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The equate-to-differentiate's way of seeing the prisoner's dilemma ☆

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Abstract

In this paper we advocate the application of the equate-to-differentiate rule to the prisoner's dilemma. As an alternative to the family of expected utility theory, the equate-to-differentiate approach [S. Li, A behavioral choice model when computational ability matters, Applied Intelligence 20 (2004) 147–163; S. Li, Equate-to-differentiate approach: an application in binary choice under uncertainty, Central European Journal of Operations Research 12 (3) (2004) 269–294] posits that the mechanism governing human risky decision making has never been one of maximising some kind of expectation, but rather some generalisation of dominance detection. In the light of the proposed representation system to describe uncertain alternatives, a decision maker's cognitive representation of the choice alternatives in the prisoner's dilemma situations is described by reference to two dimensions. The choice behaviour is thus modelled as a process in which the individual equates offered differences between alternatives on one dimension, but differentiates another one-dimensional difference as the determinant of the final choice. The predictions derived from these theoretical developments are empirically tested in six experiments with new data introduced to determine if people follow the theoretical prescriptions. In all these experiments, choices could be explained as a consequence of radically simplifying decision information.

Keywords: Sure-thing principle; Sunk cost; Windfall gain; Multi-investment; Non-compatriot player

1. The problem and the approach

von Neumann and Morgenstern [25] formalised the modern expected utility (EU) theory in the course of developing their game theory, the same theory that launched research on decision making under risk. One of

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the most famous of game theory games, prisoner's dilemma illustrates the conflict between individual and group interest. In an archetypal prisoner's dilemma situation, two players separately have two choices, a "cooperative" choice C and a "defective" choice D. The situation is like this: the police arrest two suspects and keep them isolated from each other. Each prisoner is told that if only one of them confesses, the one who confesses will go free but the one who remains silent will receive a severe sentence of 10 years. They are also told that if they both confess, each will receive a moderate sentence of five years, and if neither confesses, each will receive an even milder sentence of one year. The essentials of the game are diagrammed in Table 1 as a payoff matrix. The paradoxical (and problematic) aspect is that both partners could have been better off jointly if they had chosen the cooperative move that both keep quiet. The peculiar irony of the prisoner's dilemma is the fact that rationality in both players produces a far from optimal outcome for both.

Prisoner's dilemma highlights and embodies a conflict between individual and group interests that lies at the heart of many important real-life situations. In this paper we advocate the application of the equate-to-differentiate rule to the prisoner's dilemma. As an alternative approach to human decision making, the equate-to-differentiate model [15,16] is proposed as a means by which the dominance rule can be made applicable in more general cases. Weak dominance states that if alternative A is at least as good as alternative B on all attributes, and alternative A is definitely better than alternative B on at least one attribute, then alternative A dominates alternative B (cf. [8,26]). The model postulates that in order to utilize the very intuitive or compelling rule of *weak* dominance to reach a binary choice between A and B in more general cases, the final decision is based on detecting A dominating B if there exists at least one j such that $U_{Aj}(x_j) - U_{Bj}(x_j) > 0$ having subjectively treated all $U_{Aj}(x_j) - U_{Bj}(x_j) < 0$ as $U_{Aj}(x_j) - U_{Bj}(x_j) = 0$, or, detecting B dominating A if there exists at least one j such that $U_{Bj}(x_j) - U_{Aj}(x_j) > 0$ having subjectively treated all $U_{Bj}(x_j) - U_{Aj}(x_j) < 0$ as $U_{Bj}(x_j) - U_{Aj}(x_j) = 0$, where x_j ($j = 1, \ldots, M$) is the objective value of each alternative on Dimension j (for an axiomatic analysis, see [13]). This decision rule proposes that, in one-shot two-person PD games, much human choice behaviour involves a process in which people seek to equate offered differences between alternatives on one player's payoff dimension, so as to differentiate another player's payoff dimensional difference as the determinant of the preferred alternative [9].

To appreciate how this decision approach helps make sense of choice under risk and uncertainty, we begin by analysing two well-demonstrated violations of Savage's [20] sure-thing principle (STP): one involves behaviour under risk and the other involves behaviour under competition. Both are linked historically and theoretically to von Neumann and Morgenstern's monumental *Theory of Games and Economic Behavior* (1947).

Let us first consider the well-known Allais paradox [1]. The observed preference pattern in Allais' first pair of choices ($1M$, 1.0) vs ($5M$, .10; $1M$, .89; 0, .01), implies: $u(1M) > .10u(5M) + .89u(1M)$ or $(1-.89)u(1M) > .10u(5M)$, while the preference pattern in the second pair of choices ($1M$, .11; 0, .89) vs ($5M$, .10; 0, .90), implies the reverse inequality: $.11u(1M) < .10u(5M)$.

Table 1
A typical payoff matrix representing the Prisoner's dilemma

			Player B	
			p_D	$p_C = 1- p_D$
			Defect	Cooperate
Player A	p_D	Defect	5 / 5	0 / 10
	$p_C = 1- p_D$	Cooperate	10 / 0	1 / 1

Note: You find the payoff of A in upper left corner and the payoff to B in the lower right corner.