LIMITED ATTENTION AND STATUS QUO BIAS*

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October 31, 2016

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 findings 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 show that the interaction of the two effects has important economic implications, and 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

*With thanks to Yunus Aksoy, Emre Özdenören, Ron Smith and seminar participants at Brown University, Sabancı University, University of Southern Denmark, London Business School, and Birkbeck. Funding for the experiments described in the paper provided by the Center for Experimental Social Science, New York University.

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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.

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 Samuelson and Zeckhauser [1988], Redelmeier and Shafir [1995] and Kempf and Ruenzi [2006] as well as Section 4 of this paper). The second is that the introduction of a status quo can change choices between non-status quo alternatives. For example, Herne [1998] and Masatlioglu and Uler [2013] show that, in choices between bundles of goods x and y, the introduction of a status quo s which is dominated by x but not by y can lead people to switch their choices from y to x. We call the first pattern *increasing status quo prevalence* and the second *general status quo dependence*. While previous demonstrations of each effect have been affected by confounding factors, we provide clean experimental evidence for both in Section 4.

Existing models cannot explain both increasing status quo prevalence and general 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 alters preferences (examples include Tversky and Kahneman [1991], and Masatlioglu and Ok [2005, 2014]). These models predict a "constant status quo prevalence" where the impact of the status quo is independent of the menu-size.[1] While such constant status quo prevalence models can generate general status quo dependence, they cannot explain increasing status quo prevalence. 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 [2016], Buturak and Evren [2014]). These models can capture increasing status quo prevalence but not general 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 constant status quo prevalence model, we capture both increasing status quo prevalence and general 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 modeling the effect of status quo, and that the LA-SQB model does a good job of capturing the observed pattern of choice.

[1] Other examples of "constant status quo prevalence" models include Rubinstein and Zhou [1999], Sagi [2006] and Apesteguia and Ballester [2009].

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*.[2,3] 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 package when they purchase laundry detergent in a supermarket. We operationalize the assumption that attention is relatively more scarce in larger decision problems by demanding 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.[4] 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 *(Less is More)* ensures that, a choice from a smaller menu takes precedence over a choice from a larger menu in terms of revealed preference. 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.

In order to demonstrate the importance of the LA-SQB model, we consider two special cases where precisely one of the two channels through which the status quo can affect choice is shut off. The first case 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

[2] Attention sets are sometimes referred to as 'consideration sets' in the marketing literature.

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

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

quo.

The interplay between Status Quo Bias and Limited Attention produces economically relevant behavioral patterns that are not predicted by either phenomena alone. To demonstrate this, we consider a simple dynamic setting in which the choice of a decision maker in one period becomes the status quo in another. In such a situation, policy makers or firms may wish to *dynamically* adjust the set of alternatives available to a consumer. This will allow them to guide the decision maker to choices that they could not achieve with a single, fixed choice set. We demonstrate this effect with two examples, the first involving a government trying to ensure that people will buy high quality health insurance, the second an entrant trying to lure customers away from an incumbent.

Finally, 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 2.6 studies transitivity of psychological constraint functions. Section 4 describes the experimental set up and results.

Literature Review

There is a great deal of 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 provided evidence for the fact that status quo bias increases in larger choice sets (see for example Samuelson and Zeckhauser [1988], Redelmeier and Shafir [1995], Kempf and Ruenzi [2006]). In section 4 we augment these results by showing in an incentivized experiment how randomly assigned status quo alternatives have a larger effect as the size of the choice set increases. Potentially related is the more general phenomenon of 'choice overload', by which larger choice sets can lead people to make worse decisions according to some metric (see Chernev et al. [2015] for a review). For example, Iyengar and Lepper [2000] report the results of an experiment which shows the impact of choice set size on 'choice deferral': supermarket customers were more likely to purchase jam when offered a selection of 6 than a selection of 24. Choice deferral and status quo bias have both been classified as types of 'decision avoidance' by psychologists (see Anderson [2006]).[5]

Recent studies have also suggested that SQB is not the only phenomenon caused by an initial endowment: a status quo can also impact choice between non-status quo alternatives. Herne [1998] and Masatlioglu and Uler [2013] show that choice between two alternatives can be manipulated by changes in the nature of a dominated status quo. 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 general 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. These include the loss aversion models of Tversky and Kahneman [1991], the status quo constraint models of Masatlioglu and Ok [2005, 2007, 2014],[6] 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 general status quo dependence. However, under a fixed status quo, they all predict standard choice behavior and thus, are incommensurate with increasing status quo prevalence. 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].[7] 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 [2016] and Buturak and Evren [2014]. Such models can explain increasing status quo prevalence, since larger choice sets may be viewed by the DM as more complicated, and so lead to more decision avoidance. However, they cannot explain general 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.[8]

[5]There is also recent empirical evidence for a phenomenon called choice fatigue: making more choices prior to a particular decision increases SQB as well as the likelihood of abstention. For example, Augenblick and Nicholson [2016] analyze US voting data and demonstrate evidence of choice fatigue. One interpretation of this finding is that choice fatigue reduces the attention the DM pays to a given choice problem, making it more likely that the the status quo is the best item in the consideration set.

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

[7]A third strand of literature which has tried to explain increasing status quo prevalence 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.

[8]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 general 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 two-stage choice procedures: the DM first uses some procedure to eliminate alternatives in order to construct a 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 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 increasing status quo prevalence.[9]

Experimentally, a paper concurrent to our own (Geng [2016]) uses data on consideration time to provide compelling evidence on the effect of a status quo on attention. Using Mouselab software, Geng [2016] shows that default (i.e. status quo) alternatives are more likely to be looked at by experimental subjects, and are looked at for longer periods of time.

[9]This is not surprising, as the aim of Masatlioglu and Nakajima [2013] is to study 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. 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 σ 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, σ) 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.

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*.[10]

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 $c : \mathcal{C}(\mathcal{X}) \to \mathcal{X}$, such that

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

In Section 2.7, 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.*

The *preference relation* captures the decision maker's tastes over alternatives when there is no status quo. Denoted by $\succeq$, the preference relation is a linear order over $\mathcal{X}$.[11] An alternative x is $\succeq$-best in S, denoted $x = \arg\max_{\succeq} S$, if $x \succeq y$ for each $y \in S$. Note that a linear order $\succeq$ has a unique $\succeq$-best in each non-empty set S. Let $\succ$ be the strict preference relation associated with $\succeq$.

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

[10] While the use of the symbol $\diamond$ is clearly redundant here, it will prove convenient in the forthcoming analysis.

[11] A binary relation $\succeq$ is a linear order over $\mathcal{X}$ if it is *complete* (for each $x, y \in \mathcal{X}$, $x \succeq y$ or $y \succeq x$), *transitive* ($x \succeq y$ and $y \succeq z$ imply $x \succeq z$), and *antisymmetric* ($x \succeq y$ and $y \succeq x$ imply $x = y$).

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* $\mathcal{A} : \Omega_{\mathcal{X}} \to \Omega_{\mathcal{X}}$ *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* $x \in X$ *and* $S, T \in \Omega_{\mathcal{X}}$ *such that* $x \in T \subseteq S$,
3. $\mathcal{A}(S) = S$ *for all* $S \in \Omega_{\mathcal{X}}$ *such that* $|S| = 2$.

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 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 choices, 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.[12]

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

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

[12]A plausible restriction one can additionally impose on $\mathcal{Q}$ is transitivity (*i.e.* $x \in Q(y)$ and $y \in Q(z)$ implies $x \in Q(z)$) (*e.g.* see Masatlioglu and Ok [2014]). While this additional assumption increases the predictive power of our model, it limits its explanatory power. For example, Masatlioglu and Ok [2014] provide examples where it is desirable for $\mathcal{Q}$ to be intransitive. Due to this trade-off, we initially analyze an unstructured $\mathcal{Q}$, but later explore the case of a transitive $\mathcal{Q}$ in Section 2.6.

Additional to its effect through the psychological constraint function $\mathcal{Q}$, we further assume that the status quo effects choice 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 $\succeq$-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 psychological considerations (*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 c is consistent with the limited attention with status quo bias model (LA-SQB) if there exist a linear order $\succeq$, psychological constraint function $\mathcal{Q}$, and attention function $\mathcal{A}$ such that*

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

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

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

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 α-Axiom (or Independence of Irrelevant Alternatives) in the framework of individual choice in the presence of an exogenously given reference alternative.[13] 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 is also a violation of the α-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 $\{x, z\} \subset T \subset S$. This choice pattern might happen due to increasing scarcity of attention in larger choice sets. 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 again because of reduced attention. 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 to y and chooses it.

Our next axiom is related to the "less is more" idea (e.g. see Lleras, 2010) which states that a choice x from a smaller menu S takes precedence over a choice $y \neq x$ from a larger menu $S' \supset S \supset \{x, y\}$ in terms of revealed preference. That is, if there is a choice reversal between smaller and larger menus, in a binary comparison the choice from the smaller menu will be chosen over the choice from the larger menu. For choice problems without a status quo, this axiom can be written as follows:

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

The same idea should also be applicable to choice problems with a fixed status quo σ:

$$x = c(S, \sigma) \text{ and } y = c(S', \sigma) \text{ implies } x = c(\{x, y\}, \diamond).$$

The following formulation generalizes this idea across menus with potentially different status quo alternatives. That is, for $S' \supseteq S$,

$$x = c(S, \sigma) \text{ and } y = c(S', \sigma') \text{ implies } x = c(\{x, y\}, \diamond).$$

However, this formulation is too strong. To see this, consider a decision maker who always chooses the status quo alternative at both σ and σ' without any deliberation. By looking at her choices, we cannot conclude anything, let alone $x = c(\{x, y\}, \diamond)$; yet, the above formulation does so. We will therefore weaken the above statement by additionally requiring (i) $y \neq \sigma'$ and (ii) $y = c(T, \sigma)$ for some T. These requirements make sure that the decision maker is prepared to choose some alternative other than her status quo at both σ and σ'. In addition, the second requirement reveals that y is a desirable option compared to the status quo σ whenever $y \neq \sigma$. Given these two restrictions, the axiom tells us that "less is more."

[13] As a reminder, the α axiom for a fixed status quo x would say that, for $y \in T \subset S \subseteq \mathcal{X}$, if $y = c(S, x)$ then $y = c(T, x)$. Sen [1977] also proposed a weaker version, the $\alpha 2$ axiom, which adds to the previous statement the restriction that $T = \{x, y\}$. Note that our Contraction axiom is also weaker than Sen's $\alpha 2$.

Axiom 3 ***(Less is More)*** *Assume* $\{x, y\} \subseteq S \subseteq S'$, $y \neq \sigma'$ *and* $y = c(T, \sigma)$ *for some* T. *Then*

$$x = c(S, \sigma) \text{ and } y = c(S', \sigma') \text{ implies } x = c(\{x, y\}, \diamond).^{14}$$

Notice that this axiom is a necessary condition for our model. To see this, let σ' 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 that σ does not "block" y, and so y is in the psychological constraint set of σ Therefore, from these two observations, we have learned that y is not overlooked when the choice set is S and the status quo is σ. Since x is picked from the choice problem (S, σ), 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.

2.4 Representation Theorem

Our main theorem states that the axioms described above are both necessary and sufficient for the LA-SQB model.

Theorem 1 *A choice function c satisfies Pairwise Transitivity, Contraction and Less is More 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.[15] Here, we provide a sketch of the sufficiency argument. 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 $x \succeq y$. Pairwise Transitivity and c being a function guarantee that $\succeq$ is a linear order. We then say x is in the psychological constraint set of y (*i.e.* $x \in \mathcal{Q}(y)$) if 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 show that at every choice problem, the alternative chosen by c uniquely maximizes $\succeq$ at the intersection of the attention and psychological constraint functions. We first prove this statement in binary choice problems. We then use Contraction and Less is More axioms 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

[14] Note that our formulation allows $S = S'$. In previous formulations where the status quo option was fixed, this would create illogical consequences and was thus, ruled out. Due to the possibility of $\sigma \neq \sigma'$ in this axiom, this is not the case. Furthermore, allowing $S = S'$ creates additional bite. For example, as will be discussed in the next section, we can then conclude that $x = c(\{x, y\}, \diamond)$ implies $x = c(\{x, y\}, x)$.

[15] In Appendix B, we additionally establish that these three axioms are logically independent.

choice. Since there might be multiple representations of the same choice, we need formally define what we mean by revealed preference, attention and psychological constraint.

Definition 4 *Assume c is consistent with the LA-SQB model and there are k different $(\succ_i, \mathcal{A}_i, \mathcal{Q}_i)$ triplets representing c for $1 \leq i \leq k$. In this case,*

- *x is revealed to be preferred to y if $x \succ_i y$ for all i,*
- *x is revealed to attract attention at S if $\mathcal{A}_i(S)$ includes x for all i,*
- *x is revealed to be in the psychological constraint set of y if $\mathcal{Q}_i(y)$ includes x for all i.*

This definition is very conservative. For example, we say x is revealed to be preferred to y only when all possible representations agree on it. Similarly we say x attracts attention at S only when all possible representations include x in their attention sets. That is, no matter which LA-SQB representation of a choice data we choose to employ, x should be in $\mathcal{A}(S)$. If there is even one possible representation of choice data where x is excluded from the attention set of S, we refrain from stating revealed attention This conservative approach means that we do not make any claims that are not fully implied by the data.

If one wants to know whether x is revealed to be preferred to y, it would appear necessary to check for every $(\succ_i, \mathcal{A}_i, \mathcal{Q}_i)$ whether it represents her choice or not. However, this is not practical especially when there are many alternatives. Instead we shall now provide a method to obtain revealed preferences, attention and psychological constraints.

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

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

where the subscript b indicates the use of binary choice data. It is routine to show that $\succeq_{cb}$ is a linear order if c is consistent with the LA-SQB model. Moreover, $\succeq_{cb}$ 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 is revealed to be preferred to y if and only if $x \succeq_{cb} y$.*[16]

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

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

[16] All results in this section can be easily verified by the proof of Theorem 1. We also discuss other types of behavior which reveal preferences in Section 2.7 below.

Finally, we identify the attention sets consistent with a choice function. 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 Definition 1, it also attracts attention at S.

Remark 3 *(Revealed Attention) Suppose c is consistent with LA-SQB. 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 Transitivity of $\mathcal{Q}$

So far, the only restriction we put on the psychological constraint function is that a status quo cannot rule itself out of consideration. However, an interesting additional restriction on $\mathcal{Q}$ is transitivity, that is, $\mathcal{Q} \circ \mathcal{Q} \subseteq \mathcal{Q}$. This property says that if $y \in \mathcal{Q}(x)$ and $z \in \mathcal{Q}(y)$ then we must have $z \in \mathcal{Q}(x)$, for any $x, y, z \in \mathcal{X}$. In other words, if z is admissible from the viewpoint of the status quo y, and y is admissible from the viewpoint of x, then z must be admissible from the viewpoint of x. This adds quite a bit of structure to our model. In the typical SQB model, the following axiom would be both necessary and sufficient for transitivity of $\mathcal{Q}$.

Axiom 4 *(Strong SQB) $x = c(S, \sigma)$ implies $x = c(S, x)$.*

We will first show that the axiom continues to be necessary for transitivity of $\mathcal{Q}$ in our model. However, due to limited attention, it is longer sufficient, as demonstrated in Example 1 below.

Claim 2 *If c is consistent with an LA-SQB model with a transitive $\mathcal{Q}$, then c satisfies Strong SQB.*

Example 1 *Let $\mathcal{X} = \{x, y, z\}$. Consider the following choice data:*

(S, σ)	$\diamond$	x	y	z
$\{x, y, z\}$	x	x	y	z
$\{x, y\}$	y	y	y	-
$\{x, z\}$	z	x	-	z
$\{y, z\}$	z	-	z	z

This behavior is consistent with the LA-SQB model. To see this, let the attention function be $\mathcal{A}(\{x, y, z\}) = \{x\}$, $\mathcal{A}(S) = S$ for binary S. Let the psychological function be $\mathcal{Q}(x) = \{x, y\}$, $\mathcal{Q}(y) = \{y, z\}$, $\mathcal{Q}(z) = \{z\}$. Let the preferences be $z \succ y \succ x$. The example also satisfies Strong SQB. Note that the $\mathcal{Q}$ above is not transitive.

Let us try to see if there is an alternative specification $\mathcal{Q}'$ which is transitive. Now, $y = c(\{x, y\}, x)$ and $z = c(\{y, z\}, y)$ imply $y \in \mathcal{Q}'(x)$ and $z \in \mathcal{Q}'(y)$. Now suppose $z \in Q'(x)$. Since we have full attention at binaries, specifically at $\{x, z\}$, and since $z = c(\{x, z\}, \diamond)$, we then should have $z = c(\{x, z\}, x)$, a contradiction.

Example 1 highlights the difference between our model and the model of Masatlioglu and Ok [2014] (where there is always full attention). That is, while the strong SQB axiom is enough to generate transitivity of $\mathcal{Q}$ in the SQB models, due to limited attention, this is no longer true in our model. We next strengthen our *Axiom 1* (Binary Transitivity) from binary to trinary choices to deliver the transitivity of $\mathcal{Q}$: With this stronger axiom, Strong SQB is sufficient for Q to be transitive.

Axiom 5 *(Trinary WARP) $x = c(\{x,y,z\},\sigma)$ implies $x = c(\{x,y\},\sigma)$.*

Claim 3 *If c satisfies Strong SQB, Trinary WARP, Axiom 2 and Axiom 3, then c is consistent with an LA-SQB model with transitive $\mathcal{Q}$.*

The converse of this result is not true. More specifically, the LA-SQB model with a transitive $\mathcal{Q}$ does not necessarily satisfy Trinary WARP (while it satisfies the other axioms in the above claim). The following example demonstrates this point.

Example 2 *Let $\mathcal{X} = \{x,y,z\}$. Consider the following choice data:*

(S,σ)	$\diamond$	x	y	z
$\{x,y,z\}$	x	x	y	z
$\{x,y\}$	y	y	y	-
$\{x,z\}$	z	z	-	z
$\{y,z\}$	z	-	z	z

This behavior is consistent with our model. To see this, let the attention function be $\mathcal{A}(\{x,y,z\}) = \{x\}$, $\mathcal{A}(S) = S$ for binary S. Let the psychological function be $\mathcal{Q}(x) = \{x,y,z\}$, $\mathcal{Q}(y) = \{y,z\}$, $\mathcal{Q}(z) = \{z\}$. Let the preferences be $z \succ y \succ x$. Note that $\mathcal{Q}$ is transitive. Our example also satisfies Strong SQB. However, since $c(\{x,y,z\},x) = x$ and $c(\{x,y\},x) = y$, this choice data violates Trinary WARP.

2.7 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* $c : \mathcal{C}(\mathcal{X}) \rightrightarrows \mathcal{X}$, 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 $\succcurlyeq$, is a weak order over $\mathcal{X}$.[17] An alternative x is

[17] A binary relation $\succcurlyeq$ is a *weak order* over $\mathcal{X}$ if it is *complete* and *transitive*.

a $\succcurlyeq$-best in S, denoted $x \in \arg\max_{\succcurlyeq} S$, if $x \succcurlyeq y$ for each $y \in S$. Note that we may now obtain multiple $\succcurlyeq$-best alternatives in any S.

We also adjust our concept of the attention function to remove the assumption of full attention at binary sets.

Definition 5 *A general attention function is a mapping $\mathcal{A} : \Omega_{\mathcal{X}} \to \Omega_{\mathcal{X}}$ 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 $x \in T \subset S$.*

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

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

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

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

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, $y \in c(S', \sigma')$ reveals that y is in $\mathcal{A}(S)$, while $y \in c(T, \sigma)$ reveals it to be in $Q(\sigma)$. Thus y is under consideration in decision problem (S, σ). Since y is not chosen and x is chosen from this decision problem, 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 6 ***(Acyclicity)*** *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 4 *A choice correspondence c satisfies Acyclicity 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 sufficiency argument. We take a completion of the P above as the preference relation $\succcurlyeq$ 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 Acyclicity to show that at every choice problem, the alternatives chosen by c uniquely maximize $\succcurlyeq$ at the intersection of the attention and psychological constraint functions. The next three remarks summarize how much we can learn about each component of the model from observed choice under the general LA-SQB model. These results largely mimic those of remarks 1-3 above.

Remark 4 *(Revealed Preference) Suppose c is consistent with a general LA-SQB. Then x is revealed to be preferred to y if and only if xPy.*

Remark 5 *(Revealed Psychological Constraint) Suppose c is consistent with a general LA-SQB. Then x is revealed to be in the consideration set of y if and only if $x \in c(S, y)$ for some $S \in \Omega_{\mathcal{X}}$.*

Remark 6 *(Revealed Attention) Suppose c is consistent with a general LA-SQB. Then, x is revealed to attract attention at S if and only if $x \in c(S', \sigma) \neq \sigma$ for some $S' \supseteq S \ni x$.*

In Appendix C we additionally consider the two intermediate cases between the LA-SQB and the general LA-SQB model - namely (i) a model that allows for incomplete attention over binary choices but continues to rule out indifference (a generalized-attention LA-SQB)[18] and (ii) a model

[18] i.e a general LA-SQB model in which $\succeq$ is restricted to be a linear order.

that maintains the assumption of full attention at binary choices but allows for indifference (an indifference-allowing LA-SQB). The former case is a trivial extension of the generalized model presented above, while the latter requires an axiomatization distinct from either version of the model so far presented.

2.8 Incomplete Data

So far we have considered only the case of complete data, in which the researcher observes behavior in all choice problems. Of course, in many cases, such rich data may not be available, and so, as pointed out by de Clippel and Rozen [2012], it is important to understand whether our behavioral conditions remain necessary and sufficient in cases when data is incomplete.

The answer is partially affirmative. If choices are unique, then our results are unaffected by the missing data.

Theorem 5 *Let $\mathcal{D} \subseteq \mathcal{C}(\mathcal{X})$ be a subset of choice problems which includes all singleton choice sets*[19] *and let $c : \mathcal{D} \to \mathcal{X}$ be a choice function. Then c satisfies Acyclicity if and only if c is consistent with the generalized-attention LA-SQB model.*

Unfortunately, our conditions are no longer sufficient if we allow for indifference, as the following example demonstrates.

Example 3 *Imagine that we observe the following incomplete choice data:*

	$(\{x,y,e\},\diamond)$	$(\{x,z,e\},\diamond)$	$(\{x,w,e\},\diamond)$	$(\{x,y,z\},\diamond)$	$(\{x,y,w\},\diamond)$
Choice	$\{x,y\}$	$\{x,z\}$	$\{x,w\}$	$\{x\}$	$\{y\}$

The only revealed preference information is that x, y, z and w are all indifferent, so this data satisfies our axioms. However, there is no general attention function that will rationalize this data. Consider $A(\{x,y,z,w\})$. By construction, this has to be non-empty. Assume that $x \in A(\{x,y,z,w\})$. This implies that $x \in A(\{x,y,w\})$. However, the fact that $\{y\} = c(\{x,y,w\},\diamond)$ implies that $y \succ x$, which contradicts x and y being indifferent ($c(\{x,y,e\},\diamond) = \{x,y\}$). Similar arguments create a contradiction regardless what is assumed to receive attention at $\{x,y,z,w\}$.

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.

[19] This assumption is made largely for convenience. A similar result obtains without this assumption, but requires a slightly cumbersome rewriting of the definition of Acyclicality.

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,

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

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

Notice that LSQD rules out the type of general 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 in 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.[20]

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

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

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 feature of the SQB model is that under a given status quo, it satisfies WARP.

[20] Models of decision avoidance, discussed in Section 1, also imply LSQD. Hence, they do not allow general status quo dependence.

Axiom 8 ***(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 choice 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 the choice of the status quo (see Redelmeier and Shafir [1995], Anderson [2003]).

The SQB model rules out increasing status quo prevalence, 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 increasing status quo prevalence 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 an increasing status quo prevalence 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 explain 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:

$$c(S, \diamond) = x, \quad c\left(S', \diamond\right) = y, \quad \text{and} \quad c\left(S', w\right) = z.$$

Note that these choices cannot be explained by the LA or the SQB models. The SQB model does not allow the coexistence of first two choices since they violate WARP. Similarly, the last two choice cannot be accommodated by the LA model since the choice switches from y to a third alternative z as w becomes the status quo.[21]

The LA-SQB model not only allows such choices but uses them to deduce the DM's underlying preferences. The first two choices reveal that $x \succ y$: since y attracts attention at S' ($c(S', \diamond) = y$), it must also attract attention at S and, since x is chosen at S, it must be that $x \succ y$. Additionally, the last two choices reveal that $y \succ z$: since z attracts attention at (S', w) ($c(S', w) = z$), 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 Full rationality

In this section, we discuss the relationship between the LA-SQB model and the standard model of "full rationality" where there are no issues of limited attention and status quo bias:

$$c(S, \sigma) = \arg\max_{\succeq} \; S.$$

Note that this is a special case of the LA-SQB model where (i) for each $x \in X$, $\mathcal{Q}(x) = \mathcal{X}$ and (ii) for each $S \in \Omega_{\mathcal{X}}$, $\mathcal{A}(S) = S$.

This fully rational restriction of our model is characterized by a strengthening of Axiom 3 where all conditions on y (except that it is in S) are dropped. This much stronger axiom makes no reference to the less is more idea. Instead, it requires choices from bigger sets to be consistent with choices from binary sets. Formally, a choice function c satisfies **Consistency** if $x = c(S, \sigma)$ and $y \in S$ implies $x = c(\{x, y\}, \diamond)$.

It is straightforward to check that *Consistency* implies the following two properties:

1. (Sen's α) $x = c(S, \sigma)$ and $x \in T \subset S$ implies $x = c(T, \sigma)$
2. (Status Quo Independence) $x = c(S, \sigma)$ implies $x = c(S, \sigma')$

Together, these properties characterize the above model which makes fully rational choices, independent of the status quo alternative. It is also useful to note that *Consistency* implies both *Pairwise Transitivity* and *Contraction* axioms.

A similar exercise in our general model requires a strengthening of the Acyclicity axiom by defining a new revealed preference relation from observations of the kind "$x \in c(S, \sigma)$ and $y \in S$" and requiring that this revealed preference relation is acyclical. This is precisely the SARP axiom and gives us the standard model. Note that, while both Acyclicity and SARP require acyclicity of the revealed preference relation, they are different in the way the revealed preference relation is defined. In case of full rationality (absent the joint effect of limited attention and status quo

[21] 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.

bias), each incidence of $x \in c(S, \sigma)$ and $y \in S$ is taken to reveal that $x \succcurlyeq y$. In the LA-SQB model, however, the conditions under which we conclude $x \succcurlyeq y$ are much more demanding. As a result, requiring acyclicity of the revealed preference relation under full rationality (SARP) is much stronger than the same requirement for the revealed preference relation of the LA-SQB model.

3.2 Limited Attention, Status Quo Bias and Choice Architecture

We now illustrate some economic implications of the LA-SQB model. In order to do so, we consider a trivial dynamic extension of our model. We assume that the choice of the DM in one period becomes their status quo in the next period. Moreover, for simplicity, we assume that the DM does not take into account the dynamic impact of their choice - in other words the DM is naive and fails to realize that their first-period choice will become the second-period status-quo, and so may constrain future choices.[22] This allows us to cleanly demonstrate the interaction between limited attention and status quo bias inherent in our model. However, as we make clear below, the logic of our examples does not rely on the assumption of naivety.[23] A dynamic model in which the DM is sophisticated about the effect of their choices on those of future periods is clearly of interest, but lies beyond the scope of this paper.

Choice architecture, a term coined by Thaler and Sunstein [2008], reflects the fact that there are many ways to present a choice to the decision-maker, and that what the decision maker chooses often depends upon how the choice is presented. It has been suggested that cleverly designed choice architecture can be used by planners to steer decision makers towards making better choices, or by firms towards more profitable ones.

In terms of choice architecture, the LA-SQB model exhibits a unique feature: To achieve the desired outcome, it may be necessary for a planner to *dynamically change the set of available options* when dealing with decision makers who conform to the LA-SQB model.

This feature comes about directly from the interplay of status quo bias and limited attention. Status quo bias may prevent the DM from switching to the desired outcome directly in binary choice. Instead, some intermediate alternatives are needed to draw the DM away from their current status quo. Yet if all of these alternatives are initially added to the choice set, limited attention may prevent the DM from recognizing those that they would switch to from the current status quo. Instead, the planner may have to present the DM with a sequence of smaller choice sets in order to shift their status quo to a point from which the target alternative will be chosen.

We illustrate this process with two examples.

Example 4 (Government Intervention in Insurance Choices) *Consider a market in which*

[22] For example, it might be the case that a DM prefers a to b to c, but a status quo of b means that they cannot choose a (i.e. $a \notin Q(b)$), while a is choosable from c (i.e. $a \in Q(c)$). Consider such a consumer who knows they will initially choose from $\{b, c\}$ and then from $\{a, b, c\}$. A naive consumer would pick b in the first period. However, a sophisticated consumer would have to trade off the benefit of initially picking b against the cost that this means that they would not choose a in period 2.

[23] That is, none of the examples below contain trade offs of the type outlined in the previous footnote.

there are three types of insurance n (no insurance) b (basic coverage) and f (full coverage). Assume that the government wants people to buy the full coverage (because this is the socially optimal option). In addition, the government must always offer the option of no insurance (i.e. they cannot force people to buy insurance), which is also the initial default. How can the government make the consumer buy the full insurance f?

Assume that the consumer's choice is described by the LA-SQB model. Due to limited attention, the DM will not be aware of the basic coverage if all options are offered. Additionally, status quo bias prevents her from directly switching to full insurance from no insurance. The following table summarizes all the parameters.

Attention Sets	$A(\{n,b,f\}) = \{n,f\}$, *and* $A(S) = S$ *for all other* S
Preferences	$f \succ b \succ n$
Psychological Constraints	$\mathcal{Q}(n) = \{n,b\}$, *and* $\mathcal{Q}(b) = \mathcal{Q}(f) = \{n,b,f\}$

These together will predict the following choice data.

	$(\{n,b\},n)$	$(\{n,f\},n)$	$(\{n,b,f\},n)$	$(\{n,b,f\},b)$
Choice	b	n	n	f

In order to get the DM to choose full insurance, the government must dynamically change the consumer's choice set. Remember the initial status quo is n. The government must first offer $\{n,b\}$ with status quo n, which will induce the consumer to choose b, which then becomes their status quo:

$$c(\{n,b\},n) = b.$$

After this, the government introduces the full coverage insurance, making the available options n, b, and f. In this second round, the consumer will now choose f:

$$c(\{n,b,f\},b) = f.$$

Note that there is no way to get the DM to go directly to choosing f: an intermediate choice set must be used. If the government initially offers all possible insurance plans at once, i.e., $\{n,b,f\}$, then the consumer will not be aware of the basic option, and so will continue to choose no insurance (i.e., $c(\{n,b,f\},n) = n$). On the other hand, if she is only offered f initially, the consumer will not acquire any insurance due to SQB. [24]

[24] Note that the above result would obtain with a fully sophisticated consumer who suffers from limited attention and SQB. On the one hand, the choice of b from $\{n,b\}$ and f from $\{n,b,f\}$ corresponds to unconstrained preference maximization in each set, so a sophisticate would have no incentive to deviate from this sequence: there is no trade off between better short term choices and worse long term choices. On the other, there is no way that the government could get a sophisticated consumer to jump directly to full insurance, because the combination of limited attention and SQB means that f cannot be chosen by the agent from either $(\{n,f\},n)$ or $(\{n,b,f\},n)$.

This type of a need for dynamic adjustment of the choice set is unique to our model. Such an intervention is not needed in the SQB or Limited Attention models alone. In the first case (i.e., $\mathcal{A}(S) = S$), the government should offer all the insurance plans in the first place. The consumer will eventually buy the expensive insurance plan - there is no need to dynamically adjust the choice sets.[25]

In the Limited Attention case (i.e., $\mathcal{Q}(x) = X$), if it is possible to get from n to f, then, as n is always available, it must be the case that $f \in \mathcal{A}(\{n, f\})$, otherwise, for any set containing n and f the decision maker will not be aware of f. Thus the government could just offer the choice of $\{n, f\}$ and the DM will choose f.

We next present a second example which demonstrates that in markets where consumers exhibit choice behavior that conforms with the LA-SQB model, competition amongst firms may also lead to the use of dynamic choice architecture via a sequence of offers.

Example 5 (Competition Strategy for an Entrant facing a Monopoly) *In some markets, such as insurance, telecom, cable or media, it is typical for firms to contact consumers and offer them to sign up with a new product such as a new phone, cable TV or insurance plan, or a new subscription. Firms contact their own costumers as well as costumers signed up with other companies to offer new products (plans). It is also documented that consumers in such markets often exhibit choice biases (e.g. see Frank and Lamiraud [2009]). In this example, we illustrate the use of choice architecture via dynamic choice sets in such markets.*

Consider an incumbent firm (say, a monopoly) and an entrant trying to grab a chunk of the monopoly's market share. Take a typical consumer who is currently signed up with the monopoly under plan m. Now imagine that the entrant firm comes up with two products: The first plan is what we will call a "bait". The bait b is typically an introductory limited time plan after which the consumer will be asked to make a new choice (which might possibly involve staying with b). The second plan e is what the entrant would like the consumer to eventually sign up with. If the consumer is offered all three alternatives we assume that limited attention means that only e and m are considered. Moreover, e does not belong to $\mathcal{Q}(m)$ since e and m are similar products and switching companies is costly.

The following table summarizes all the parameters.

Attention Sets	$A(\{m, b, e\}) = \{m, e\}$, *and* $A(S) = S$ *for all other* S
Preferences	$e \succ b \succ m$
Psychological Constraints	$\mathcal{Q}(m) = \{m, b\}$, *and* $\mathcal{Q}(b) = \mathcal{Q}(e) = \{m, b, e\}$

These together will predict the following choice data.

[25] Masatlioglu and Ok (2014) illustrate the dynamic adjustment of the *default option* as a tool of choice architecture, which we also utilize in this example. However, the dynamic adjustment of the *choice set* is a distinct feature of our model.

	$(\{m,b\},m)$	$(\{m,e\},m)$	$(\{m,b,e\},m)$	$(\{m,b,e\},b)$
Choice	b	m	m	e

Note first that the consumer exhibits increasing status quo prevalence. That is, if offered an abundance of plans by the entrant, the consumer chooses to stay with her status quo:

$$c(\{m,b,e\},m) = m.$$

Second, the consumer chooses to stay with m *if offered* e *as an alternative but chooses to switch to* b *if that is the offer:*

$$c(\{m,b\},m) = b \text{ and } c(\{b,e\},b) = e.$$

Finally, after b *becomes the consumer's status quo, if the entrant calls her with an offer of* e*, the consumer chooses it (even if* m *is still available):*

$$c(\{e,b\},b) = e \text{ and } c(\{m,e,b\},b) = e.$$

In a market where a significant portion of the consumers exhibit such choice behavior, the optimal strategy of the entrant is as follows. First, it only offers b *to consumers signed up with the monopoly. Second, it offers* e *to its own costumers (i.e. consumers who had previously signed up with the entrant under the bait* b*). This dynamic choice architecture moves consumers first from* m *to* b*, and then from* b *to* e*.*[26]

A recent book by Humby et al. [2008] (Chapter 11) documents how the Tesco supermarket chain in the UK used choice architecture in the 1990s to increase its customer base, in a way that is akin to our examples.

In mid 1990s, the Tesco marketing team discovered one important regularity. A significant fraction of families expecting a baby did not prefer Tesco for their consumption needs even though Tesco offered very good incentives to do so. In response, Tesco created the Baby Club in 1996, which targeted expecting families by offering them special discounts on baby products as well as other programs such as a monthly magazine and direct mailings offering professional advice on pregnancy and childcare. The results were spectacular, eclipsing any other innovation of the Tesco marketing team. "*Inside its first two critical years,* 37 *per cent of all British parents-to-be joined. Thanks to Baby Club, the company had increased its share of the mother and baby market to almost* 24 *per cent.*" Once consumers had been encouraged to join the Baby Club, they were then targeted with special offers for non-baby related Tesco products. As a result, a significant fraction of the Baby Club members switched to Tesco for other consumption needs as well and "*the members of Baby Club outspent their peer group by* £40 *million a year in total.*"

[26] Again, the above result would go through for a for a fully sophisticated agent. The choice of b from $\{m,b\}$ and e from $\{m,b,e\}$ corresponds to unconstrained preference maximization in each set.

The Tesco case shows that the British consumers responded to a two-stage choice architecture to switch to Tesco. Through the Baby Club program, Tesco convinced a significant part of these consumers to first switch to Tesco for their baby product needs. Then, using this recognition as leverage, these consumers were then persuaded to choose Tesco for all other consumption needs.

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 does a good job of explaining 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. We emphasize that these experiments do not represent a thorough test of the LA-SQB model. Rather they provide clear demonstrations of both increasing status quo prevalence and general status quo dependence in experimental choice.

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 to $45, and was represented on screen in the form of a bar graph.[27] Subjects each took part in between 13 and 28 rounds. The data used in this paper is taken from a sequence of experiments was used to generate the data reported in Dean [2009]. Therefore not all experimental questions are used.[28] 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.

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

[27] An example of a typical screenshot is shown in Figure 1.

[28] The interested reader can find a complete list of all questions asked in the online appendix.

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.

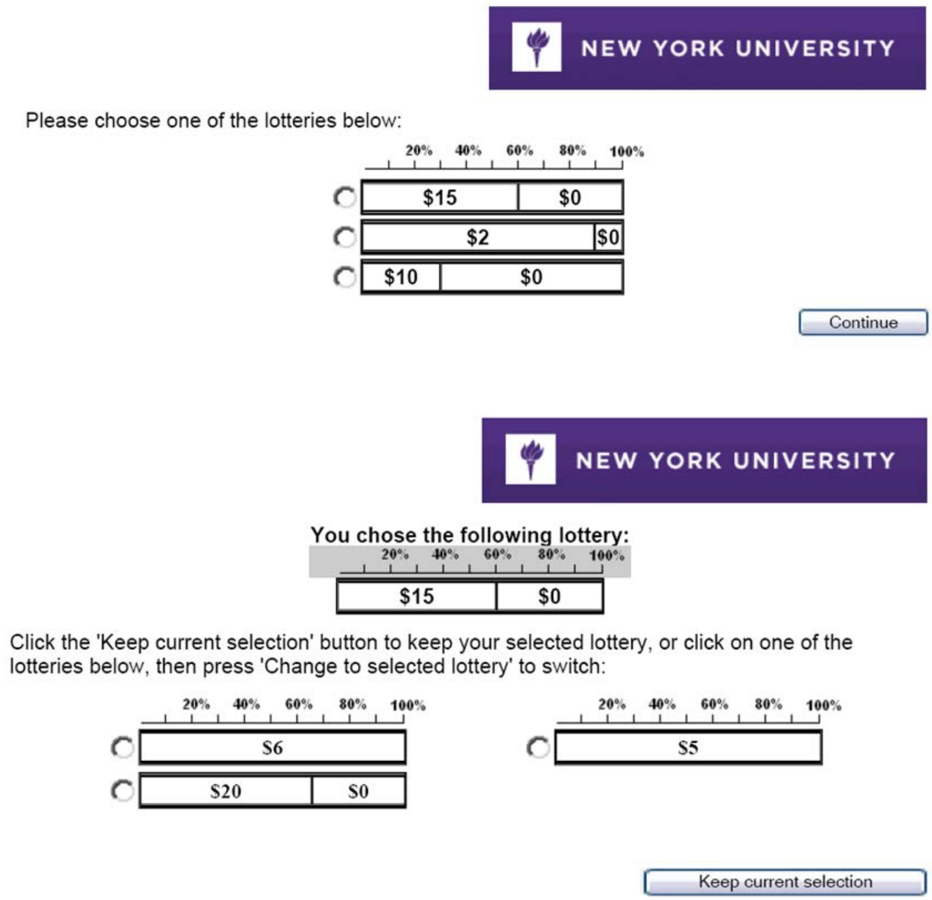

Figure 1: Screenshots

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 increasing status quo prevalence, 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 increasing status quo prevalence) 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.[29] 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 a lottery which gives prize $\$x_1$ with probability p_1 and $\$x_2$ with probability p_2. The total number of subjects facing each choice environment were 17, 17, 18 and 23. Overall, 9 subjects were dropped due to making dominated choices in the first stage questions designed to set up the status quo.[30] Such subjects typically made different first stage choices in the small and large choice set treatments, meaning they effectively had different status quos for the two choice sets. Their data therefore cannot be used to test WARP or contraction.

Data from the remaining 66 subjects is reported below.

Table 1 splits subjects into four groups. The first group are those subjects whose choices satisfy WARP (and therefore also contraction) either by always choosing x or always choosing y. 59% fall into this category. The second category are those that violate WARP but satisfy Contraction, by choosing the status quo in the larger choice set but not in the smaller choice set. 29% of subjects fall into this category. The third group (6%) are those that violate WARP and contraction by choosing the status quo in the smaller choice set but not in the larger set. The final group (6%) are those that choose a stochastically dominated choice in the larger choice set.

Overall, 88% of subjects were consistent with our model, as were 94% of the subjects who did

[29] In each case the two choice problems were separated in the experiment with other, unrelated choice problems.

[30] 2 subjects from choice problem 1, 3 from choice problem 2, 3 from choice problem 3 and 1 from choice problem 4.

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

Table 1: Results of Experiment 1

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.[31] 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 general 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 general 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].

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. Because we did not want to have the same subjects facing the same choices with different status quo we use a between-subject design. 23 subjects took part in the no status

[31]Z test that the proportion of subjects in the two categories are equal.

quo treatment[32], and 32 took part in the treatment with L as the status quo. These were distinct subjects from experiment 1. Figure 2 shows the result of experiment 2.

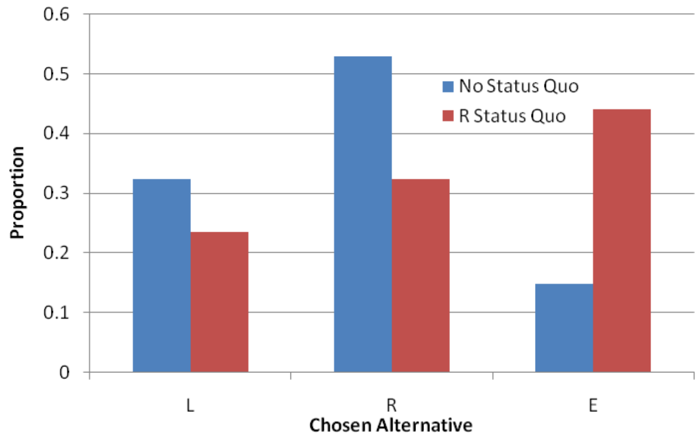

Figure 2: Results of Experiment 2

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.

[32]These are the same subjects who took part in the status quo $\{0.8, 4; 0.2, 20\}$, alternative $\{0.8, 3; 0.2, 23\}$ treatment in Experiment 1.

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A Proofs

A.1 The Benchmark Model: Proof of Theorem 1

Claim 6 *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 7 *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 $x \succeq y$ if $c(\{x, y\}, \diamond) = x$ and $x \succ y$ if $c(\{x, y\}, \diamond) = x$ for $x \neq y$. Note that, $x \succeq x$ since $x = c(\{x\}, \diamond)$. Therefore, $\succeq$ is *complete*. Since c is a function, $\succeq$ is also *antisymmetric* ($x = c(\{x, y\}, \diamond)$ and $y = c(\{x, y\}, \diamond)$ implies $x = y$). Finally, *Axiom 1* implies that $\succeq$ is *transitive*. Thus, $\succeq$ 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

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

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 $x \succeq y$. By completeness of $\succeq$, we also have $x \succeq x$. Thus, $x = \arg\max_{\succeq} \mathcal{A}(S)$. 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 $x = \arg\max_{\succeq}(\mathcal{A}(S)\cup\{x\})\cap\mathcal{Q}(x)$. 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 6, $x = c(\{x,y\},y)$ implies $x = c(\{x,y\},\diamond)$, that is, $x \succeq y$. Since $x \succeq x$ holds by completeness of $\succeq$, we have $x = \arg\max_{\succeq}(\mathcal{A}(S)\cup\{y\})\cap\mathcal{Q}(y)$.

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, $x \succeq y$ for each $y \in \mathcal{A}(S)$, implying $x = \arg\max_{\succeq}\mathcal{A}(S)$. 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 $\succeq$. 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, $x \succeq y$. This implies $x = \arg\max_{\succeq}(\mathcal{A}(S)\cup\{x\})\cap\mathcal{Q}(x)$, 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 6, implies $x \succeq z$. 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, $x \succeq y$. Finally, $x \succeq x$ by completeness of $\succeq$. Thus, $x = \arg\max_{\succeq}(\mathcal{A}(S)\cup\{z\})\cap\mathcal{Q}(z)$, that is, representation (3) holds for this case too. ■

A.2 Transitivity of $\mathcal{Q}$: Proofs of Claim 2 and 3

Proof. For a contradiction, suppose $x = c(S,y)$ and $x \neq c(S,x) = z$. By *Axiom 2*, we have $c(\{x,y\},y) = x$ and $c(\{x,z\},x) = z$. Hence, $x \in \mathcal{Q}(y)$ and $z \in \mathcal{Q}(x)$ (as well as $z \succ x \succ y$). By transitivity of $\mathcal{Q}$, we then have $z \in \mathcal{Q}(y)$. By $x \neq c(S,x) = z$, z must be in $\mathcal{A}(S)$. Thus z must be in $\mathcal{A}(S)\cap\mathcal{Q}(y)$. Hence we must have $c(S,y) \succeq z$, which contradicts $z \succ x = c(S,y)$. ■

Proof. It is routine to show that Trinary WARP implies Axiom 1, hence we have an LA-SQB representation for c by Theorem 1. We want to show that $z \in \mathcal{Q}(y)$ and $y \in \mathcal{Q}(x)$ imply $z \in \mathcal{Q}(x)$.

Assume $z \in \mathcal{Q}(y)$ and $y \in \mathcal{Q}(x)$. Let $S = \{x,y,z\}$. First suppose $c(S,x) = x$. By Trinary WARP then, $c(\{x,y\},x) = x$. But $y \in \mathcal{Q}(x)$ implies $c(\{x,y\},x) = y$, a contradiction. Alternatively, suppose $c(S,x) = y$. By Strong SQB, we have $c(S,y) = y$. By Trinary WARP $c(\{y,z\},y) = y$. But $z \in \mathcal{Q}(y)$ implies $c(\{y,z\},y) = z$, a contradiction. We therefore conclude that $c(S,x) = z$. This, by Trinary WARP implies $c(\{x,z\},x) = z$, that is, $z \in \mathcal{Q}(x)$. ■

A.3 The General Model: Proof of Theorem 2

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

Let $\succcurlyeq$ be a completion of P. By definition, $\succcurlyeq$ 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:

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

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 $(S, \diamond) \in \mathcal{C}(\mathcal{X})$

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

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 $x \succcurlyeq y$. 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 $x \succcurlyeq y$.

Next, let $x \in \mathcal{A}(S)$ be such that $x \succcurlyeq y$ 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 Acyclicity contradicts $x \succcurlyeq y$. To see this, note that $x \succcurlyeq y$ 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 Acyclicity, implies not $y \succ_c x$, a contradiction.

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

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

First, let $x \in c(S, z)$. If $x = z$, completeness of $\succcurlyeq$ implies $x \succcurlyeq z$. Alternatively if $x \neq z$, by "abandonment of default" we have $x \succ_c z$ and thus, $x \succcurlyeq z$. 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 $x \succcurlyeq y$. 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 $x \succcurlyeq y$.

Next, let $x \in (\mathcal{A}(S) \cup \{z\}) \cap \mathcal{Q}(z)$ be such that $x \succcurlyeq y$ 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 Acyclicity contradicts $x \succcurlyeq y$. 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 Acyclicity contradicts $x \succcurlyeq y$. ■

A.4 Incomplete Data: Proof of Theorem 3

Proof. It is straightforward to show that a c that is consistent with the general LA-SQB model satisfies Acyclicity. For the converse, let c be a choice function that satisfies the axiom. As $\sim_c$ is empty, $\succ_c$ is acyclic and there exists a linear order $\succeq$ which is an extension of $\succ_c$.

Define the correspondence $\mathcal{A}' : \Omega_{\mathcal{X}} \to \mathcal{X}$ as

$$\begin{aligned} \mathcal{A}'(S) &= \{c(S,\sigma) \mid (S,\sigma) \in \mathcal{D} \text{ and } c(S,\sigma) \neq \sigma\} \text{ if there is } \sigma \text{ such that } (S,\sigma) \in \mathcal{D} \text{ and } c(S,\sigma) \neq \sigma \\ &= \{x \in S \mid y \succeq x \text{ for all } y \in S\} \text{ otherwise.} \end{aligned}$$

Now define $\mathcal{A} : \Omega_{\mathcal{X}} \to \mathcal{X}$ as

$$\mathcal{A}(S) = \cup_{T \supseteq S} \mathcal{A}'(T) \cap S.$$

It is clear that $\mathcal{A}$ is a *general attention function*. Finally, define the *psychological constraint function* $\mathcal{Q}$. For each $x \in \mathcal{X}$, let

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

Note that, since singleton choice sets are in $\mathcal{D}$, we have $x \in \mathcal{Q}(x)$.

Between them, $\succeq$, $\mathcal{A}$ and $\mathcal{Q}$ form a generalized-attention LA-SQB model. It remains only to show that they represent the data. Note that, for every $(S,\diamond) \in \mathcal{D}$

$$c(S,\diamond) = \{x \in \mathcal{A}(\mathcal{S}) \mid x \succeq y \text{ for all } y \in \mathcal{A}(\mathcal{S})\}.$$

As $c(S,\diamond) \in \mathcal{A}(\mathcal{S})$ by construction, and for any $c(S,\diamond) \neq y \in \mathcal{A}(\mathcal{S})$, either $y = c(S',\sigma) \neq \sigma$ for some $S' \supset S$ implying that $c(S,\diamond) \succ_c y$ and so $c(S,\diamond) \succeq y$, or y was $\succeq -$minimal for some $S' \supset S$, and so $c(S,\diamond) \succeq y$.

Similarly, for every $(S,x) \in \mathcal{D}$

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

Again, by construction, $c(S,x) \in (\mathcal{A}(S) \cup \{x\}) \cap \mathcal{Q}(x))$. Now, consider any $c(S,x) \neq y \in (\mathcal{A}(S) \cup \{x\}) \cap \mathcal{Q}(x))$. If $y = x$, then by construction $c(S,y) \succ_c y$ and so $c(S,y) \succeq y$. If $y \neq x$ then the fact that $y \in \mathcal{A}(\mathcal{S})$ implies either that y is $\succeq -$minimal for some $S' \supset S$, and so $c(S,x) \succeq y$, or $y = c(S',\sigma) \neq \sigma$ for some $S' \supset S$. Moreover, the fact that $y \in \mathcal{Q}(x)$ implies that there exists some T such that $y = c(T,x)$. Put together, these also imply that $c(S,x) \succ_c y$ and so $c(S,s) \succeq y$. ■

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, $\mathcal{X} = \{x,y,z\}$. Each row represents a 2 or 3 element subset S. Each column represents a possible value of the status quo.

Example 6 *A choice rule that satisfies all axioms of Theorem 1 but A1:*

(S,σ)	$\diamond$	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 7 *A choice rule that satisfies all axioms of Theorem 1 but A2:*

(S, σ)	$\diamond$	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 8 *A choice rule that satisfies all axioms of Theorem 1 but A3:*

(S, σ)	$\diamond$	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* $y \neq c(\{x, y\}, \diamond)$.

C Choice correspondences with Binary Full Attention

Our benchmark model assumes (i) choice functions and (ii) full attention at binary sets. In Subsection 2.6, we later analyze a generalized model that drops both these assumptions simultaneously. The objective of this section is to discuss the two possible "intermediate" cases where precisely one of these assumptions is imposed.

Let us first discuss the possibility of only assuming (i). This intermediate model simply restricts the choice corrsependences in our general model to be singleton-valued (a generalized-attention LA-SQB). And, except for the rather trivial implications of this additional restriction, the analysis of the general model fully applies to this intermediate case.

The second intermediate model where we only assume (ii), however, presents an interesting extension of our benchmark model. For this, in what follows we allow c to be a correspondence and take a weak preference relation $\succcurlyeq$ as in the general model.

Consider the following axioms on c. The first two are straightforward generalizations of Axiom 1 and Axiom 2 to choice correspondences.

Axiom 9 ***(Pairwise transitivity)*** *If* $x \in c(\{x, y\}, \diamond)$ *and* $y \in c(\{y, z\}, \diamond)$ *then* $x \in (\{x, z\}, \diamond)$.

Axiom 10 ***(Contraction)*** *If* $x \in c(S, y)$, *then* $x \in c(\{x, y\}, y)$.

Axiom 2 would naturally imply our next axiom in case of choice functions. This, however, is not the case for choice correspondences and we need to impose the following axiom which basically refines the Contraction idea to make a distinction between "indifference" and "strict preference".

Axiom 11 ***(Expansion)*** *If* $\{x, y\} = c(\{x, y\}, y)$ *and* $x \in c(S, y)$, *then* $y \in c(S, y)$.

The following is a generalization of Axiom 3 of the benchmark model to choice correspondences.

Axiom 12 ***(Less is More for Choice Correspondences)*** *Let* $(S,\sigma),(T,\sigma),(S',\sigma')\in\mathcal{C}(\mathcal{X})$ *and* $x,y\in S$ *be such that* $x\in c(S,\sigma)$, $y\in c(S',\sigma')$, $y\neq\sigma'$, $S\subseteq S'$, *and* $y\in c(T,\sigma)$. *Then (i)* $x\in c(\{x,y\},\diamond)$ *and (ii)* $\{x\}=c(\{x,y\},\diamond)$ *whenever* $y\notin c(S,\sigma)$.

As discussed in Subsection 2.3.1, Axiom 3 would naturally imply our next axiom in case of choice functions. This, however, is not the case for choice correspondences. Thus, we need to impose it as a separate axiom. It ensures that the being the status quo creates a "weak" bias towards an alternative.

Axiom 13 ***(Status Quo Bias)*** *If* $x\in c(\{x,y\},y)$, *then* $x\in c(\{x,y\},\diamond)$.

The following lemmas present two important implications of Axiom 12 and Axiom 13.

Lemma 1 *Assume A12. If* $x\in c(\{x,y\},\diamond)$, *then* $x\in c(\{x,y\},x)$.

Proof. Assume $x\in c(\{x,y\},\diamond)$ and suppose $\{y\}=c(\{x,y\},x)$. These and $x\in c(\{x\},x)$ imply by Axiom 12 that $\{y\}=c(\{x,y\},\diamond)$, contradicting $x\in c(\{x,y\},\diamond)$. ■

Lemma 2 *Assume A12-13. If* $x\in c(\{x,y\},y)$ *then* $c(\{x,y\},y)=c(\{x,y\},\diamond)$.

Proof. Let $x\in c(\{x,y\},y)$.

First assume $c(\{x,y\},y)=\{x,y\}$. Then for $S=S'=T=\{x,y\}$ and $\sigma=\sigma'=y$, Axiom 12 implies $y\in c(\{x,y\},\diamond)$. By Axiom 13, $x\in c(\{x,y\},y)$ implies $x\in c(\{x,y\},\diamond)$. Together, $c(\{x,y\},y)=c(\{x,y\},\diamond)$.

Alternatively assume $c(\{x,y\},y)=\{x\}$. By Axiom 13 then, $x\in c(\{x,y\},\diamond)$. Suppose $y\in c(\{x,y\},\diamond)$. Then by Lemma 1, $y\in c(\{x,y\},y)$, a contradiction. Thus, $y\notin c(\{x,y\},\diamond)$. ■

The main result of this section is as follows.

Theorem 8 *A choice correspondence c satisfies A9-13 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 axioms. For the converse, let c be a choice correpondence that satisfies the axioms.

We first define the *preferences.* For each $x,y\in\mathcal{X}$, let $x\succcurlyeq y$ if $x\in c(\{x,y\},\diamond)$. Note that, $x\succcurlyeq x$ since $x\in c(\{x\},\diamond)$. Thus $\succcurlyeq$ is *complete. Axiom 9* implies that $\succcurlyeq$ is *transitive.*

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

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

Note that $\{x\}=c(\{x\},x)$ implies $x\in\mathcal{Q}(x)$. Thus, *Definition 2* is satisfied.

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 of Definition 1.* For any other $S\subseteq\mathcal{X}$, we define

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

By this definition, $y \in \mathcal{A}(S)$ and $y \in T \subseteq S$ imply $y \in \mathcal{A}(T)$, satisfying *Condition 2 of Definition 1.* Since $\mathcal{A}$ also satisfies *Condition 1 of Definition 1*, it is an attention function.

We will first prove that the representation holds for binary sets. For this purpose let $x \neq y$. First, we prove the representation when there is no status quo:

$$c(\{x,y\},\diamond) = \arg\max_{\succcurlyeq} \{x,y\}.$$

Let $x \in c(\{x,y\},\diamond)$. Then, by definition of $\succcurlyeq$, $x \succcurlyeq y$. Since $x \succcurlyeq x$, we have $x \in \arg\max_{\succcurlyeq} \{x,y\}$. Conversely, let $x \in \arg\max_{\succcurlyeq} \{x,y\}$. Then $x \succcurlyeq y$, by definition, implies $x \in c(\{x,y\},\diamond)$.

Second, we show the representation in the presence of a status quo:

$$c(\{x,y\},y) = \arg\max_{\succcurlyeq} \mathcal{Q}(y).$$

First assume $x \in c(\{x,y\},y)$. Then by definition of $\mathcal{Q}$, $x \in \mathcal{Q}(y)$. Also, by *Axiom 13*, $x \in c(\{x,y\},y)$ implies $x \in c(\{x,y\},\diamond)$. Thus, $x \succcurlyeq y$. Since $x \succcurlyeq x$, we have $x \in \arg\max_{\succcurlyeq} \mathcal{Q}(y)$. Next assume $y \in c(\{x,y\},y)$. If $x \in c(\{x,y\},y)$, by *Lemma 2*, $c(\{x,y\},y) = c(\{x,y\},\diamond)$. Thus, $y \in c(\{x,y\},\diamond)$. This implies $y \succcurlyeq x$ and thus, $y \in \arg\max_{\succcurlyeq} \mathcal{Q}(y)$. Alternatively if $x \notin c(\{x,y\},y)$, then by definition of $\mathcal{Q}$, $x \notin \mathcal{Q}(y)$. Thus, $y \succcurlyeq y$ implies $y \in \arg\max_{\succcurlyeq} \mathcal{Q}(y)$.

Conversely, let $x \in \arg\max_{\succcurlyeq} \mathcal{Q}(y)$. Then $x \in \mathcal{Q}(y)$ and by definition of $\mathcal{Q}$, $x \in c(\{x,y\},y)$. Alternatively, let $y \in \arg\max_{\succcurlyeq} \mathcal{Q}(y)$. If $x \notin \mathcal{Q}(y)$, by definition of $\mathcal{Q}$, $x \notin c(\{x,y\},y)$. Thus $y \in c(\{x,y\},y)$. Alternatively if $x \in \mathcal{Q}(y)$, then $y \succcurlyeq x$ by definition implies $y \in c(\{x,y\},\diamond)$. This, by *Lemma 1*, implies $y \in c(\{x,y\},y)$.

Next, we prove that the representation holds for any $S \in \Omega_{\mathcal{X}}$ such that $|S| > 2$.

First, we prove the representation when there is no status quo:

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

Assume $x \in c(S,\diamond)$. By definition of $\mathcal{A}$, $x \in \mathcal{A}(S)$. Let $y \in \mathcal{A}(S)$. Then, by definition of $\mathcal{A}$, there is $(S',\sigma') \in \mathcal{C}(\mathcal{X})$ such that $S \subseteq S'$, $y \neq \sigma'$, and $y \in c(S',\sigma')$. Also $y \in c(\{y\},\diamond)$. Thus, by *Axiom 12*, $x \in c(\{x,y\},\diamond)$, that is, $x \succcurlyeq y$. This implies, $x \in \arg\max_{\succcurlyeq} \mathcal{A}(S)$.

Conversely, assume $x \in \arg\max_{\succcurlyeq} \mathcal{A}(S)$. Suppose $x \notin c(S,\diamond)$. Let $y \in c(S,\diamond)$. Since $x \in \mathcal{A}(S)$, there is $(S',\sigma') \in \mathcal{C}(\mathcal{X})$ such that $S \subseteq S'$, $x \neq \sigma'$, and $x \in c(S',\sigma')$. Also $x \in c(\{x\},\diamond)$. Thus, by *Axiom 12*, $\{y\} = c(\{x,y\},\diamond)$. However, $x \in \arg\max_{\succcurlyeq} \mathcal{A}(S)$ implies $x \in c(\{x,y\},\diamond)$, a contradiction. Thus, $x \in c(S,\diamond)$.

Next, we prove the representation in the presence of a status quo:

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

Assume $x \in c(S,z)$. If $x = z$, then $x \in (\mathcal{A}(S) \cap \mathcal{Q}(z)) \cup \{z\}$ and $x \succcurlyeq z$ trivially holds. If $x \neq z$, then $x \in c(S,z)$, by definition of $\mathcal{A}$, implies $x \in \mathcal{A}(S)$. Also, $x \in c(S,z)$, by *Axiom 10*, implies $x \in c(\{x,z\},z)$. Thus, $x \in \mathcal{Q}(z)$. This implies $x \in (\mathcal{A}(S) \cap \mathcal{Q}(z)) \cup \{z\}$. Also, $x \in c(\{x,z\},z)$, by *Axiom 13*, implies $x \in c(\{x,z\},\diamond)$, that is, $x \succcurlyeq z$. Now let $y \in \mathcal{A}(S) \cap \mathcal{Q}(z)$ such that $y \neq z$.

Then, $y \in \mathcal{A}(S)$, by definition of $\mathcal{A}$, implies there is $(S', \sigma') \in \mathcal{C}(\mathcal{X})$ such that $S \subseteq S'$, $y \neq \sigma'$, and $y \in c(S', \sigma')$. Also, $y \in \mathcal{Q}(z)$, by definition of $\mathcal{Q}$, implies $y \in c(\{z, y\}, z)$. Thus, by *Axiom 12*, $x \in c(\{x, y\}, \diamond)$, that is, $x \succcurlyeq y$. This implies, $x \in \arg\max_{\succcurlyeq} (\mathcal{A}(S) \cap \mathcal{Q}(z)) \cup \{z\}$.

Conversely, assume $x \in \arg\max_{\succcurlyeq} (\mathcal{A}(S) \cap \mathcal{Q}(z)) \cup \{z\}$. First assume that $x = z$. If $c(S, x) = \{x\}$, we are done. Alternatively, let $y \in c(S, x)$ be such that $y \neq x$. By definition of $\mathcal{A}$ then, $y \in \mathcal{A}(S)$. Also, by *Axiom 10*, $y \in c(S, x)$ implies $y \in c(\{x, y\}, x)$, that is, $y \in \mathcal{Q}(x)$. Now $x \succcurlyeq y$ implies $x \in c(\{x, y\}, \diamond)$, which by *Lemma 1*, implies $x \in c(\{x, y\}, x)$. But then, $\{x, y\} = c(\{x, y\}, x)$ and $y \in c(S, x)$, imply by *Axiom 11*, $x \in c(S, x)$.

Alternatively assume that $x \neq z$. Suppose $x \notin c(S, z)$. Let $y \in c(S, z)$. Then, $x \in \mathcal{A}(S)$ implies there is $(S', \sigma') \in \mathcal{C}(\mathcal{X})$ such that $S \subseteq S'$, $x \neq \sigma'$, and $x \in c(S', \sigma')$. Also, $x \in \mathcal{Q}(z)$ implies $z \in c(\{x, z\}, z)$. Thus, by *Axiom 12*, $\{y\} = c(\{x, y\}, \diamond)$. Also, by the previous step, $y \in c(S, z)$ implies $y \in (\mathcal{A}(S) \cap \mathcal{Q}(z)) \cup \{z\}$. But then, $x \in \arg\max_{\succcurlyeq} (\mathcal{A}(S) \cap \mathcal{Q}(z)) \cup \{z\}$ implies $x \in c(\{x, y\}, \diamond)$, contradicting $\{y\} = c(\{x, y\}, \diamond)$. Thus, $x \in c(S, z)$. ■