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Calibration without reduction for non-expected utility

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Abstract

Calibration results in Rabin (2000) and Safra and Segal (2008, 2009) suggest that both expected and non-expected utility theories cannot produce non-negligible risk aversion over small stakes without producing implausible risk aversion over large stakes. This paper provides calibration results for recursive non-expected utility theories that relax the Reduction of Compound Lotteries axiom (as in Segal, 1990). These calibration results imply that a broad class of non-expected utility theories can accommodate both small and large stakes risk aversion, even for a decision-maker who faces background risk.

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1. Introduction

Rabin's (2000) calibration theorem shows that a risk averse expected utility decision-maker who rejects an actuarially favorable gamble over small stakes for a wide range of initial wealth levels must also reject extremely favorable gambles over larger stakes. For example, a decision-maker (DM) who would reject a 50–50 gamble between a loss of $100 and a gain of $110 at any initial wealth level must also reject a 50–50 gamble between a loss of $1000 and an infinite gain. But while we see people rejecting risks like the 50–50 lose $100/gain $110 gamble, we also see people taking risks that are much less favorable than the 50–50 lose $1000/gain infinity gam-

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ble. Expected utility's inability to simultaneously accommodate descriptively reasonable levels of risk aversion over different sizes of stakes limits its applicability as a descriptive model.

Rabin (2000) suggests that non-expected utility theories are not susceptible to his theorem. However, Safra and Segal (2008, 2009) show that if a DM faces background risk and evaluates an offered gamble by merging the offered gamble and her background risk into a single-stage lottery by applying the laws of probability, then non-expected utility theories that define utility over final wealth are susceptible to a similar critique.[1]

If we view the offered gamble in the presence of background risk as a two-stage compound lottery, then this assumption used in Safra and Segal (2008, 2009) is equivalent to the Reduction of Compound Lotteries (ROCL) axiom in their setting. Experimental evidence suggests that many people violate ROCL (e.g. Halevy, 2007), which motivates the use of recursive preferences over multi-stage lotteries following Segal (1990). Artstein-Avidan and Dillenberger (2010) point out that Safra and Segal's (2008, 2009) results do not apply when a DM has recursive non-expected utility (RNEU) preferences and views the risk in an offered gamble as resolving at a distinct stage from her background risk. However, they do not explore what alternative results do apply in this case. This paper's contribution is to provide calibration results that clarify the connection between small- and large-stakes risk aversion under RNEU with background risk.

This paper considers a DM with non-expected utility preferences defined over lotteries over final wealth levels who faces background risk, as in Safra and Segal's (2008) analysis of 'non-smooth' non-expected utility theories. This paper assumes that the DM views an offered gamble in the presence of background risk as a two-stage lottery with the offered gamble resolving first, and that the DM evaluates compound lotteries recursively, as in Segal (1990). The main theoretical results of this paper show that under these assumptions, the DM will behave as-if she engages in 'narrow bracketing' – her evaluation of an offered gamble is independent of her background risk – if her single-stage lottery preferences satisfy Constant Absolute Risk Aversion (Theorem 1) or for small stakes if her preferences satisfy a differentiability requirement (Theorems 2, 3). These results elucidate a relationship between RNEU and 'as-if' narrow bracketing conjectured earlier by Dillenberger (2010, p. 1976). Corollary 1 characterizes the calibration implications of small-stakes risk aversion for large-stakes risk aversion for a range of non-expected utility theories. It implies that recursive versions of the major classes of non-expected utility preferences are immune to unreasonable calibration arguments à la Rabin. Section 3 quantitatively calibrates a version of the model and shows it can provide descriptively reasonable risk aversion.

2. Theory: RNEU risk preferences with background wealth risk

2.1. Non-expected utility over single-stage lotteries

Let $W = \mathbb{R}_+$ denote the set of feasible final wealth levels, let $\Delta(W)$ denote the set of all finite-support probability distributions over W, and refer to $\Delta(W)$ as the set of (one-stage) *lotteries* over W. A one-stage lottery over W can be written as $q = [w_1, q_1; ...; w_m, q_m] \in \Delta(W)$, where q_i denotes the probability of receiving prize w_i; for such lotteries, adopt the convention that $w_1 \leq \ldots \leq w_m$. Given $q \in \Delta(W)$, let F_q denote the cumulative distribution function (CDF) of q, where $F_q(w)$ denotes the probability that q gives an outcome weakly less than w. The notation $\tilde{w} \in \Delta(W)$ will be used to denote a lottery that captures uninsurable wealth risk.

[1] See also Barberis, Huang, and Thaler (2006, Section II), who make a related argument.