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The hunt for a descriptive theory of choice under risk—A view from the road not taken☆

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ABSTRACT

In this paper I propose that the development of descriptive theories of choice in economics has been profoundly influenced by an arbitrary and seemly innocuous decision as to how to present risky choices to experimental subjects. This decision to represent lotteries as prospects has lead to a preoccupation with the question of whether preferences conform to what is known as the "independence axiom." Had the profession chosen to represent lotteries in the action-by-state matrices favored by Savage, the independence axiom would have appeared uncontroversial but we would have questioned whether preferences obeyed arguably more fundamental tenets of rationality like transitivity. That different ways of representing lotteries lead to different conclusions regarding which axioms preferences do and don't obey suggests that the choices people make aren't necessarily reflecting properties of their preferences at all. Instead the choices reveal properties of the decision rule individuals use to try to satisfy their preferences – a rule that involves judgments regarding the similarity or dissimilarity of prizes and their associated payoffs across alternatives. The paper discusses how such judgments explain observed behaviors given both prospect and matrix representations of lottery choices as well as explaining anomalies in other choice domains.

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1. Introduction

A moment's reflection confirms that much of "where we are" as individuals is a consequence of sometimes entirely arbitrary decisions we made in the past. Had I been diligent as an undergraduate and continued to work on my music composition rather than partaking in my college's 90th anniversary festivities I might have a wife named Jane rather than Annette and children named Mady, Emily, and Bob rather than Julian, Marshall, and Eraine. Had I not decided to take an elective on problems in choice theory after completing my fields in monetary theory, urban economics, and industrial organization, this paper, if I was writing a paper at all, might be on why money exists rather than decision making. In sum then, "where we are" as individuals is largely a consequence of a dollop of planning and a huge measure of happenstance. I propose in this paper that the development of descriptive theories of choice in economics has been profoundly influenced by an equally arbitrary and seemly innocuous decision as to how to present risky choices to experimental subjects. The paper begins with a description of how the quest for a descriptive theory has evolved over more than a half century – noting, in particular, where there was a fork in the road and where choosing to go left down "the road taken" rather than right – has taken us largely to a preoccupation with the question of whether preferences conform to what is known as the "independence axiom." The next section traces developments on the other side of the fork – "the road less traveled". Had the profession as a whole chosen this road, the focus of concern in terms of rational behavior and what rules preferences do and don't obey would have been entirely different – adherence to the independence axiom appears plausible viewed from this road but adherence to other, arguably more fundamental tenets of choice like transitivity and dominance, is suspect. The next section presents a view from a still more distant perspective – the road not taken at all, at least not by most economists.[1] The roads taken and less traveled differ in the way lottery choices are represented. Along either road, however, the behavior reflected in choices between risky alternatives is interpreted as revealing properties of preferences. Along the road not taken, choices instead reveal properties of the decision rule

☆ With apologies to Chris Starmer (2000).

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[1] Rubinstein (1988) is an exception among economists. Tversky's (1969) work on lexicographic decision rules, Payne et al. (1993) work on adaptive decision makers, Gigerenzer and Todd's (1999) work on ecological rationality and Brandstätter et al., 2006) work on the priority heuristic are examples of research following the road not taken by psychologists.

individuals use to try to satisfy their preferences – a rule involving judgments regarding the similarity or dissimilarity of prizes and their associated payoffs across alternatives. I show that application of this rule enables us to understand behaviors that have preoccupied economists on the road traveled and the road less taken while also providing insights into anomalies in other choice domains.

2. In the beginning

The context for any discussion of the current status of a descriptive theory of choice in economics logically starts with von Neumann and Morganstern's (1944) Theory of Games and Economic Behavior. In the book, actually in an appendix, they presented the first axiomatization of what is now the normative (and for some economists still the descriptive) theory of individual choice under uncertainty.[2] Loosely speaking, what von Neumann and Morganstern and subsequent theorists have shown is that if people's preferences satisfy certain requirements then we can describe their behavior under uncertainty in a very simple way.[3] Specifically, it implies that given any lotteries L_1, L_2, and L_3, if agent's preferences obey:

- Completeness
  - agents can always rank L_1, L_2 and L_3 in terms of preference,
- Descriptive invariance
  - preferences are defined on probability distributions of outcomes,
- Stochastic dominance
  - probabilistically more is preferred to probabilistically less,
- Transitivity
  - if a risky or degenerate lottery L_1 is preferred to L_2 and L_2 is preferred to L_3 then L_1 is preferred to L_3,
- Independence
  - if L_1 is preferred to L_2 then the lottery $\{L_1, p; L_3, 1-p\}$is preferred to the lottery $\{L_2, p; L_3, 1-p\}$

then the desirability of any lottery L_i:$\{\$x_1, p_1; \$x_2, p_2; \ldots; \$x_n, p_n\}$[4] will be determined as the probability weighted sum of the utilities of the outcomes or $EU(L_i) = p_1\,U(\$x_1) + p_2\,U(\$x_2) + \cdots + p_n\,U(\$x_n)$ and an agent will choose between two lotteries L_1 and L_2 according to which has the greater index value or:

$$\begin{cases} > \\ \blacksquare\ EU(L_1) = EU(L_2) \\ < \end{cases}$$

To see how this works, consider making the choice between the lotteries shown below where, for reasons to become apparent in a minute, the alternatives are referred to as "Situation C" and "Situation D."

Situation C:	Offers an 11 in 100 chance of \$100,000,000. Offers an 89 in 100 chance of \$0.
Situation D:	Offers a 10 in 100 chance of \$500,000,000 Offers a 90 in 100 chance of \$0.

The desirability of C will be evaluated as .11U(\$100M) + .89U(\$0) while the utility of D will be .10U(\$500M) + .90U(\$0) with the decision as to which to choose resting on whether EU(C) is greater than, equal to, or less than EU(D).

Before leaving our discussion of the details of the expected utility hypothesis, it's worth pointing out something about the independence axiom. Specifically, it says that the choice between lotteries depends only on those dimensions in which they differ—prize–probability combinations that are common across lotteries, like the 89% chance of receiving \$0 common in C and D above, are irrelevant. The probability of receiving the outcome common to both options is the same and, if received, the outcome will contribute exactly as much satisfaction to one lottery as to the other. It also implies that replacing the prize in the common prize–probability combination with any other prize will be inconsequential.

3. Early rumblings

In the period after the publication of the theory of games two controversies arose. The first and the one over which the most ink was spilled concerned whether Von Neuman and Morganstern hadn't snuck the cardinal "strength of preference" notion of utility a generation of economists (e.g., Hicks and Allen, 1934) had worked hard to rid the profession of back in through an abstract mathematical side door. While this debate was quite heated for a period of time, economists like Alchian (1953) and Ellsberg (1954), subsequently of Ellsburg Paradox and Pentagon Papers fame, eventually came up with expositions of the sense in which expected utility involved a cardinal utility function and the sense in which it didn't that were clear and compelling enough to put skeptics' minds to rest. A second controversy regarding expected utility came from the French economist Maurice Allais who, in an article in Econometrica in 1953, argued that expected utility should not be afforded the status of the normative theory of choice under uncertainty. To bolster this argument, he presented simple choice situations in which peoples' choices tended to depart from the requirements of expected utility and, in particular, the requirements of the independence axiom. The crux of his concern is summarized in the two choice problems shown in Fig. 1. These are reproduced from the original article – the reason for noting this fact to become clear momentarily.

(1) *Préférez-vous la situation A à la situation B?*

SITUATION A: *Certitude* de recevoir 100 millions.

SITUATION B { *10 chances sur 100* de gagner 500 millions. / *89 chances sur 100* de gagner 100 millions. / *1 chance sur 100* de ne rien gagner.

(2) *Préférez-vous la situation C à la situation D?*

SITUATION C { *11 chances sur 100* de gagner 100 millions. / *89 chances sur 100* de ne rien gagner.

SITUATION D { *10 chances sur 100* de gagner 500 millions. / *90 chances sur 100* de ne rien gagner.

Fig. 1. Lotteries à la Allais.

For the benefit of the author who neither reads nor writes in French, the options are translated below. To begin, consider the choice between the safe option A paying \$100 million for sure, and the risky one B offering a 10% chance of \$500 million, an 89% chance of \$100 million and a 1% chance of \$0.

[2] It is striking to think that Von Neumann and Morganstern relegated their theory of choice to an appendix – viewed only as a means to the end of providing an approach to understanding strategic behavior and not as a contribution in its own right.

[3] These are not the original VnM axioms but are instead a list of properties VnM preferences obey which will prove useful to have explicated in what follows.

[4] This notation is intended to imply that prize $\$x_1$ offered in the lottery occurs with probability p_1, prize $\$x_2$ with probability p_2 and so forth.