldots, s_{N2}\}$, where $M_{N1} \subset M_{N2}$.[25] Consider a group of subjects in an experiment who are randomly assigned to one of these two assortments and requested to decide whether and which variety to choose. The choice overload effect will emerge if $P(s_0, M_{N1}) < P(s_0, M_{N2})$; i.e., expanding the assortment size increases the proportion of subjects who choose the outside option.

Suppose the subjects are homogeneous and consider a representative decision maker. The (expected) utility for the outside option is u_0, and the ex post utility for variety s is $u(\theta, x_s)$. Suppose that under the prior belief for θ, the outside option is not ex ante preferred in the small choice set; i.e., $\bar{s}(M_{N1}) \neq s_0$. It follows from the IIA property of rational choice that $\bar{s}(M_{N2}) \neq s_0$. That is, if θ remains uncertain, the outside option cannot become optimal in the large assortment either. For simplicity, assume that the ex ante preferred variety does not change as the assortment size increases: $\bar{s}(M_{N1}) = \bar{s}(M_{N2})$. It follows from (4) that

$$P(s_0, M_{N1}) = \pi(\alpha^*_{M_{N1}}) \int_{\Theta(s_0, M_{N1})} df(\theta),$$

$$P(s_0, M_{N2}) = \pi(\alpha^*_{M_{N2}}) \int_{\Theta(s_0, M_{N2})} df(\theta).$$

Adding more varieties to the choice set may give rise to two effects on the choice behavior. First, the added varieties may cannibalize the choice likelihood of the outside option. That is, the set of θ over which the outside option is ex post preferred may shrink in the presence of more varieties: $\Theta(s_0, M_{N2}) \subseteq \Theta(s_0, M_{N1})$. This means that, holding deliberation

[21] The outside option can represent either choosing none of the available options or deferring the current choice.

[22] Other possible adverse consequences of increasing the number of options to choose from include lower preference for larger assortments and lower satisfaction with the finally chosen option. However, as noted in a meta-analysis by Scheibehenne et al. (2010), the measures of these dependent variables are typically confounded, and the empirical results are mixed in the literature. For example, Jacoby et al. (1974) show in an experiment setting that subjects have greater satisfaction with a larger number of alternatives.

[23] In an online grocery setting, Boatwright and Nunes (2001) show that when assortment size was reduced for a fraction of customers, their sales were increased by 11%. Iyengar et al. (2004) report that the rate of employee participation in a 401(k) plan drops from 75% to 60% when the number of available funds is increased from 2 to 59. A similar phenomenon is also seen by Bertrand et al. (2005), who present evidence that offering more loan options may lead to less taking-up by borrowers.

[24] Other mechanisms for choice avoidance include self-control (Gul and Pesendorfer 2001) and regret (Irons and Hepburn 2007, Sarver 2008).

[25] Examples can be constructed for the choice overload effect even when the small assortment is not a subset of the large assortment. Nevertheless, the regularity property is immaterial if a choice set does not subsume the other.

unchanged, the subjects are more likely to choose one of the presented varieties from a larger assortment.

However, the subjects may have higher incentive to invest cognitive resources on deliberation when more varieties are present. This can happen if, conditional on θ, not all of the added varieties are ex post dominated; i.e., $\Theta(s, M_{N2}) \neq \varnothing$ for some s: $s \in M_{N2}$ and $s \notin M_{N1}$. If the subjects indeed deliberate more, they are more likely to switch to choose alternative options (including the outside option) other than the one that is optimal under the prior belief (i.e., $\bar{s}(M_{N2})$). As a result, increasing deliberation under M_{N2} can exert a positive effect on the likelihood that the outside option is preferred.

When the deliberation effect dominates the cannibalization effect, the net impact of increasing the assortment size would be to make the outside option become more likely to be preferred. The following result follows from Proposition 1.

Proposition 5. *The regularity property can be violated for the outside option s_0 when the choice set is expanded from M_{N1} to M_{N2}; i.e., $P(s_0, M_{N1}) < P(s_0, M_{N2})$.*

The choice overload effect is typically regarded as a distinctive behavioral phenomenon from the compromise effect. First, the focus of the compromise effect is on how an option's choice share may change when its position in physical attribute space relative to other options is modified, whereas the choice overload effect pertains to how assortment size may influence the likelihood that the outside option is chosen. Thus, the compromise effect is concerned with options that can be ranked on vertical attributes, whereas the choice overload effect is applicable to assortments with both vertical and/or horizontal attributes. Second, it is sufficient for the emergence of the compromise effect if only the relative choice share of the middle option is increased, whereas the choice overload effect implies an absolute increase in the choice share of the outside option. That is, when the choice set is expanded, the regularity property is necessarily violated for choice overload, but not so for the compromise effect.

However, the economic mechanism that may lead to the choice overload effect can be essentially similar to that underlying the compromise effect. In both cases, it is the expansion of the choice set that may increase the incentive for deliberation and hence benefit options that are not ex ante preferred under the prior belief (e.g., the outside option here and the middle option in §3.1). Therefore, both choice overload and compromised choices may be driven by contextual deliberation. This demonstrates that the theory of contextual deliberation can explain seemingly disparate phenomena that are otherwise captured in the literature by different ad hoc models.

This explanation for the choice overload effect also implies that the choice overload effect is not necessarily a robust phenomenon. In fact, there are many studies that found no such effect, or they found the opposite result, that more options can lead to more choice. In a meta-analysis with 50 experiments, Scheibehenne et al. (2010) conclude that the mean size of the impact of number of options on the choice of outside option is virtually zero. This means that the choice overload effect is not an inevitable empirical finding.

Nevertheless, the interpretation of choice overload as resulting from contextual deliberation yields several predictions that can be tested to examine whether contextual deliberation is indeed the driving force when the choice overload effect emerges. These predictions, presented in Table 2, resemble those for the compromise effect. For instance, the mediating role of deliberation can be tested by investigating whether a larger assortment leads to higher choice likelihood for the outside option through increasing the incentive to deliberate. Similarly, the cost of deliberation may nonmonotonically moderate the choice overload effect. That is, the increasing preference for the outside option under larger assortments may arise only when the deliberation cost or the need for deliberation is neither too high nor too low. Chernev (2003) shows that subjects who are asked to articulate their attribute preferences prior to making a choice are more likely to choose from large assortments than those subjects without articulated preferences. This result is consistent with the prediction here that lowering the need for deliberation during the choice process (e.g., through prechoice articulation of preferences) can mitigate choice overload.

Another prediction that can be derived for the choice overload effect is that choice shares are more concentrated under small assortments than under large assortments. That is, choices under small assortments are more likely to come from a limited number of options, whereas they are more likely to spread

Table 2 Empirical Predictions of Explanations of the Choice Overload Effect

Explanation	Mediation of response time	Choice share concentration	Moderation of deliberation cost
Contextual deliberation	+	−	Inverted U
Psychological theories (e.g., regret)	−	?	+
Contextual inference (costly search)	−	+	+

Notes. "+" means positive effect. "−" means negative effect. "Inverted U" means that as the value of the moderating variable increases, the predicted effect is first positive and then negative. "?" means that no prediction is made.

over more options under large assortments. This is because expanding assortment size can boost the subjects' incentive to deliberate and hence may increase not only the choice likelihood of the outside option but also those of other options that are not ex ante preferred. As a result, as the second column in Table 2 shows, an increase in assortment size may lead to lower choice concentration.

4.2. Identification from Alternative Explanations of the Choice Overload Effect

The psychological explanations for the choice overload effect posit that a larger assortment can lead to anticipated negative consequences (e.g., regret, dissatisfaction, lack of accountability) because of the increasing similarity among the options (Schwartz et al. 2002, Schwartz 2004). Consequently, these anticipated consequences may yield a lower likelihood of choosing any of the options. For instance, regret may arise from choosing from a large assortment, because the second-best alternative is likely to be more attractive than that in a small assortment. Similarly, larger assortments may boost expectation and hence lower the satisfaction for the chosen option. In addition, justifying the choice of any option in a large assortment can be more difficult than in a small assortment.

Kamenica (2008) proposes contextual inference as an explanation for choice overload. In his model, consumers are ex ante indifferent among the offered varieties: they would randomly select one variety from an assortment or make no purchase at all. However, the firm privately knows the varieties' relative popularity, and it is in the firm's interest to always introduce the most popular varieties and move down to less popular ones as the assortment size increases. Therefore, the equilibrium average popularity of the offered varieties decreases with assortment size. The consumers can make inference, from the size of an assortment, about the expected utility of a randomly selected variety. They would then become more reluctant to make a choice from a larger assortment.

Similarly, the explanation proposed by Kuksov and Villas-Boas (2010) rests on consumers making strategic inference from observed assortment size. They consider a setup in which the consumers can make a random and uninformed choice or engage in sequential search to figure out the varieties' location on a horizontal attribute before making a more informed choice. The firm can decide the varieties' location on the horizontal attribute. They show that the information that is endogenously conveyed by assortment size influences not only the expected utility of a randomly chosen variety but also the marginal value of search. As a result, too many varieties can lead to less search and less choice.

As summarized in Table 2, contextual deliberation may make different predictions from these alternative explanations. Recall first that the mediation of deliberation (e.g., response time) on the choice overload effect is positive under the theory of contextual deliberation. By contrast, both the psychological theories and the theory of contextual inference may argue that a larger assortment can lead to less choice through decreasing the incentive to search for more information (e.g., Kuksov and Villas-Boas 2010). This means that, under these two explanations, response time would have a negative mediating effect.

Furthermore, the explanation of contextual deliberation can be empirically identified from those of the other two through investigating the impact of assortment size on the concentration of choice shares. This is because, whereas the psychological theories may make no prediction about choice share concentration, the theory of contextual inference makes the opposite prediction that larger assortments lead to less information acquisition and hence narrower distribution of choice shares over the alternatives.

Similarly, the predictions regarding the moderating effect of deliberation cost are different across the alternative explanations. Contextual deliberation predicts that the choice overload effect can be nonmonotonically moderated by the cost of deliberation. By contrast, both the psychological explanations and contextual inference would predict that the choice overload effect can be strengthened as the cost of processing/acquiring information increases. This moderating effect can be empirically tested through manipulating factors that may influence the cost/need of deliberation (e.g., time pressure, depletion of cognitive resources, experience, cognitive skills).

5. Conclusion

Empirical findings that depart from classical models of rational choice have led to the proposition that preferences are constructive. In this paper I develop a parsimonious theory of contextual deliberation to endogenize the construction of preference. A number of comments are in order. First, the current theory is developed with some simplifying features (e.g., attribute-based utility, ad hoc information structure). Nevertheless, it is important to point out that the essence of the theory is contextual deliberation in the two-stage decision process and that the theory can be extended to accommodate more general scenarios. Second, it is an empirical question whether the present theory can indeed explain the context effects. We are in the process of collecting experimental data to test the predictions made in the current paper.

The theory of contextual deliberation can also be extended to accommodate other types of preference construction. For example, Guo and Hong (2013) show that endogenous deliberation can mediate the spurious correlation between arbitrarily generated numbers

and experimentally elicited valuations. As a result, it is not necessary to interpret the anchoring effect as evidence that preferences are nonexisting or arbitrary (Ariely et al. 2003, Fudenberg et al. 2012). Another cause of preference construction is alternative methods used in experiments to elicit preferences (e.g., choice, valuation, matching, joint versus separate evaluations). To the extent that preference elicitation methods may endogenously influence decision makers' incentive to deliberate, they would play an important role in the preference construction process. Similarly, other factors such as mood or decision framing may indirectly influence choice behavior through affecting the cost/effectiveness of deliberation. In essence, these seemingly irrelevant characteristics of decision environment may actually be highly relevant if preferences are indeed constructed systematically through endogenous deliberation.

Future research can investigate how these factors may structurally influence preference construction. In addition, there may be an interaction between choice context and preference elicitation methods in the construction of preferences. More importantly, preferences may not be revealed independent of the elicitation methods. That is, there may be an endogenous "mere measurement" effect in the elicitation of preferences. Therefore, theories of joint choice and measurement can be developed. This can be especially important for empirical studies.

The theory of contextual deliberation advocates modeling bounded rational behavior through endogenizing the primitives of preference (e.g., information). This stands in contrast to the popular approach in which bounded rationality is modeled as some exogenously imposed behavioral assumptions. More generally, the observed choice is but one outcome of a series of decisions an agent may have made before reaching the final choice: the agent may have decided whether and how to acquire/process various signals, and there may have been some strategic interaction between different selves within the agent (Fudenberg and Levine 2006). To the extent that these intermediate decisions can be accurately measured (e.g., information processing time/efforts), classical models of rational choice can be enriched by expanding the scope of decision making (even for a single choice task). I believe that, should we incorporate these intermediate measures of decision making, the theory of contextual deliberation can be axiomatically generalized.

Another fruitful direction for future research is to extend the theory of contextual deliberation to enlighten the emerging literature in neuroeconomics. For example, neuroimaging techniques can yield better measures of deliberation than response time and thus can be employed to test the empirical predictions developed in the current paper. In addition, working models of the brain can be constructed to shed light on how decision-relevant information can be retrieved, processed, and transferred within different areas of the brain.

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Appendix

Proof of Proposition 1. Consider $q_A > q_B > q_C$ and $p_A > p_B > p_C$ for $A \mid B \mid C$. By A2, the indifference points θ_{AB}, θ_{AC}, and θ_{BC} are not equal to each other. By $\partial^2 v/\partial q \partial\theta > 0$, $v(\theta, q_A, p_A) > v(\theta, q_B, p_B)$ if and only if $\theta > \theta_{AB}$, $v(\theta, q_A, p_A) > v(\theta, q_C, p_C)$ if and only if $\theta > \theta_{AC}$, and $v(\theta, q_B, p_B) > v(\theta, q_C, p_C)$ if and only if $\theta > \theta_{BC}$. Suppose $\theta_{AB} > \theta_{AC}$. This means that $v(\theta_{AC}, q_B, p_B) > v(\theta_{AC}, q_A, p_A) = v(\theta_{AC}, q_C, p_C)$, which in turn implies that $\theta_{AC} > \theta_{BC}$. Conversely, $\theta_{AB} < \theta_{AC}$ implies $\theta_{AC} < \theta_{BC}$.

Suppose $\theta_{AB} < \theta_{AC} < \theta_{BC}$. This implies $\Theta(B, M_2) = \varnothing$, contradicting the condition A2. Therefore, it must be that $\theta_{BC} < \theta_{AC} < \theta_{AB}$. It follows from A2 that $\theta_{AB} < \bar{\theta}$ and $\underline{\theta} < \theta_{BC}$. This proves that $\underline{\theta} < \theta_{BC} < \theta_{AC} < \theta_{AB} < \bar{\theta}$.

Consider the choice set $M_1 = \{B, C\}$. Note that

$$\begin{aligned}\hat{u}_{M_1} - \bar{u}_{M_1} &= \int_{\underline{\theta}}^{\theta_{BC}} u(\theta, x_C)\, df(\theta) + \int_{\theta_{BC}}^{\bar{\theta}} u(\theta, x_B)\, df(\theta) \\ &\quad - \int_{\underline{\theta}}^{\bar{\theta}} u(\theta, x_C)\, df(\theta) \\ &= \int_{\theta_{BC}}^{\bar{\theta}} [u(\theta, x_B) - u(\theta, x_C)]\, df(\theta) < c.\end{aligned}$$

We have $c/(\hat{u}_{M_1} - \bar{u}_{M_1}) > \pi'(0)$. This leads to $\alpha^*_{M_1} = 0$. Thus, $P(B, M_1) = \pi(\alpha^*_{M_1}) \int_{\theta_{BC}}^{\bar{\theta}} df(\theta) = 0$.

Consider then the choice set $M_2 = \{A, B, C\}$. Note that

$$\begin{aligned}\hat{u}_{M_2} - \bar{u}_{M_2} &= \int_{\underline{\theta}}^{\theta_{BC}} u(\theta, x_C)\, df(\theta) + \int_{\theta_{BC}}^{\theta_{AB}} u(\theta, x_B)\, df(\theta) \\ &\quad + \int_{\theta_{AB}}^{\bar{\theta}} u(\theta, x_A)\, df(\theta) - \int_{\underline{\theta}}^{\bar{\theta}} u(\theta, x_C)\, df(\theta) \\ &= \int_{\theta_{BC}}^{\bar{\theta}} [u(\theta, x_B) - u(\theta, x_C)]\, df(\theta) \\ &\quad + \int_{\theta_{AB}}^{\bar{\theta}} [u(\theta, x_A) - u(\theta, x_B)]\, df(\theta) > c.\end{aligned}$$

This leads to $\alpha^*_{M_2} > 0$. Thus, $P(B, M_2) = \pi(\alpha^*_{M_2}) \int_{\theta_{BC}}^{\theta_{AB}} df(\theta) > 0 = P(B, M_1)$.

Proof of Proposition 2. Consider first $c \to +\infty$ and hold other parameters fixed. It follows that $c/(\hat{u}_{M_1} - \bar{u}_{M_1}) > \pi'(0)$ and $c/(\hat{u}_{M_2} - \bar{u}_{M_2}) > \pi'(0)$. Therefore, the optimal deliberation is zero for both M_1 and M_2; i.e., $\alpha^*_{M_1} = \alpha^*_{M_2} = 0$. This in turns implies that $P(B, M_1) = P(B, M_2)$ and $P(C, M_1) = P(C, M_2)$.

Conversely, when $c \to 0$, $c/(\hat{u}_{M_1} - \bar{u}_{M_1}) < \pi'(\alpha)$ and $c/(\hat{u}_{M_2} - \bar{u}_{M_2}) < \pi'(\alpha)$ for any $\alpha \geq 0$. As a result, the optimal deliberation converges to infinite for both M_1 and M_2; i.e., $\alpha^*_{M_1} = \alpha^*_{M_2} = +\infty$. This in turns implies that $P(B, M_1) > P(B, M_2)$ and $P(C, M_1) = P(C, M_2)$.

Proof of Proposition 3. Note that θ_{AB} is increasing in p_A. Consider first the case when p_A is too high such that θ_{AB} converges to $\bar{\theta}$. Then $\Theta(A, M_2)$ will converge to $\varnothing$. This means that $\alpha^*_{M_2} = \alpha^*_{M_1}$. As a result, $P(B, M_1) = P(B, M_2)$ and $P(C, M_1) = P(C, M_2)$.

Consider then the case when p_A is too low such that $\theta_{AB} \leq \theta_{BC}$. It follows that $\Theta(B, M_2) = \varnothing$. This implies that $P(B, M_2) = 0$. Therefore, the compromise cannot arise.

Proof of Proposition 4. It follows from $A2'$ and the proof of Proposition 1 that $\underline{\theta}_i < \min\{\theta_{CD}, \theta_{BD}, \theta_{AD}\} < \theta_{BC} < \theta_{AC} < \theta_{AB} < \bar{\theta}_i$. Following the proof of Proposition 1, this in turn implies that $\theta_{CD} < \theta_{BD} < \theta_{BC}$ and $\theta_{BD} < \theta_{AD} < \theta_{AC}$.

Consider first extending the choice set from M_1 to M_2. For type 1, $\bar{\theta}_1 \to \theta_{AB}$ leads to $\alpha^*_{1M_2} \to \alpha^*_{1M_1}$ and $\hat{p}_1(B, M_2) \to \hat{p}_1(B, M_1)$. In addition, condition (iii) ensures that, for type 2, $\alpha^*_{2M_2} > 0 = \alpha^*_{2M_1}$ and $\hat{p}_2(B, M_2) = f_2(\theta_{AB}) - f_2(\theta_{BC}) > 0$. Therefore, $P(B, M_2) > P(B, M_1)$.

Consider then the extension from the choice set M_1 to M_3. For type 2, $\underline{\theta}_2 \to \theta_{CD}$ leads to $\alpha^*_{2M_3} \to \alpha^*_{2M_1}$ and $\hat{p}_2(C, M_3) \to \hat{p}_2(C, M_1)$. In addition, condition (iv) ensures that, for type 1, $\alpha^*_{1M_3} > 0 = \alpha^*_{1M_1}$ and $\hat{p}_1(C, M_3) = f_1(\theta_{BC}) - f_1(\theta_{CD}) > 0$. Therefore, $P(C, M_3) > P(C, M_1)$.

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