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# LIMITED ATTENTION AND STATUS QUO BIAS\*

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## Abstract

We introduce and axiomatically characterize a model of status quo bias in which the status quo affects choices by both changing preferences and focusing attention. The resulting Limited Attention Status Quo Bias model can explain both the finding that status quo bias is more prevalent in larger choice sets and that the introduction of a status quo can change choices between non-status quo alternatives. Existing models of status quo bias are inconsistent with the former finding while models of decision avoidance are inconsistent with the latter. We report the results of laboratory experiments which show that both attention and preference channels are necessary to explain the impact of status quo on choice.

*Keywords:* Status Quo Bias, Reference Dependence, Attention, Revealed Preference

*JEL Codes:* D03, D83

## 1 Introduction

When a decision maker (DM) chooses between alternatives, it is often the case that one will be the “status quo”, or default option. This is the alternative that the DM will end up with if they do not actively change to another - for example their current cell phone plan, the default alternative in their 401k retirement plan, or the brand of detergent they habitually buy. A large empirical literature has demonstrated in a wide variety of settings that the status quo can have a dramatic effect on choice behavior.

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Recent empirical work has suggested two important patterns related to the effect of a status quo. The first is that status quo bias (the tendency to choose the status quo alternative) is more prevalent in larger choice sets (see Iyengar and Lepper [2000]). The second is that the introduction of a status quo can change choices between non-status quo alternatives (see Masatlioglu and Uler [2013]). We call the first pattern *choice overload* and the second *generalized status quo dependence*. While previous demonstrations of each effect have been affected by confounding factors, we provide clean evidence for both in section 4.

Existing models cannot explain both choice overload and generalized status quo dependence. The vast majority of models of status quo bias (SQB) focus on the role of the status quo as a reference point which affects preferences (examples include Tversky and Kahneman [1991] and Masatlioglu and Ok [2005]).<sup>1</sup> While such “preference based” models can generate generalized status quo dependence, they cannot explain choice overload. A much smaller literature has tried to capture the phenomenon of “decision avoidance”, by which the status quo may be chosen in order to avoid a difficult decision (Tversky and Shafir [1992], Dean [2009], Gerasimou [2012], Buturak and Evren [2014]). These models can capture choice overload but not generalized status quo dependence.

In this paper we consider an additional channel by which the status quo can affect choice: by focussing the DM’s attention on that alternative. This assumption naturally generates the prediction that SQB will be more prevalent in larger choice sets in which attention is relatively more scarce. By adding an attentional channel to a preference based model of status quo, we obtain a model that can capture both choice overload and generalized status quo dependence. We axiomatically characterize the resulting model of *limited attention with status quo bias* (LA-SQB). Using simple laboratory experiments we demonstrate that both channels are necessary for modelling the effect of status quo, and that the LA-SQB model does a good job of capturing the observed pattern of choice.

Our model is based on the assumption of limited consumer attention. There is extensive evidence from the marketing and economics literatures that attentional constraints are binding. When faced with a large or complicated set of options, consumers tend to focus their attention on a small number of alternatives - their *attention set*.<sup>2,3</sup> Attention sets can be very small in repeat-purchase situations in which there is a status quo option: Hoyer [1984] finds that 72% of consumers look at only one

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<sup>1</sup>Other examples of “preference based” models of status quo bias include Rubinstein and Zhou [1999], Sagi [2006] and Apesteguia and Ballester [2009].

<sup>2</sup>Attention sets are sometimes referred to as ‘consideration sets’ in the marketing literature.

<sup>3</sup>See for example Roberts and Lattin [1991], Hauser and Wernerfelt [1990], Caplin et al. [2011] and Santos et al. [2012].

package when they purchase laundry detergent in a supermarket. We make the assumption that attention is relatively more scarce in larger decision problems, so that if an alternative is considered in some choice set it will also be considered in any subset.

Status quo affects choice through two channels in our model. The first is by focussing attention: the status quo option always receives attention, even in choice sets where it would not do so were it not the status quo. This captures the idea that the DM is always aware of the default option - for example their current cellphone plan, or the laundry detergent they usually buy.<sup>4</sup> The second channel is through preferences: a status quo option may cause the DM to rule out some alternatives - for example due to a potential loss in some dimensions or possible regret considerations. As in Masatlioglu and Ok [2014], each status quo generates an associated *psychological constraint set* of alternatives that the DM is prepared to choose from given that status quo. The DM then chooses in order to maximize utility on the intersection of the attention set and the psychological constraint set.

We axiomatically characterize the LA-SQB model. Initially we do so under the simplifying assumptions that attention is complete in choice problems with two alternatives and that there is no indifference. In this case, the LA-SQB model is equivalent to three intuitive axioms. The first (*Pairwise Transitivity*) insists that pairwise choices are consistent with utility maximization. The second (*Contraction*) ensures that choice behavior does not contradict the assumption that the status quo is always considered. The third (*Consistency*) ensures that revealed preference information is consistent between choice problems with and without the status quo. We also use a revealed preference method to provide necessary and sufficient conditions for behavior to be consistent with a “generalized” LA-SQB model that need not satisfy these two simplifying assumptions.

We demonstrate using laboratory experiments that both the psychological constraint set and attention set are important in explaining the effect of status quo. We do so by considering two special cases of the LA-SQB model. The first is that of complete attention, which reduces our model to that of Masatlioglu and Ok [2014]. This restriction implies the Weak Axiom of Revealed Preference (WARP) amongst choices with a fixed status quo. The second special case is where no object is ever ruled out due to the psychological constraint sets, meaning that the status quo has only attentional effects. This implies the property of “Limited Status Quo Dependence”, which states that the choice from any decision problem must either be the status quo, or the option that would be chosen if there were no status quo. Existing preference-based models of SQB imply

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<sup>4</sup>A similar assumption is used in, for example, de Clippel et al. [2013].

WARP, while decision avoidance models imply Limited Status Quo Dependence.

We report the results of two experiments in which subjects made choices between lotteries. Status quo was generated using a two-stage procedure similar to that used by Samuelson and Zeckhauser [1988] – the choice a subject makes at the first stage becomes the status quo in a second stage choice. In the first experiment we show that subjects who do not select the status quo in small choice sets often switch to doing so in larger choice sets. This is in line with the Contraction axiom, but a violation of WARP and so implies that attention sets are necessary for our model to describe behavior. In the second experiment we show that Limited Status Quo Dependence also fails: the introduction of a somewhat risky status quo can lead people to choose a much riskier option. Thus, psychological constraint sets are also necessary to understand the impact of status quo on choice.

The paper is organized as follows. Next, we present a discussion of the related literature. Section 2 introduces the LA-SQB model. Section 3 discusses the implications of limited attention and psychological constraint functions. Section 4 describes the experimental set up and results.

## Literature Review

There is vast empirical and experimental evidence showing that the presence of an initial entitlement affects one’s choice behavior for a fixed set of available options. Classic references include Samuelson and Zeckhauser [1988] (medical insurance) Johnson et al. [1993] (car insurance) and Madrian and Shea [2001] (retirement savings).

Previous studies have suggested that “choice overload” is an important feature of status quo bias. Iyengar and Lepper [2000] report the results of an experiment in which displays of jam were set up in a local supermarket. In the “limited choice” treatment, 6 jams were available, whereas in the “extensive choice” treatment 24 were available. Iyengar and Lepper [2000] report that significantly more shoppers purchased jam in the former treatment than the latter. One natural interpretation of this observation is that shoppers were more likely to stick with the status quo of “no jam” in the extensive choice treatment. While other explanations are possible given that the experiment does not include changes in the status quo, we demonstrate in Section 4 that subjects are indeed more likely to choose the status quo in larger choice sets.<sup>5</sup>

Recent studies have also suggested that SQB is not the only phenomenon caused by an initial

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<sup>5</sup>See also Samuelson and Zeckhauser [1988], and Kempf and Ruenzi [2006] for an example from the mutual funds industry.

endowment: a status quo can also impact choice between non-status quo alternatives. Masatlioglu and Uler [2013] show that choice between two alternatives can be manipulated by changes in the nature of a dominated status quo. Again, these results are open to other interpretations: specifically there is not a clear distinction between the effect of the status quo and more general effects of choice set composition. However, we provide a robust demonstration of generalized status quo dependence in Section 4.

Due to the ubiquity of SQB, a huge variety of models has been introduced to explain reference-dependent choice with exogenously determined reference points. There include the loss aversion models of Tversky and Kahneman [1991], the status quo constraint models of Masatlioglu and Ok [2005, 2007, 2014],<sup>6</sup> the reference-dependent CES model of Munro and Sugden [2003], the reference-dependent SEU model of Sugden [2003], the anchored preference model of Sagi [2006] and the choice with frames models of Salant and Rubinstein [2008]. We classify all these models as “preference based”, meaning that the decision maker (DM) behaves *as if* they have a set of preference relations - one for each status quo - and then makes choices in order to maximize the relevant preference relation. Such models allow for choice reversals due to changes in the status quo, as well as generalized status quo dependence. However, under a fixed status quo, they all predict standard choice behavior and thus, are incommensurate with choice overload. We formalize this claim in section 3.

A smaller, more recent branch of the theoretical literature has tried to capture the concept of “decision avoidance” introduced by Tversky and Shafir [1992].<sup>7</sup> Decision avoidance implies that a DM will seek ways of trying to avoid having to make difficult decisions, potentially leading to status quo bias. Recent papers that try to axiomatically capture decision avoidance include Dean [2009], Gerasimou [2012] and Buturak and Evren [2014]. Such models can explain choice overload, since larger choice sets may be viewed by the DM as more complicated, and so lead to more decision avoidance. However, they cannot explain generalized status quo dependence. In these models, the status quo affects choice because it is what is chosen when the DM does not engage in the decision, and so cannot lead to changes in choice between non-status quo alternatives.<sup>8</sup>

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<sup>6</sup>See Tapki [2007], Houy [2007], Ortoleva [2010] extensions and variations of this class of models.

<sup>7</sup>A third strand of literature which has tried to explain choice overload relies on “contextual inference” (e.g. Kamenica [2008]), by which the DM makes inferences about the nature of available alternatives from features of the choice set. Kamenica [2008] does not discuss the impact of changes in the default option. Moreover, such models rely on the consumer drawing inferences based on the assumption that choice sets are determined by profit maximizing firms, which is not the case in our experiments.

<sup>8</sup>Buturak and Evren [2014] do not consider the impact of changes in the status quo, but a natural extension of their work to such cases would not allow for generalized status quo dependence.

Our paper is also related to the literature on limited attention. While classic choice theory assumes that decision-makers consider all available alternatives before they make decisions, there is ample evidence that this is not the case, leading to a recent interest in incorporating the idea of limited consideration into decision-making. One strand of this literature considers a two-stage choice process: the DM first eliminates several alternatives by a particular procedure to construct consideration sets and then makes a decision from the remaining alternatives. In Manzini and Mariotti [2007], the DM creates a shortlist by applying a rationale, which might be orthogonal to her preferences (Shortlisting). In Manzini and Mariotti [2012], an alternative is not considered if it belongs to an “inferior” category (Categorization). In Cherepavov et al. [2013], the DM eliminates alternatives which she cannot justify (Rationalization). In Salant and Rubinstein [2008], the decision-maker only considers the top  $n$  elements according to some ranking.

Lleras et al. [2010] and Masatlioglu et al. [2012] take a different approach. Each paper imposes a property on consideration sets rather than focusing on a particular algorithm by which such sets are generated. Neither of these models are designed to capture reference-dependent choice. Masatlioglu et al. [2012] is based on the concept of unawareness: If a consumer is not only unaware of a particular product, but is also unaware that she overlooks that product, then her consideration set stays same if that product is removed. Lleras et al. [2010] is based on the idea of competition among products. If a product does not grab the consumer’s consideration in a small convenience store with fewer rivals, then definitely it will not win her attention when more alternatives are introduced, say in a large supermarket. The attention sets in our model satisfy this property.

To our knowledge, the closest theoretical paper in the attention literature to ours is Masatlioglu and Nakajima [2013]. They provide a framework to study behavioral search by utilizing the idea of consideration sets. If we interpret the starting point of search as the default option, this model becomes a reference-dependent choice model. Masatlioglu and Nakajima [2013] allow for choice reversals even for a fixed status quo. However, as opposed to our model, they allow a choice pattern by which the DM chooses the status quo in the smaller set but not in the larger set, and they rule out the case of choosing the status quo in the larger but not the smaller choice set. Hence, their model is not consistent with the experimental evidence for choice overload.<sup>9</sup>

Experimentally, a paper concurrent to our own (Geng [2014]) uses data on consideration time to provides compelling evidence on the effect of a status quo on attention.

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<sup>9</sup>This is not surprising, as the aim of Masatlioglu and Nakajima [2013] is behavioral search rather than status quo bias.

## 2 Limited Attention with Status Quo Bias

### 2.1 Preliminaries

In what follows, we designate an arbitrary finite set  $\mathcal{X}$  to act as the universal set of all mutually exclusive alternatives. The set  $\mathcal{X}$  is thus viewed as the grand alternative space and is kept fixed throughout. The members of  $\mathcal{X}$  are denoted as  $x, y, z, \dots$ . We designate the symbol  $\diamond$  to denote an object that does not belong to  $\mathcal{X}$ , which will be used to represent the absence of a status quo option. We shall use the symbol  $\sigma$  to denote a generic member of  $\mathcal{X} \cup \{\diamond\}$ .

We let  $\Omega_{\mathcal{X}}$  denote the set of all non-empty subsets of  $\mathcal{X}$ . By a *choice problem*, we mean a list  $(S, \sigma)$  where  $S \in \Omega_{\mathcal{X}}$  and either  $\sigma \in S$  or  $\sigma = \diamond$ . The set of all choice problems is denoted by  $\mathcal{C}(\mathcal{X})$ . Given any  $x \in \mathcal{X}$  and  $S \in \Omega_{\mathcal{X}}$  with  $x \in S$ , the list  $(S, x)$  is called a *choice problem with a status quo*. The set of all such choice problems is denoted as  $\mathcal{C}_{sq}(\mathcal{X})$ . The interpretation is that the decision maker is confronted with the problem of choosing an alternative from the feasible set  $S$  while her default or status quo alternative is  $x$ . Viewed this way, choosing an alternative  $y \in S \setminus \{x\}$  means that the decision maker gives up her status quo  $x$  and switches to  $y$ .<sup>10</sup>

On the other hand, many real-life choice situations do not have a natural status quo alternative. Within the formalism of this paper, choice problems of the form  $(S, \diamond)$  model such situations. Given any  $S \in \Omega_{\mathcal{X}}$ , the list  $(S, \diamond)$  is called a *choice problem without a status quo*.<sup>11</sup>

For the majority of the paper we will assume that observable behavior is captured by a *choice function*, which reports exactly one chosen element from each choice problem. A choice function is therefore a function  $c : \mathcal{C}(\mathcal{X}) \rightarrow \mathcal{X}$ , such that

$$c(S, \sigma) \in S \quad \text{for every } (S, \sigma) \in \mathcal{C}(\mathcal{X}).$$

In Section 2.6, we relax this assumption and allow choice correspondences.

### 2.2 Model

The LA-SQB model consists of three elements - a *preference relation*, an *attention function* and a *psychological constraint function*.

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<sup>10</sup>In the language of Salant and Rubinstein [2008], any  $(S, x)$  in  $\mathcal{C}_{sq}(\mathcal{X})$  is a choice problem with a frame, where initial endowment  $x$  provides the “frame” for the problem. We assume throughout this paper that this frame is observable.

<sup>11</sup>While the use of the symbol  $\diamond$  is clearly redundant here, it will prove convenient in the forthcoming analysis.



The *preference relation* captures the decision maker's tastes over alternatives when there is no status quo. Denoted by  $\succ$ , the preference relation is a linear order over  $\mathcal{X}$ .<sup>12</sup> An alternative  $x$  is  $\succ$ -*best* in  $S$ , denoted  $x = \arg \max_{\succ} S$ , if  $x \succ y$  for each  $y \in S$ . Note that a linear order  $\succ$  has a unique  $\succ$ -best in each non-empty set  $S$ .

The *attention function* defines which alternatives in each choice set the DM pays attention to in the absence of a status quo. It defines for each choice set  $S$  the subset of alternatives to which the DM attends, denoted by  $\mathcal{A}(S)$ , which we term the attention set of  $S$ .

In order to capture the notion that attention is relatively more scarce in larger choice sets we assume that if an alternative attracts attention in a choice set  $S$ , it also attracts attention in subsets of  $S$  in which it is included. Lleras et al. [2010] make use of a similar identification assumption, and also describe a number of procedures which give rise to attention functions with this property. Generally, such procedures involve ranking alternatives according to some "attention ordering", then paying attention to the first  $n$  according to that ordering. Specific examples include choosing from the  $n$  cheapest alternatives, or from the first page of results on an internet search engine.

In addition we assume in the benchmark model that attention is complete in choice sets consisting of two elements. While this assumption is intuitive and plausible, we later drop it to extend the analysis to more general choice rules.

**Definition 1** *An attention function is a mapping  $\mathcal{A} : \Omega_{\mathcal{X}} \rightarrow \Omega_{\mathcal{X}}$  such that*

1.  $\mathcal{A}(S) \subseteq S$  for all  $S \in \Omega_{\mathcal{X}}$
2.  $x \in \mathcal{A}(S) \Rightarrow x \in \mathcal{A}(T)$  for all  $x \in T \subset S$
3.  $\mathcal{A}(S) = S$  for all  $|S| = 2$

In decision problems without a status quo, the consumer makes choices in order to maximize their preference ordering among options to which they pay attention. Due to the attention constraints captured by  $\mathcal{A}$ , it is possible that our consumer might not choose the preference maximizing option in  $S$  even at the absence of a status quo option.

The third component of our model is the *psychological constraint function*. This assigns to each alternative in  $x \in \mathcal{X}$  a subset of  $\mathcal{X}$ , which we interpret as the set of options that the DM

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<sup>12</sup> A binary relation  $\succ$  is a linear order over  $\mathcal{X}$  if it is *complete* (for each  $x, y \in \mathcal{X}$ ,  $x \succ y$  or  $y \succ x$ ), *transitive* ( $x \succ y$  and  $y \succ z$  imply  $x \succ z$ ), and *antisymmetric* ( $x \succ y$  and  $y \succ x$  imply  $x = y$ ).

is prepared to consider if  $x$  is the status quo. This is the psychological constraint set generated by  $x$  and it captures the fact that a status quo could affect the DM's preferences, causing them to eliminate options from consideration which they might have chosen in the absence of a status quo. We are agnostic about what it is that causes a status quo to “rule out” options that would be preferred in a choice without status quo. It could be (for example) due to transaction costs, an endowment effect, loss aversion along some dimension, or regret considerations. We adopt a general, canonical approach, and assume only that such constraints may exist (see Masatlioglu and Ok [2014] for further details). The only restriction we put on the psychological constraint function is that a status quo cannot rule itself out of consideration.

**Definition 2** *A psychological constraint function is a mapping  $\mathcal{Q} : \mathcal{X} \rightarrow \Omega_{\mathcal{X}}$  such that*

$$x \in \mathcal{Q}(x) \text{ for each } x \in \mathcal{X} \quad (1)$$

$\mathcal{Q}$  captures the impact of the status quo on choice via preferences. We further assume that the status quo has an effect through the channel of attention. Specifically, we assume that in every choice problem the decision maker is aware of the status quo. Thus, even if  $x$  is not in  $\mathcal{A}(S)$ , and so is not generally considered from the choice set  $S$ , it will be considered in the choice problem  $(S, x)$ . Thus the choice from such a problem will be the  $\succ$ -best option amongst the set of alternatives which both receive attention (*i.e.*  $\mathcal{A}(S) \cup \{x\}$ ) and are not ruled out by  $x$  due to preference effects (*i.e.*  $\mathcal{Q}(x)$ ).

We are now ready to introduce the model of limited attention with a status quo bias.

**Definition 3** *A choice function  $\mathbf{c}$  is consistent with the limited attention with status quo bias model (LA-SQB) if there exist a linear order  $\succ$ , psychological constraint function  $\mathcal{Q}$ , and attention function  $\mathcal{A}$  such that*

$$c(S, \diamond) = \arg \max_{\succ} \mathcal{A}(S) \quad (2)$$

*for each choice problem without a status quo  $(S, \diamond) \in \mathcal{C}(\mathcal{X})$  and*

$$c(S, x) = \arg \max_{\succ} (\mathcal{A}(S) \cup \{x\}) \cap \mathcal{Q}(x) \quad (3)$$

*for each choice problem with a status quo  $(S, x) \in \mathcal{C}_{sq}(\mathcal{X})$ .*

## 2.3 Axioms

We now introduce a set of axioms which are necessary and sufficient to guarantee that a data set is consistent with the LA-SQB model.

We begin by introducing a rationality property. This requires that preference maximization does take place in binary choices and in the absence of a status quo.

**Axiom 1 (*Pairwise transitivity*)** *If  $c(\{x, y\}, \diamond) = x$  and  $c(\{y, z\}, \diamond) = y$  then  $c(\{x, z\}, \diamond) = x$ .*

This axiom conditions the behavior of a decision maker across binary choice problems with no status quo. If  $x$  is chosen over  $y$  when there is no status quo, given that the DM pays attention to both alternatives, it is revealed that  $x$  is better than  $y$ . The axiom implies that there is no conflict (*i.e.* cycles) in these revelations.

**Axiom 2 (*Contraction*)** *If  $x = c(S, y)$ , then  $x = c(\{x, y\}, y)$ .*

This axiom compares the choice behavior across two nested choice problems with the same status quo. It is based on the idea that the status quo always attracts attention. If  $x$  is chosen from  $S$  when  $y$  is the status quo, we know that  $x$  is preferred to  $y$ , as for sure  $y$  was considered. This in turn implies that the DM chooses  $x$  in the binary comparisons with the status quo.

Contraction is a weaker version of the classical  $\alpha$ -Axiom (or Independence of Irrelevant Alternatives) in the framework of individual choice in the presence of an exogenously given reference alternative.<sup>13</sup> While it rules out a choice pattern by which the DM chooses the status quo in the smaller set but not in the larger set, it does not rule out the case of choosing the status quo in the larger but not the smaller choice set, which would also be a violation of the  $\alpha$ -Axiom. Furthermore, it imposes no restriction on the subsets of  $S$  except  $\{x, y\}$ . In other words, the axiom allows that  $x = c(S, y)$  and  $z = c(T, y)$  where  $\{x, z\} \subset T \subset S$  and  $z \neq y$ . This choice pattern might happen due to choice overload. While  $z$  is better than both  $x$  and  $y$ , the DM overlooks this alternative at  $S$ . When the choice problem gets smaller, she pays attention to  $z$  and chooses it.

Notice that the Contraction axiom does not apply to choice problems without a status quo. In other words, it is possible that we have  $y = c(\{x, y\}, \diamond)$  and  $x = c(S, \diamond)$  for some  $S \ni y$ . This is

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<sup>13</sup>As a reminder, the  $\alpha$  axiom for a fixed status quo  $x$  would say that, for  $y \in T \subset S \subseteq \mathcal{X}$ , if  $y \in C(S, x)$  then  $y \in C(T, x)$ .

again because of choice overload. When there are many alternatives in the choice set, the DM might overlook some alternatives, specifically  $y$ , and choose  $x$ . When the choice problem gets smaller, she pays attention  $y$  and chooses it.

**Axiom 3 (Consistency)** *If  $y = c(T, \sigma) = c(S', \sigma') \neq \sigma'$  and  $x = c(S, \sigma)$  and  $y \in S \subseteq S'$ , then  $x = c(\{x, y\}, \diamond)$ .*

Consistency relates revealed preference information in choice problems with and without a status quo alternative. Let  $\sigma'$  and  $y$  be two distinct alternatives. The observation  $y = c(S', \sigma')$  and  $y \in S \subseteq S'$  reveals that  $y$  attracts attention at  $S'$ , hence at any subset of it, particularly at  $S$ . The observation  $y = c(T, \sigma)$  reveals that the DM is prepared to move away from the status quo option,  $\sigma$ , in favor of  $y$ . This implies that  $\sigma$  does not “block”  $y$ . Therefore, from these two observations, we have learned that  $y$  is not overlooked when the budgets set is  $S$  and the status quo is  $\sigma$ . Since  $x$  is picked from the choice problem  $(S, \sigma)$ , we can conclude that  $x$  is preferred to  $y$ . The axiom states that this revelation should not conflict with binary choices made in the absence of a status quo.

### 2.3.1 Relation to Other Axioms

The consistency axiom implies that weak-WARP holds for choice problems without a status quo (Manzini and Mariotti [2007]). Weak WARP requires that

$$\text{if } x \neq y, \{x, y\} \subset S \subseteq S' \text{ and } y = c(S', \diamond) = c(\{x, y\}, \diamond), \text{ then } x \neq c(S, \diamond).$$

It says that if an alternative  $y$  is chosen in binary comparison with  $x$  as well as from a set  $S'$  containing  $x$ , then  $x$  cannot be chosen from any subset of  $S'$  including  $y$ . A violation of weak WARP would also lead to a violation of Consistency.<sup>14</sup>

Another implication of Consistency is the weak axiom of status quo bias (WSQB) of Masatlioglu and Ok [2014].<sup>15</sup> That is,

$$x = c(\{x, y\}, y) \text{ implies } x = c(\{x, y\}, \diamond)$$

and

$$y = c(\{x, y\}, \diamond) \text{ implies } y = c(\{x, y\}, y).$$

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<sup>14</sup> Assume  $y = c(S', \diamond) = c(\{x, y\}, \diamond)$  and  $x = c(S, \diamond)$ . This is a direct violation of Consistency if we set  $\sigma$  and  $\sigma'$  to  $\diamond$  and  $T = S'$ .

<sup>15</sup> The WSQB axiom in Masatlioglu and Ok [2014] is for choice correspondences. We adopt it for single valued choice correspondences.

These conditions capture the idea that making an option the status quo makes it more, rather than less attractive. The first clause says that if a DM is prepared to choose  $x$  over  $y$  when  $y$  is the status quo then they must also be prepared to do so when there is no status quo. The second states that if  $y$  is chosen over  $x$  when there is no status quo, then it must also be chosen when  $y$  is the status quo.

Claim 3 in *Appendix A* shows that axiom A3 implies the second condition. A similar implication holds for the first condition as well since, for binary choice sets, it is the contrapositive of the second.<sup>16</sup>

We can combine these two conditions to get the following axiom:

$$x = c(\{x, y\}, \sigma) \text{ implies } x = c(\{x, y\}, x).$$

It says that if an alternative is chosen over some other alternative when it is not the status quo, it must be again chosen if it is itself the status quo. That is, being the status quo can not hurt the relative ranking of an alternative. Hence, a DM who obeys the LA-SQB model might exhibit status quo bias, but does never exhibit status quo aversion.

## 2.4 Representation Theorem

We now state our main theorem, which shows that the axioms described above are necessary and sufficient for the LA-SQB model. In *Appendix B*, we additionally establish that these three axioms are logically independent.

**Theorem 1** *A choice function  $c$  satisfies A1-3 if and only if  $c$  is consistent with the LA-SQB model.*

We refer the interested reader to *Appendix A.1* for the detailed proof. Here, we provide a sketch of the general argument. It is straightforward to show that the LA-SQB model satisfies the given axioms. For the converse direction, the proof proceeds as follows. We first use binary choices to construct the preferences and the psychological constraint function. If  $x$  is chosen over  $y$  in the absence of a status quo (*i.e.* if  $x = c(\{x, y\}, \diamond)$ ), we say  $x \succ y$ . A1 and  $c$  being a function guarantee that  $\succ$  is a linear order. We then say  $x$  is in the psychological constraint set of  $y$  (*i.e.*  $x \in \mathcal{Q}(y)$ ) if

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<sup>16</sup>As can be seen in Claim 4 and the following discussion, our axioms also imply a generalization of the second condition to arbitrary choice sets, though not the first one.

$x$  is chosen from the pair  $\{x, y\}$  when  $y$  is the status quo. Finally, we say  $x$  is paid attention to in  $S$  (i.e.  $x \in \mathcal{A}(S)$ ) if either at  $S$  or at a superset of  $S$ ,  $x$  is chosen even though it is not the status quo. We then use A1-3 to show that at every choice problem, the alternative chosen by  $c$  uniquely maximizes  $\succ$  at the intersection of the attention and psychological constraint functions. We first prove this statement in binary choice problems. We then use A2-3 to extend it to larger sets.

## 2.5 Recovery of Preference, $\mathcal{Q}$ and $\mathcal{A}$

Our model has three components: the preferences, the psychological constraint function and the attention function. We now discuss how much we can learn about each of them from observed choice.

Revealed preference is trivial in our benchmark model due to the assumption that attention is complete in binary choice sets. This implies that observed choice in such sets in the absence of status quo ( $x = c(\{x, y\}, \diamond)$ ) uniquely identifies preferences. Formally, given  $c$ , let

$$x \succ_c y \text{ if } x = c(\{x, y\}, \diamond)$$

It is routine to show that  $\succ_c$  is a linear order if  $c$  is consistent with the LA-SQB model. Moreover,  $\succ_c$  is the only linear order with which the LA-SQB model can replicate  $c$ .

**Remark 1** (*Revealed Preference*) Suppose  $c$  is consistent with LA-SQB. Then  $x \succ y$  if and only if  $x \succ_c y$ .<sup>17</sup>

Next we illustrate the extent to which we can identify the psychological constraint function. Notice that generally there are many such functions consistent with the same choice data. To see this, assume  $x$  is the best alternative among all alternatives, that is  $x \succ_c y$  for all  $y \in \mathcal{X}$ . Then any set including  $x$  can serve as the psychological constraint set of  $x$  because  $c(S, x) = x$  for all such constraint sets. Therefore, we need to introduce a new definition for revealed psychological constraint. We say  $x$  is *revealed to be in the psychological constraint set* of  $y$  if every possible LA-SQB representation of a choice function agrees that  $x$  belongs to the psychological constraint set of  $y$ .

The identification of the revealed psychological constraint set relies only on decision problems in which the DM abandons the status quo.

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<sup>17</sup>All results in this section can be easily verified by the proof of Theorem 1.

**Remark 2** (*Revealed Psychological Constraint*) Suppose  $c$  is consistent with LA-SQB. Then  $x$  is revealed to be in the consideration set of  $y$  ( $x \in \mathcal{Q}(y)$ ) if and only if  $x = c(S, y)$  for some  $S \in \Omega_{\mathcal{X}}$ .

Finally, we identify the attention sets consistent with a choice function. As above, there might be multiple such sets representing the same choice function. We say  $x$  is *revealed to attract attention* at  $S$  if every possible LA-SQB representation of a choice function agrees that  $x$  belongs to the attention set of  $S$ .

If  $x = c(S, \sigma) \neq \sigma$ , we must conclude that  $x$  attracts attention at  $S$ . However, this is not the only observation we can use to learn about attention sets. If  $x = c(S', \sigma) \neq \sigma$ , and  $x \in S \subseteq S'$ , we know that  $x$  attracts attention at  $S'$  and so, by the choice overload assumption it also attracts attention at  $S$ .

**Remark 3** (*Revealed Attention*) Suppose  $c$  is consistent with LA-SQB and  $|S| \geq 3$ .<sup>18</sup> Then,  $x$  is revealed to attract attention at  $S$  if and only if  $x = c(S', \sigma) \neq \sigma$  for some  $S' \supseteq S \ni x$ .

## 2.6 A Generalized Model

We now demonstrate how to characterize the behavioral implications of the LA-SQB model without the simplifying assumptions of (i) full attention for binary choices and (ii) unique choice.

We first adjust our data set to reflect these changes. We now assume that we observe a nonempty-valued *choice correspondence*  $c : \mathcal{C}(\mathcal{X}) \Rightarrow \mathcal{X}$ , such that

$$c(S, \sigma) \subseteq S \quad \text{for every } (S, \sigma) \in \mathcal{C}(\mathcal{X}).$$

We also adjust the assumptions of our model. First, we relax the linear order structure on preference. A preference relation, denoted by  $\succsim$ , is a weak order over  $\mathcal{X}$ .<sup>19</sup> An alternative  $x$  is a  $\succsim$ -best in  $S$ , denoted  $x \in \arg \max_{\succsim} S$ , if  $x \succsim y$  for each  $y \in S$ . Note that we may now obtain multiple  $\succsim$ -best alternatives in any  $S$ .

We also adjust our concept of the attention function to remove the assumption of complete attention over binary choices.

**Definition 4** A general attention function is a mapping  $\mathcal{A} : \Omega_{\mathcal{X}} \rightarrow \Omega_{\mathcal{X}}$  such that

<sup>18</sup>Otherwise, the revelation is trivial because of the assumption of full attention in binary choice sets.

<sup>19</sup>A binary relation  $\succsim$  is a *weak order* over  $\mathcal{X}$  if it is *complete* and *transitive*.

1.  $\mathcal{A}(S) \subseteq S$  for all  $S \in \Omega_{\mathcal{X}}$
2.  $x \in \mathcal{A}(S) \Rightarrow x \in \mathcal{A}(T)$  for all  $x \in T \subset S$

The psychological constraint function is defined as before. Using these adjusted components, we can now define a generalized version of the LA-SQB model.

**Definition 5** *A choice correspondence  $c : \mathcal{C}(\mathcal{X}) \Rightarrow \mathcal{X}$  is consistent with the general LA-SQB (limited attention with status quo bias) model if there exist a weak order  $\succsim$ , psychological constraint function  $\mathcal{Q}$ , and general attention function  $\mathcal{A}$  such that*

$$c(S, \diamond) = \arg \max_{\succsim} \mathcal{A}(S)$$

for each choice problem without a status quo  $(S, \diamond) \in \mathcal{C}(\mathcal{X})$  and

$$c(S, x) = \arg \max_{\succsim} (\mathcal{A}(S) \cup \{x\}) \cap \mathcal{Q}(x)$$

for each choice problem with a status quo  $(S, x) \in \mathcal{C}_{sq}(\mathcal{X})$ .

Our characterization of the general LA-SQB model relies on identifying the various patterns of behavior which reveal preference. There are two behaviors which reveal that the DM strictly prefers  $x$  over a distinct alternative  $y$ :

1. Abandonment of the default:  $x \in c(S, y)$  and  $y \notin c(S, y)$ .
2. Choice reversal:  $x \in c(S, \sigma)$ ,  $y \notin c(S, \sigma)$ , and  $y \in c(S', \sigma') \cap c(T, \sigma)$  where  $y \in S \subseteq S'$  and  $y \neq \sigma, \sigma'$ .

The first choice pattern is straightforward:  $x$  is chosen,  $y$  is not, yet  $y$  must be considered, as it is the status quo. In the second choice pattern,  $y \in c(S', \sigma') \cap c(T, \sigma)$  reveals that  $y$  is in  $\mathcal{A}(S) \cap \mathcal{Q}(\sigma)$ . Since  $y$  is not chosen and  $x$  is chosen when  $\sigma$  is the status quo,  $x$  must be strictly better than  $y$ .

Note that similar patterns also identify revealed preference in the less general version of the LA-SQB model described in Section 2.2. While they are redundant when choices from binary sets completely reveal preferences (as in Section 2.2), in empirical applications it may still be useful to use the above conditions to recover preferences.



Any preference that can represent  $c$  must be consistent with the above revelations. Formally, given  $c$ , let

$$x \succ_c y \text{ if one of the above two choice patterns is observed.}$$

The binary relation  $\succ_c$  identifies the strict revealed preference information in the data. Indifference is identified by cases in which  $x$  and  $y$  are chosen at the same time:

$$x \sim_c y \text{ if } x, y \in c(S, \sigma)$$

In order for  $\succ_c$  and  $\sim_c$  to be consistent with a weak order, they must obey a standard acyclicity property:

**Axiom 4 (SARP)** *Let  $P$  be the transitive closure of  $\succ_c \cup \sim_c$ . Then if  $xPy$  it cannot be the case that  $y \succ_c x$ .*

The existence of such a weak order is in turn enough to allow for the construction of attention and psychological constraint functions that explain the data set.

**Theorem 2** *A choice correspondence  $c$  satisfies SARP if and only if  $c$  is consistent with the general LA-SQB model.*

We refer the interested reader to *Appendix A.2* for the detailed proof. Here, we provide a sketch of the general argument. It is straightforward to show that the generalized LA-SQB model satisfies SARP. For the converse direction, the proof proceeds as follows. We take a completion of the  $P$  above as the preference relation  $\succsim$  of the model. We say  $x$  is in the psychological constraint set of  $y$  (*i.e.*  $x \in \mathcal{Q}(y)$ ) if there is a set from which  $x$  is chosen when  $y$  is the status quo. We then say  $x$  is paid attention to in  $S$  (*i.e.*  $x \in \mathcal{A}(S)$ ) if either at  $S$  or at a superset of  $S$ ,  $x$  is chosen even though it is not the status quo. We then use SARP to show that at every choice problem, the alternatives chosen by  $c$  uniquely maximize  $\succsim$  at the intersection of the attention and psychological constraint functions.

### 3 Implications of Full Attention and Status Quo Independence

Our model simultaneously captures the effect of the status quo through preferences and through attention. In this section, we discuss the implications of shutting down either one of these channels.

We first discuss the implications of removing the psychological constraint set from the model, meaning that the status quo only impacts choice through the attention channel. The resulting model, which we call the *LA model*, is an extension of the limited attention model of Lleras et al. [2010], where an “almost neutral” status quo is added. Formally,

$$c(S, x) = \arg \max_{\succ} \mathcal{A}(S) \cup \{x\} \quad \text{and} \quad c(S, \diamond) = \arg \max_{\succ} \mathcal{A}(S) \quad (4)$$

where  $\mathcal{A}$  is an attention function in the sense of Definition 1.

Notice that the LA model is a special case of the LA-SQB model where for each  $x \in X$ ,  $\mathcal{Q}(x) = \mathcal{X}$ . The LA model allows only very limited interaction between the status quo and the choice. A status quo alternative can tilt the choice towards itself but not towards other alternatives. Hence, this restricted model satisfies the following Limited Status Quo Dependence (LSQD) axiom, while the LA-SQB model does not.

**Axiom 5 (*LSQD*)**  $c(S, x)$  is either equal to  $x$  or  $c(S, \diamond)$ .

Notice that LSQD rules out the type of generalized status quo dependence described in the introduction and demonstrated by the experiments of Masatlioglu and Uler [2013]. It also rules out a variety of other plausible choice behavior that one can observe in real life. Consider an individual who wishes to choose among three job offers,  $x, y$  and  $z$ , while being currently employed at  $z$  (job  $z$  is thus the status quo of the agent.) Suppose that the agent likes  $y$  better than both  $x$  and  $z$ , absent any reference effects, that is,  $c(\{x, y, z\}, \diamond) = y$ . On the other hand, perhaps because  $x$  dominates  $z$  from every dimension relevant to the agent, while  $y$  does not do so (say, the location of  $z$  is better than  $y$ ), the agent chooses  $x$  from the feasible set  $\{x, y, z\}$  when  $z$  is the status quo:  $c(\{x, y, z\}, z) = x$ .

$$z \neq c(S, z) \neq c(S, \diamond)$$

Such choice behavior, while intuitive, violates LSQD and it is forbidden by the LA model. In Section 4 we describe further experimental evidence of violations of LSQD.

We next consider the implications of eliminating limited attention from our model. The result, which we call the *SQB model*, has been thoroughly analyzed in the literature (Masatlioglu and Ok [2014]). It is formally defined as

$$c(S, x) = \arg \max_{\succ} \mathcal{Q}(x) \cap S \quad \text{and} \quad c(S, \diamond) = \arg \max_{\succ} (S) \quad (5)$$

where  $\mathcal{Q}$  is a psychological constraint function in the sense of Definition 2. This model is also a special case of our model where for each  $S$ , the attention set is  $\mathcal{A}(S) = S$ . That is, the DM always pays full attention to alternatives in  $S$ , absent any status quo effects.

A central property of the SQB model is that under a given status quo, it is consistent with utility maximization. Once a status quo alternative is fixed, the model satisfies WARP.

**Axiom 6 (WARP)** *If  $T \subseteq S$  and  $c(S, \sigma) \cap T \neq \emptyset$ , then  $c(S, \sigma) \cap T = c(T, \sigma)$ .*

The SQB model does not allow for the possibility that due to too many options, the DM might end up making inferior choices. In the SQB model, an expansion of the budget set always makes the DM better off since it provides an opportunity to find a better alternative. Hence, according to the SQB model more is always better. Yet, there is ample empirical evidence that an increase in the number of options might decrease the DM's satisfaction with the decision (Schwartz [2005]) or lead to no decision (Anderson [2006]).

The SQB model rules out choice overload of the type discussed in the introduction: an increase in the size of the choice set which leads the DM to switch to choosing the status quo - *i.e.*

$$y = c(S, y) \neq c(T, y) = x \text{ where } y \in T \subseteq S$$

Such behavior is clearly a violation of WARP: If some  $x \neq y$  is chosen at  $T$  then it must be in the psychological constraint set  $\mathcal{Q}(y)$ , and also be preferred to  $y$ . Both of these things are still true in set  $S$ , meaning there is no way  $y$  can be chosen from that set.

Note that the LA-SQB model allows for specific violations of WARP, in particular the choice overload pattern described above:  $x$  may drop out of the attention set at  $S$ , despite being noticed in  $T$ . This is not to say that any violation of WARP is allowable, as is clear from the Contraction axiom. For example, the LA-SQB model does not allow the following choice pattern:

$$y = c(S, y) \neq c(T, y) = x \text{ where } x \in S \subseteq T.$$

If  $x$  is being chosen from the bigger set  $T$  then we know that it is in  $\mathcal{Q}(y)$  and  $\mathcal{A}(T)$  and so  $\mathcal{A}(S)$ , and must also be preferred to  $y$ . This means that  $x$  is available for selection in  $S$ , and preferred to  $y$ , meaning that  $y$  cannot be chosen. Thus, the LA-SQB model allows for a choice overload type pattern, by which the DM violates WARP by switching to the status quo in larger choice sets, but not the reverse pattern, by which subjects switch away from the status quo to some previously available alternative as the choice set expands.

The LA-SQB model allows us to use choice patterns that are not allowed by either the LA or the SQB models. This, in turn, helps us make inferences about the DM's preferences. To demonstrate this point, assume  $x, y, z, w \in S \subset S'$  and consider a choice rule  $c$  which exhibits the following observations:

$$\begin{aligned} (O1) \quad x &= c(S, \diamond), \\ (O2) \quad y &= c(S', \diamond), \\ (O3) \quad z &= c(S', w). \end{aligned}$$

Note that these choices can not be explained by the LA or the SQB models. The SQB model does not allow the move from (O2) to (O1) since the preference reversal it exhibits violates WARP. Similarly, the move from (O2) to (O3) is not allowed by the LA model since the choice switches from  $y$  to a third alternative  $z$  as  $w$  becomes the status quo.<sup>20</sup>

The LA-SQB model not only allows such choices but uses them to deduce the DM's underlying preferences. The move from (O2) to (O1) reveals that  $x \succ y$ : since (by (O2))  $y$  attracts attention at  $S'$ , it must also attract attention at  $S$  and, since  $x$  is chosen at  $S$ , it must be that  $x \succ y$ . Additionally, the move from (O3) to (O2) reveals that  $y \succ z$ : since by (O3)  $z$  attracts attention at  $(S', w)$ , it also attracts attention at  $(S', \diamond)$  and, since  $y$  is chosen in the latter problem, it must be that  $y \succ z$ . Bringing these observations together, the LA-SQB model is thus able to deduce that the DM's preferences are  $x \succ y \succ z$ .

### 3.1 Existing Models, Limited Status Quo Dependence and WARP

In Section 1 we categorized existing models as either “preference based” or “decision avoidance” - claiming that the former could not capture choice overload and the latter could not capture generalized status quo dependence. We can now formalize these claims.

**Definition 6** *A **preference based** model of status quo bias consists of a set of complete preference relations*

$$\succsim_\sigma \text{ for all } \sigma \in \mathcal{X} \cup \diamond$$

*such that*

$$c(S, \sigma) = \{x \in S \mid x \succsim_\sigma y \text{ for all } y \in S\}.$$

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<sup>20</sup>One could further generalize the LA model to allow the attention set to depend on both the choice set and the status quo alternative:  $\mathcal{A}(S, \sigma)$ . While this model would allow the choice behavior in our example, it would have very little predictive power.

All the models of SQB discussed in Section 1 fall into this class. It is also clear that models in this class satisfy WARP, and so are incommensurate with choice overload.

Models of decision avoidance are harder to characterize neatly. However, Dean [2009] provides a canonical example. In this model, a decision maker is equipped with a possibly incomplete preference ordering  $\succsim$ . In any given choice set, if their preference ordering identifies a best alternative<sup>21</sup> then they will choose it. If not, then they find the decision difficult and try to avoid it by sticking with the status quo (if they have a suitable status quo). While such models are consistent with choice overload, they also imply LSQD and so are also inconsistent with the experimental evidence presented below.

## 4 Experiments

In this section we report the results of two experiments. The first examines the impact of changing the size of the choice set while keeping the status quo fixed. It is designed to test both WARP and the Contraction axiom, and thus whether the class of attention functions we introduce is necessary and sufficient to explain behavior. The second keeps the size of the choice set fixed and examines the impact of changing the status quo. It tests LSQD, and so whether a psychological constraint set is necessary to explain our data.

### 4.1 Experimental Design

The results described in this paper come from a sequence of experiments run at the Center for Experimental Social Sciences at New York University between January and October 2008. In all treatments subjects were asked to make choices from groups of lotteries presented to them on a computer terminal. Each lottery had either one or two prizes, varying in value from \$0 and \$45, and was represented on screen in the form of a bar graph.<sup>22</sup> Subjects each took part in between 13 and 28 rounds.<sup>23</sup> At the end of the experiment one round was selected at random for each subject and the subject played the lottery that was their final choice in that round for real money, in addition to a \$5 show up fee. On average, subjects earned \$12 in total, and the experiments lasted approximately 30 minutes.

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<sup>21</sup>i.e. an alternative  $x$  such that  $x \succsim y$  for all available  $y$ .

<sup>22</sup>An example of a typical screenshot is shown in Figure 1.

<sup>23</sup>The same sequence of experiments was used to generate the data reported in Dean [2009]. Therefore not all experimental questions are used in this paper.

In order to induce a “status quo” or default option for the subjects, we adapted a technique used by Samuelson and Zeckhauser [1988]. Subjects were offered choices in two stages, with their choice in the first stage becoming the status quo in the second stage. Thus a choice round consisted of two parts. First, the subject was presented with a group of three lotteries from which they were asked to make a choice. Having made this choice, their selected lottery was presented at the top of a screen along with a selection of other lotteries in a second stage. The subject could then click on a button marked “keep current selection” in order to keep the lottery selected in the first round, or could click on one of the new lotteries in order to select it. If they did click on a new lottery, they were offered the choice to either “change to selected lottery” or to “clear selection” (thus reselecting the status quo lottery). Figure 1 shows typical first and second stage screenshots.

NEW YORK UNIVERSITY

Please choose one of the lotteries below:

20% 40% 60% 80% 100%

☐ \$15 \$0

☐ \$2 \$0

☐ \$10 \$0

Continue

NEW YORK UNIVERSITY

You chose the following lottery:

20% 40% 60% 80% 100%

\$15 \$0

Click the 'Keep current selection' button to keep your selected lottery, or click on one of the lotteries below, then press 'Change to selected lottery' to switch:

20% 40% 60% 80% 100%

☐ \$6 \$20

☐ \$5 \$0

Keep current selection

In order to allow the experimenter to control the status quo in each round, the lotteries offered in the first stage of a status quo round consisted of a target lottery and two decoy lotteries. The decoy lotteries were designed to have expected values of less than half that of the target lottery, thus ensuring that the target lottery was almost always chosen, and so became the status quo in the next round. Any choice set/status quo pair in which a decoy lottery was chosen over a target

lottery was discarded. This method encompasses two key properties of a status quo: It is both the subject’s current selection and the object they receive if they do not make an active choice to change in the second round. Decision problems without status quo were implemented using a single stage.

To mitigate the effect of learning, no subject was presented with the same choice set on two separate occasions with different status quo alternatives. The order in which rounds were presented was reversed for half the subjects.

A sample set of instructions are included in the appendix.

## 4.2 Experiment 1: Changing the Size of the Choice Set

In the first experiment, we compare the behavior of subjects in two different choice problems:  $(\{x, y\}, y)$  and  $(S, y)$  with  $\{x, y\} \subset S$ . This allows us to test two important behavioral properties: WARP and Contraction. In this pair of choice problems, the former condition states that if  $x$  or  $y$  is chosen in  $S$ , then it must also be chosen in  $\{x, y\}$ . The latter states that if  $x$  is chosen in  $S$  then it must be chosen in  $\{x, y\}$ . However, if  $y$  is chosen in  $S$  then it may be that  $x$  is chosen in  $\{x, y\}$ . Thus, contraction allows for choice overload, while WARP does not. Clearly, Contraction is weaker than WARP. Observing the above choices will therefore allow us to categorize subjects into three groups: those that are consistent with both WARP and Contraction, those that are consistent with Contraction only (because they exhibit choice overload) and those that are consistent with neither.

In order to make our test more informative, we construct the set  $S$  by adding to  $\{x, y\}$  18 lotteries that are stochastically dominated by either  $x$  or  $y$ . Thus, we would expect (and indeed find) that most subjects will only choose  $x$  or  $y$  in the set  $S$ . We therefore categorize subjects as consistent with WARP if they either always choose  $x$  or always choose  $y$  and add a fourth category of subjects who choose a dominated option in  $S$ .

We report results from four groups of subjects, each of which made choices from a set  $\{x, y\}$  and a set  $S$ .<sup>24</sup> We made use of two pairs of lotteries, with each lottery being the status quo for one group of subjects. Table 1 reports the results of the experiment. Note that  $\{p_1, x_1; p_2, x_2\}$  refers to

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<sup>24</sup>In each case the two choice problems were separated in the experiment with other, unrelated choice problems.

a lottery which gives prize  $\$x_1$  with probability  $p_1$  and  $\$x_2$  with probability  $p_2$ .<sup>25</sup>

Choice Problem		# Subjects				
Status Quo	Alternate	WARP	Contraction	Neither	Dominated	Total
{0.3, 1; 0.7, 13}	{0.8, 4; 0.2, 20}	10	3	2	0	15
{0.8, 4; 0.2, 20}	{0.3, 1; 0.7, 13}	9	5	0	0	14
{0.8, 3; 0.2, 23}	{0.8, 4; 0.2, 20}	7	4	2	2	15
{0.8, 4; 0.2, 20}	{0.8, 3; 0.2, 23}	13	7	0	2	22
Total		39	19	4	4	66

59% of subjects were consistent with both WARP and Contraction. However, a significant fraction (29%) were consistent with Contraction but not WARP. Overall, 88% of subjects were consistent with our model, as were 94% of the subjects who did not choose a dominated alternative.

It is important to note that violations of WARP are skewed heavily towards consistency with Contraction. Given our design, if subjects were choosing randomly between undominated alternatives (for example in line with a Random Utility model), we would expect both possible types of violation to be equally common: *i.e.* the “Contraction” category should have as many subjects in as the “Neither” category. This hypothesis can be rejected at the 1% level.<sup>26</sup> We therefore conclude both that the LA-SQB model does a reasonable job of describing our data, and that allowing for limited attention (in the sense of weakening WARP to Contraction) improves the performance of the model significantly.

### 4.3 Experiment 2: Changing the Status Quo

Our second experiment demonstrates a particular type of generalized status quo dependence. Because this is also a failure of LSQD, it also demonstrates the need to include the psychological constraint set in our model. As a reminder, LSQD states that the only possible effect of making some object  $x$  the status quo is to cause people to switch to choosing  $x$  instead of choosing some other alternative. Experiment 2 contrasts this hypothesis with a particular type of generalized status quo dependence, in which the introduction of a risky status quo can increase a subject’s appetite for risk, and so potentially lead to a violation of LSQD. Such an effect has been suggested by the work of Koszegi and Rabin [2007].

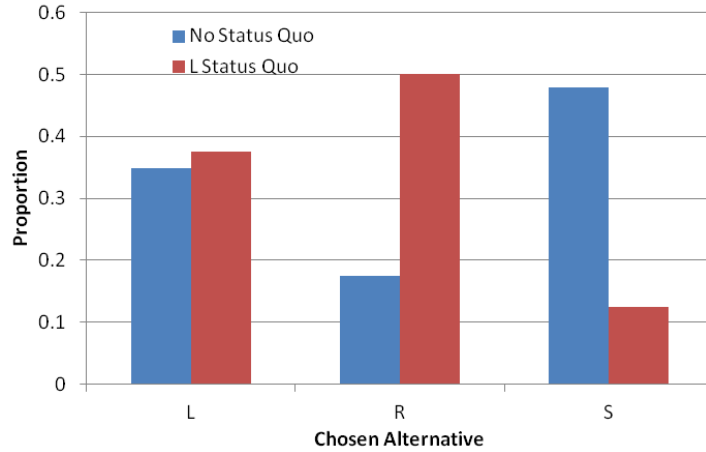
<sup>25</sup>2 subjects from choice problem 1, 3 from choice problem 2, 3 from choice problem 3 and 1 from choice problem 4 were dropped due to making dominated choices in the first stage questions designed to set up the status quo.

<sup>26</sup>Z test that the proportion of subjects in the two categories are equal.



In the experiment, we examine the choices of subjects between the lotteries  $\{0.5, 4; 0.5, 9\}$ ,  $\{0.8, 4; 0.2, 20\}$  and  $\{1.0, 6; 0, 0\}$ . Note that the first of these is a low risk lottery (with a mean payoff of 6.5 and a standard deviation of 2.5), the second is a higher risk lottery (mean 7.2, standard deviation 6.4) and the third is a sure thing (\$6 for sure). We will refer to these three lotteries as  $L$ ,  $R$  and  $S$  respectively.

Experiment 2 compares two treatments - one with no status quo, and one in which the status quo is lottery  $L$ . According to LSQD, the only effect of making  $L$  the status quo should be to increase the proportion of people choosing  $L$  at the expense of  $R$  and  $S$ . However, if the introduction of a risky status quo does increase risk attitudes, then the proportion of people choosing the lottery  $R$  could also increase. Figure 2 shows the result of experiment 2.



The results show a clear rejection of LSQD. When there was no status quo, 4 out of 23 (17%) subjects chose lottery  $R$  compared to 16 out of 32 when  $L$  is the status quo (50%). This difference is significant at 2% (Z test of equal proportion).

While this finding is incommensurate with the LSQD axiom and so the LA model, it is consistent with the LA-SQB model. What is required is that, for some subjects, the introduction of  $L$  as the status quo blocks the choice of  $S$  - *i.e.*  $S \notin \mathcal{Q}(L)$ . Then, if  $S \succ R \succ L$  we would observe that making  $L$  the status quo would lead the DM to switch their choice from  $S$  to  $R$ .

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## A Proofs

### A.1 The Benchmark Model: Proof of Theorem 1

**Claim 3** *Axiom 3 implies that  $x = c(\{x, y\}, x)$  whenever  $x = c(\{x, y\}, \diamond)$ .*

**Proof.** The statement trivially holds if  $x = y$ . Alternatively, let  $x \neq y$ . Assume  $x = c(\{x, y\}, \diamond)$  and suppose  $y = c(\{x, y\}, x)$ . Then,  $x = c(\{x, y\}, \diamond)$ ,  $x = c(\{x\}, x)$ , and  $y = c(\{x, y\}, x)$ , by Axiom 3, imply  $y = c(\{x, y\}, \diamond)$ , a contradiction. ■

We next show that if we assume Axiom 2 in addition to Axiom 3, we can strengthen the above claim for any arbitrary set. That is, if an alternative is chosen from  $S$  in the absence of status quo, then it will be chosen from  $S$  when it is itself the status quo.

**Claim 4** *Axioms 2 and 3 together imply that  $x = c(S, x)$  whenever  $x = c(S, \diamond)$ .*

**Proof.** Assume  $x = c(S, \diamond)$ . Let  $y \in S \setminus \{x\}$  and suppose  $y = c(S, x)$ . By Axiom 2,  $y = c(S, x)$  implies  $y = c(\{x, y\}, x)$ . This, by the previous claim, implies  $y = c(\{x, y\}, \diamond)$ . Now,  $y = c(S, x) \neq x$ ,  $y = c(\{x, y\}, \diamond)$ , and  $x = c(S, \diamond)$ , by Axiom 3, imply  $x = c(\{x, y\}, \diamond)$ . Since  $x \neq y$ , this contradicts  $y = c(\{x, y\}, \diamond)$ . ■

Our model (and axioms) however allows the choice pattern  $x = c(S, y)$  and  $x \neq c(S, \diamond)$  where  $x \neq y$ . For example, consider  $S = \{x, y, z\}$ ,  $z \succ x \succ y$ ,  $\mathcal{A}(S) = S$  and  $\mathcal{Q}(y) = \{x, y\}$ .

**THEOREM:** A choice function  $c$  satisfies A1-3 if and only if  $c$  is consistent with the LA-SQB model.

**Proof.** It is straightforward to show that a  $c$  that is consistent with the LA-SQB model satisfies the three axioms. For the converse, let  $c$  be a choice function that satisfies A1-3.

We first define the *preferences*. For each  $x, y \in \mathcal{X}$ , let  $x \succ y$  if  $c(\{x, y\}, \diamond) = x$ . Note that,  $x \succ x$  since  $x = c(\{x\}, \diamond)$ . Therefore,  $\succ$  is *complete*. Since  $c$  is a function,  $\succ$  is also *antisymmetric* ( $x = c(\{x, y\}, \diamond)$  and  $y = c(\{x, y\}, \diamond)$  implies  $x = y$ ). Finally, *Axiom 1* implies that  $\succ$  is *transitive*. Thus,  $\succ$  is a linear order over  $\mathcal{X}$ .

We now define the *psychological constraint function*  $\mathcal{Q}$ . For each  $x \in \mathcal{X}$ , let

$$\mathcal{Q}(x) = \{y \in \mathcal{X} \mid y = c(\{x, y\}, x)\}.$$

Note that  $x = c(\{x\}, x)$  implies  $x \in \mathcal{Q}(x)$ . Thus, Condition 1 is satisfied and  $\mathcal{Q}$  is a psychological constraint function.

Finally, we define the *attention function*. First, let  $\mathcal{A}(S) = S$  for each  $S \subseteq \mathcal{X}$  with  $|S| \leq 2$ , to satisfy Condition 3. For any other  $S \subseteq \mathcal{X}$ , we define

$$\mathcal{A}(S) = \{y \in S \mid y = c(S', \sigma') \neq \sigma' \text{ for some } (S', \sigma') \in \mathcal{C}(\mathcal{X}) \text{ such that } S \subseteq S'\}.$$

By this definition,  $y \in \mathcal{A}(S)$  and  $y \in T \subseteq S$  imply  $y \in \mathcal{A}(T)$ , satisfying conditions 1 and 2. Thus,  $\mathcal{A}$  is a collection of attention sets.

The representation trivially holds for singleton sets. We thus first prove that the representation holds for  $|S| = 2$ . Let  $S = \{x, y\}$  where  $x \neq y$  and note that  $\mathcal{A}(S) = S$ . To see representation (2), let  $x = c(\{x, y\}, \diamond)$ . This, by definition of  $\succ$ , implies  $x \succ y$ . By completeness of  $\succ$ , we also have  $x \succ x$ . Thus,  $x = \arg \max_{\succ} \mathcal{A}(S)$ . To see representation (3), we check two cases. First, let  $x = c(\{x, y\}, x)$ . Then  $y \notin \mathcal{Q}(x)$ . Thus  $(\mathcal{A}(S) \cup \{x\}) \cap \mathcal{Q}(x) = \{x\}$  and  $x = \arg \max_{\succ} (\mathcal{A}(S) \cup \{x\}) \cap \mathcal{Q}(x)$ . Second, let  $x = c(\{x, y\}, y)$ . Then  $x \in \mathcal{Q}(y)$  and thus,  $\mathcal{A}(S) \cap \mathcal{Q}(y) = \{x, y\}$ . Also, by Claim 3,  $x = c(\{x, y\}, y)$  implies  $x = c(\{x, y\}, \diamond)$ , that is,  $x \succ y$ . Since  $x \succ x$  holds by completeness of  $\succ$ , we have  $x = \arg \max_{\succ} (\mathcal{A}(S) \cup \{y\}) \cap \mathcal{Q}(y)$ .

Now assume that  $|S| > 2$ . First consider a choice problem  $(S, \diamond)$  without a status quo. Let  $x = c(S, \diamond)$ . By definition of  $\mathcal{A}$ ,  $x \in \mathcal{A}(S)$ . Now let  $y \in \mathcal{A}(S)$ . This implies  $y = c(S', \sigma') \neq \sigma'$  for some  $(S', \sigma') \in \mathcal{C}(\mathcal{X})$  such that  $S \subseteq S'$ . Also,  $y = c(\{y\}, \diamond)$ . Since  $x = c(S, \diamond)$ , Axiom 3 then implies  $x = c(\{x, y\}, \diamond)$ . Thus,  $x \succ y$  for each  $y \in \mathcal{A}(S)$ , implying  $x = \arg \max_{\succ} \mathcal{A}(S)$ . This proves representation (2).

Next consider a choice problem  $(S, z)$  with a status quo. Let  $x = c(S, z)$ .

First assume  $x = z$ . Note that then  $x \in (\mathcal{A}(S) \cup \{x\}) \cap \mathcal{Q}(x)$ . If  $|(\mathcal{A}(S) \cup \{x\}) \cap \mathcal{Q}(x)| = 1$ , representation (3) holds by completeness of  $\succ$ . Alternatively suppose there is  $y \in (\mathcal{A}(S) \cup \{x\}) \cap \mathcal{Q}(x)$  such that  $y \neq x$ . Now  $y \in \mathcal{A}(S)$  implies  $y = c(S', \sigma') \neq \sigma'$  for some  $(S', \sigma') \in \mathcal{C}(\mathcal{X})$  such that  $S \subseteq S'$ . Also,  $y \in \mathcal{Q}(x)$  implies  $y = c(\{x, y\}, x)$ . Thus,  $x = c(S, x)$ , by Axiom 3, implies  $x = c(\{x, y\}, \diamond)$ , that is,  $x \succ y$ . This implies  $x = \arg \max_{\succ} (\mathcal{A}(S) \cup \{x\}) \cap \mathcal{Q}(x)$ , establishing representation (3).

Next, assume  $x \neq z$ . Then  $x \in \mathcal{A}(S)$  by definition of  $\mathcal{A}$ . Also  $x = c(S, z)$ , by Axiom 2, implies  $x = c(\{x, z\}, z)$  and thus,  $x \in \mathcal{Q}(z)$ . Therefore,  $x \in (\mathcal{A}(S) \cup \{z\}) \cap \mathcal{Q}(z)$ . Also,  $x = c(\{x, z\}, z)$ , by Claim 3, implies  $x \succ z$ . Now let  $y \in \mathcal{A}(S) \cap \mathcal{Q}(z)$  such that  $y \neq z$ . Then,  $y \in \mathcal{A}(S)$  implies  $y = c(S', \sigma') \neq \sigma'$  for some  $(S', \sigma') \in \mathcal{C}(\mathcal{X})$  such that  $S \subseteq S'$ . Also,  $y \in \mathcal{Q}(z)$  implies  $y = c(\{y, z\}, z)$ .

Thus,  $x = c(S, z)$ , by Axiom 3, implies  $x = c(\{x, y\}, \diamond)$ , that is,  $x \succ y$ . Finally,  $x \succ x$  by completeness of  $\succ$ . Thus,  $x = \arg \max_{\succ} (\mathcal{A}(S) \cup \{z\}) \cap \mathcal{Q}(z)$ , that is, representation (3) holds for this case too. ■

## A.2 The General Model: Proof of Theorem 2

**Proof.** It is straightforward to show that a  $c$  that is consistent with the LA-SQB model satisfies SARP. For the converse, let  $c$  be a choice correspondence that satisfies the axiom. SARP guarantees that  $P$  exists.

Let  $\succsim$  be a completion of  $P$ . By definition,  $\succsim$  is complete and transitive. We now define the *psychological constraint function*  $\mathcal{Q}$ . For each  $x \in \mathcal{X}$ , let

$$\mathcal{Q}(x) = \{y \in \mathcal{X} \mid y \in c(S, x) \text{ for some } (S, x) \in \mathcal{C}(\mathcal{X})\}.$$

Note that  $\{x\} = c(\{x\}, x)$  implies  $x \in \mathcal{Q}(x)$ . Thus, *Condition 1* is satisfied and  $\mathcal{Q}$  is a *psychological constraint function*. Finally, we define the *attention function* as follows:

$$\mathcal{A}(S) = \{y \in S \mid y \in c(S', \sigma) \text{ for some } (S', \sigma) \in \mathcal{C}(\mathcal{X}) \text{ such that } S \subseteq S' \text{ and } y \neq \sigma\}.$$

By this definition,  $y \in \mathcal{A}(S)$  and  $y \in T \subseteq S$  imply  $y \in \mathcal{A}(T)$ , satisfying *Condition 2*. Thus,  $\mathcal{A}$  is an attention function.

We next show that for each  $(S, \diamond) \in \mathcal{C}(\mathcal{X})$

$$c(S, \diamond) = \arg \max_{\succsim} \mathcal{A}(S).$$

First, let  $x \in c(S, \diamond)$  and  $y \in \mathcal{A}(S)$ . If  $y \in c(S, \diamond)$ , this by definition of  $\sim_c$  implies that  $x \succsim y$ . Alternatively assume  $y \notin c(S, \diamond)$ . Since  $y \in \mathcal{A}(S)$ , there is  $(S', \sigma') \in \mathcal{C}(\mathcal{X})$  such that  $S \subseteq S'$ ,  $y \in c(S', \sigma')$  and  $y \neq \sigma'$ . Since  $y \in c(\{y\}, \diamond)$ , this by “choice reversal”, implies  $x \succ_c y$ . Thus we conclude  $x \succ y$ .

Next, let  $x \in \mathcal{A}(S)$  be such that  $x \succsim y$  for each  $y \in \mathcal{A}(S)$ . Suppose  $x \notin c(S, \diamond)$ . Let  $y \in c(S, \diamond)$ . Now  $x \in \mathcal{A}(S)$  implies there is  $(S', \sigma') \in \mathcal{C}(\mathcal{X})$  such that  $x \in c(S', \sigma')$ ,  $S \subseteq S'$ , and  $x \neq \sigma'$ . Also,  $x \in c(\{x\}, \diamond)$ . These, by “choice reversal” imply that  $y \succ_c x$ , which by SARP contradicts  $x \succsim y$ . To see this, note that  $x \succsim y$  by definition implies [not  $xPy$  and not  $yPx$ ] or  $xPy$ . Since  $y \succ_c x$ , by definition of  $P$ , [not  $xPy$  and not  $yPx$ ] is not possible. Thus,  $xPy$ . This, by SARP, implies not  $y \succ_c x$ , a contradiction.

Finally, we show that for each  $(S, z) \in \mathcal{C}(\mathcal{X})$

$$c(S, z) = \arg \max_{\succsim} (\mathcal{A}(S) \cup \{z\}) \cap \mathcal{Q}(z).$$

First, let  $x \in c(S, z)$ . If  $x = z$ , completeness of  $\succsim$  implies  $x \succsim z$ . Alternatively if  $x \neq z$ , by “abandonment of default” we have  $x \succ_c z$  and thus,  $x \succsim z$ . Next, let  $y \in \mathcal{A}(S) \cap \mathcal{Q}(z)$  be such that  $y \neq z$ . If  $y \in c(S, z)$ , this by definition of  $\sim_c$  implies  $x \succsim y$ . Alternatively assume  $y \notin c(S, z)$ . Since  $y \in \mathcal{A}(S)$ , there is  $(S', \sigma') \in \mathcal{C}(\mathcal{X})$  such that  $y \in c(S', \sigma')$ ,  $S \subseteq S'$ , and  $y \neq \sigma'$ . Since  $y \in \mathcal{Q}(z)$ , there is  $(T, z) \in \mathcal{C}(\mathcal{X})$  such that  $y \in c(T, z)$ . By “choice reversal”, these together imply  $x \succ_c y$ , and thus  $x \succsim y$ .

Next, let  $x \in (\mathcal{A}(S) \cup \{z\}) \cap \mathcal{Q}(z)$  be such that  $x \succsim y$  for all  $y \in (\mathcal{A}(S) \cup \{z\}) \cap \mathcal{Q}(z)$ . Suppose  $x \notin c(S, z)$ . Let  $y \in c(S, z)$ . If  $x = z$ , by “abandonment of default” we have  $y \succ_c x$ , which by SARP contradicts  $x \succsim y$ . Alternatively if  $x \neq z$ , then  $x \in \mathcal{A}(S)$  and thus, there is  $(S', \sigma') \in \mathcal{C}(\mathcal{X})$  such that  $x \in c(S', \sigma')$ ,  $S \subseteq S'$ , and  $x \neq \sigma'$ . Also  $x \in \mathcal{Q}(z)$  and thus, there is  $(T, z) \in \mathcal{C}(\mathcal{X})$  such that  $x \in c(T, z)$ . By “choice reversal”, these together imply  $y \succ_c x$ , which by SARP contradicts  $x \succsim y$ . ■

## B Independence of the axioms

We present three examples which demonstrate that axioms A1-3 of Theorem 1 are logically independent. In each one of the following tables,  $X = \{x, y, z\}$ . Each row represents a 2 or 3 element subset  $S$ . Each column represents a possible value of the status quo.

**Example 1** *A choice rule that satisfies all axioms of Theorem 1 but A1:*

$(S, \sigma)$	$\diamond$	$y$	$x$	$z$
$xyz$	$x$	$y$	$x$	$z$
$xy$	$x$	$y$	$x$	-
$xz$	$z$	-	$x$	$z$
$yz$	$y$	$y$	-	$z$

*The violation of A1 occurs due to the triple  $x = c(\{x, y\}, \diamond)$ ,  $y = c(\{y, z\}, \diamond)$  and  $z = c(\{x, z\}, \diamond)$ .*



**Example 2** A choice rule that satisfies all axioms of Theorem 1 but A2:

$(S, \sigma)$	$\diamond$	$y$	$x$	$z$
$xyz$	$x$	$y$	$x$	$y$
$xy$	$x$	$y$	$x$	-
$xz$	$x$	-	$x$	$z$
$yz$	$z$	$y$	-	$z$

The violation of A2 occurs due to the pair  $y = c(\{x, y, z\}, z)$  and  $z = c(\{y, z\}, z)$ .

**Example 3** A choice rule that satisfies all axioms of Theorem 1 but A3:

$(S, \sigma)$	$\diamond$	$y$	$x$	$z$
$xyz$	$x$	$y$	$x$	$z$
$xy$	$x$	$x$	$x$	-
$xz$	$x$	-	$x$	$z$
$yz$	$y$	$y$	-	$z$

The violation of A3 occurs due to  $x = c(\{x, y, z\}, \diamond) = c(\{x, y\}, y)$ ,  $y = c(\{x, y, z\}, y)$  and  $y \neq c(\{x, y\}, \diamond)$ .



NEW YORK UNIVERSITY

## Welcome

You are about to participate in an experimental session designed to study decision making. You will be paid for your participation with cash vouchers at the end of the session. What you earn will depend partly on your decisions and partly on chance. Anything you earn from the experiment will be added to your show-up fee of \$5.

Please turn off pagers and cellular phones now.

The entire session will take place through your computer terminal. Please do not talk or in any way communicate with other participants during the session.

We will start with a brief instruction period. During this instruction period, you will be given a description of the main features of the session and will be shown how to use the program. If you have any questions during this period, please raise your hand.

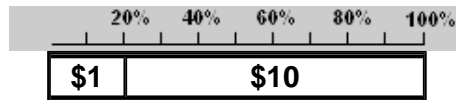
After you have completed the experiment, **please remain quietly seated until everyone has completed the experiment.**

Next



## Instructions

Thank you very much for taking part in our experiment. Over the course of the experiment, you will be asked to make choices amongst lotteries. These lotteries will be represented by bar charts, like the one below:

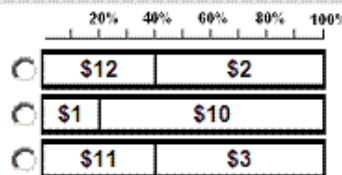


This lottery has a 20% chance of paying \$1 and an 80% chance of paying \$10.

The experiment consists of 19 or 20 rounds. In each round you will first be asked to choose one lottery from a group of alternatives. Sometimes, that will be the end of the round. The choice that you make at this first stage will be recorded as your final choice for that round. However, in other rounds, after you have made your choice, you will be presented with a second group of lotteries. You will have the opportunity to exchange the lottery you chose in the first stage for one of these new lotteries, or to stick with your original choice. The lottery you choose at this time will be your 'final choice' for that round. At the end of the experiment, one round will be selected at random, and you will play your 'final choice' from that round for real money.

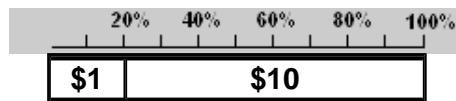
The following is an example of a round in which you are given the option to exchange your lottery. Imagine that in round 8 you are initially offered the following choices:

Please choose one of the lotteries below:



Continue

and you chose:



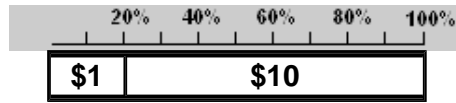
You would then be offered the chance to keep this lottery, or exchange it for some other lotteries such as these:

Click the 'Keep current selection' button to keep your selected lottery, or click on one of the lotteries below, then press 'Change to selected lottery' to switch:



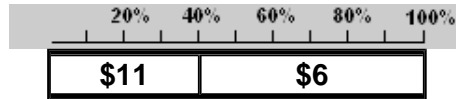
Keep current selection

If you chose to stick with your original choice, and round 8 was the randomly selected round for payment, then you would play the lottery:



for real money. In other words, you would have a 20% chance of earning \$1 for this part of the experiment and an 80% chance of earning \$10 for this part of the experiment.

Alternatively, if you chose to switch to:



and round 8 was randomly selected, then you would have a 40% chance of earning \$11 for this part of the experiment and a 60% chance of earning \$6 for this part of the experiment.

Whichever amount you win will be added to your \$5 show-up fee.

Continue