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Probability weighting in different domains: The role of affect, fungibility, and stakes

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ABSTRACT

This paper reports the results of a laboratory experiment in which probability weighting functions for risky gains were elicited non-parametrically in over 500 incentivized subjects. I compared probability weights for monetary rewards to two less fungible domains involving vouchers for different types of consumption, inducing stronger or weaker (positive) emotions. The level of stakes was also manipulated. I found that the probability to win monetary rewards was weighted almost linearly in the high stakes condition, the probability to win vouchers associated with stronger positive affect was underweighted and the probability to win affect-poor vouchers was strongly underweighted. Substantial underweighting also prevailed in all three domains in the low stakes condition.

1. Introduction

Several studies (Abdellaoui, 2000; Booij & van de Kuilen, 2006; Wu & Gonzalez, 1996) have reported that the decision weight attached to any particular outcome might deviate substantially from its probability. Within the framework of (Cumulative) Prospect Theory (Tversky & Kahneman, 1992; Wakker, 2010) this is modelled as a non-linear probability weighting function (PWF). It is often found to be inverse-S (overweighting of small probabilities, underweighting of intermediate and high probabilities) for the median decision-maker (although substantial heterogeneity is typically observed and many studies find other patterns prevail, see e.g. van de Kuilen & Wakker, 2011 and studies cited therein).

While Prospect Theory does not allow for that, isolated studies identified dependence of probability weighting on stakes: Fehr-Duda, Bruhin, Epper, and Schubert (2010) observed greater probability weights (making risky gambles generally more attractive) when decision concerned low rather than high winnings and Etchart-Vincent (2004, 2009) reported that probability weights depend on level and spacing of losses. Perhaps even less is known about how probability weights might change when the nature (and not only height) of rewards is altered and how the differences (if any) could be explained. This is of great importance given that, on top of financial risks, an individual daily takes chances in many other walks of like. Should I cheat at exams if I am a student? Should I cross the street at red light? Should I ski off-piste? Should I engage in extra-marital flirts? Should I quit my job in the academia and launch my own business? While all of these activities might perhaps eventually have dire monetary consequences, they primarily entail other sorts of risks, associated with ethical

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integrity, health/physical safety etc. Studies find that willingness to take risks is only moderately correlated across different domains (Blais & Weber, 2006) but there are very few attempts to compare probability weights.

Berns, Capra, Moore, and Noussair (2007) asked their subjects to make choices between gambles resulting in painful electric shocks (that were actually delivered). The PWF was not much different from what had typically been observed in studies with monetary losses. Bleichrodt and Pinto (2000) elicited probability weights for life years (how fortunate that their study was hypothetical!). Deviations from the linear benchmark seemed more pronounced than in most studies using monetary rewards. None of these studies involved a control treatment with cash payments. Recently, a difference depending on the reward domain was also reported by Abdellaoui and Kemel (2013)—probability weighting function was more elevated and less sensitive to probabilities for (real) delay time than for money.

Where could these differences (if any) come from? A priori, there are good theoretical reasons to expect probability weights to be identical in all domains. Clearly, the normative benchmark is the identity function, never mind the nature of rewards. If, however, we observe deviations, predictions as to whether they will be identical in various reward domains depend on where these deviations are believed to come from in the first place. In the original formulation of the PT and perhaps in most of the extant literature, weighting of probabilities is proposed to result from "diminishing sensitivity". In view of this psychophysical explanation, the same change in probability of an event is perceived as large when it occurs close to the limits of its admissible range—changing something impossible into possible or something certain into uncertain. By contrast, the perceptional apparatus is relatively insensitive in the middle of the scale. As a side note, this explains inverse-S but not convex probability weighting which is also often observed. It would seem that such effects should operate similarly in different domains, so that generally analogous weighting functions are predicted.

More recently, an alternative account has been proposed, based on emotions, which had previously been largely neglected in economic research (Hanoch, 2002). Here, the shape of the probability weighting function is proposed to be mediated by emotions, which are said to respond to mere possibility of an event, rather than its likelihood (see e.g. Monat, Averill, & Lazarus, 1972, who observed anticipatory stress reactions to be independent of the probability of an electric shock). This is a route taken by Loewenstein, Weber, Hsee, and Welch (2001). It is predicted in particular that favorable yet unlikely events will be given more weight if they evoke strong positive emotions, such as hope and excitement.[1] An analogous effect may show up for negative emotions. Johnson, Hershey, Meszaros, and Kunreuther (1993) found that their responders declared higher willingness to pay for flight insurance that protected against death due to "any act of terrorism" than due to "any reason", presumably because the former evoked stronger negative emotions. Sunstein (2003) asked his subjects how much they would pay to remove a slight risk of cancer (1 in 100,000 or 1 in 1,000,000). It turned out that the probability affected this WTP if the disease was described in neutral terms, not in ones with highly negative emotional loading.

The study by Rottenstreich and Hsee (2001) provides particularly striking evidence here: subjects showed extreme insensitiveness (over a very wide range of 1–99%) to changes in probability in "affect-rich" domains (such as a kiss from a movie star).[2] It appears thus plausible that decision makers derive direct utility from cherishing positive *anticipatory* emotions. It is also possible that *expected* emotions such as elation or regret are stronger in affect-rich domains. These could also lead to apparent probability distortions. For example, a low-probability reward may be relatively attractive (and so the chance "overweighed") because the decision maker knows she will enjoy this positive surprise a lot (Brandstätter, Kühberger, & Schneider, 2002; Mellers, Schwartz, & Ritov, 1999). Curiously, however, both affective priming and inhibition of systematic processing by means of cognitive load appeared to lead to *greater* sensitivity to probability on the 1–99% interval in Experiment 1 of Mukherjee (2011). Further discussion and references on the role of emotions in high- vs. low-probability gambles can be found in Van Winden, Krawczyk, and Hopfensitz (2011).

These considerations might shed some light on the insensitivity to probability observed by Bleichrodt and Pinto (2000). Indeed, it is (literally) vitally important and thus presumably emotionally engaging how many more years we might live, although there is no doubt that life years differ from (small to moderate) monetary stakes on several other dimensions as well. Similarly, substantial insensitivity to risk is often reported in the literature on health risks, such as poisoning (but see Hammitt & Graham, 1999).

Another perspective that could shed light on differences in probability weighting functions elicited for different reward domains is that of substitutability. As Leclerc, Schmitt, and Dube (1995) convincingly argued, money is unusually fungible; in other domains (such as time), planning may be more demanding (e.g. to make sure that we have enough time available in one slot for a specific activity) "and because uncertainty makes planning difficult, [it] is especially aversive". Leclerc and colleagues indeed reported strong risk aversion for gambles whose consequences were expressed in waiting time. This observation may be related to findings on risk taking and evaluation periods (Gneezy & Potters, 1997)—people tend to accept risk more easily (corresponding to higher probability weights) when several gambles are bracketed together rather than taken one by one. Indeed, money may be perceived as less fungible when gambles are framed as separate from one another. The general prediction here would thus be that less fungible domains lead to less elevated probability weighting function (in the gain domain).

[1] There is also voluminous and rather equivocal psychological literature on the impact of incidental positive vs. negative mood, typically induced by the experimenter, on willingness to take risks, see e.g. Halicka and Krawczyk (2014) for a short review.

[2] Related effects have been reported for the utility function. For example, Schunk and Betsch (2006) found that valuation of money was correlated with each subject's score on the Preference for Intuition and Deliberation scale. Individuals prone to deliberation showed roughly linear utility functions, while those with tendency to make intuitive, emotional decisions, deviated from this benchmark. Likewise, Hsee and Rottenstreich (2004) were able to cause large behavioral differences in their experiments by priming "valuation by calculation" vs. "valuation by feelings".