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Do we act differently under risk? - An analysis based on Prospect Theory

Seminar Paper

Seminar: Behavioral Economics and the Seven Sins

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1 Introduction

How do we behave under risk? – At first glance, this question may seem more theoretical than practical. In fact, however, individuals are constantly exposed to the concept of risk in their day-to-day lives. The two most prominent areas in this context are finance and insurance. For the former, decision-making under risk is inevitable, as it is essential for investment decisions to weigh risk against return – a situation many people will find themselves in over the course of their lives, whether due to retirement provision or obtaining a home loan. For the latter, this can be observed in the form of car and household insurances, where individuals are confronted with the choice of spending small periodic amounts of money to insure themselves against the possibility of a large loss. In order to better understand why individuals act like they do in these situations, behavior under risk will subsequently be analyzed in more detail.

In the following, chapter 2 provides a comprehensive insight into the behavioral model called "Prospect Theory". Chapter 3 examines its assumptions and implications using various empirical studies, chapter 4 compares and discusses these findings, and finally chapter 5 gives a brief summary.
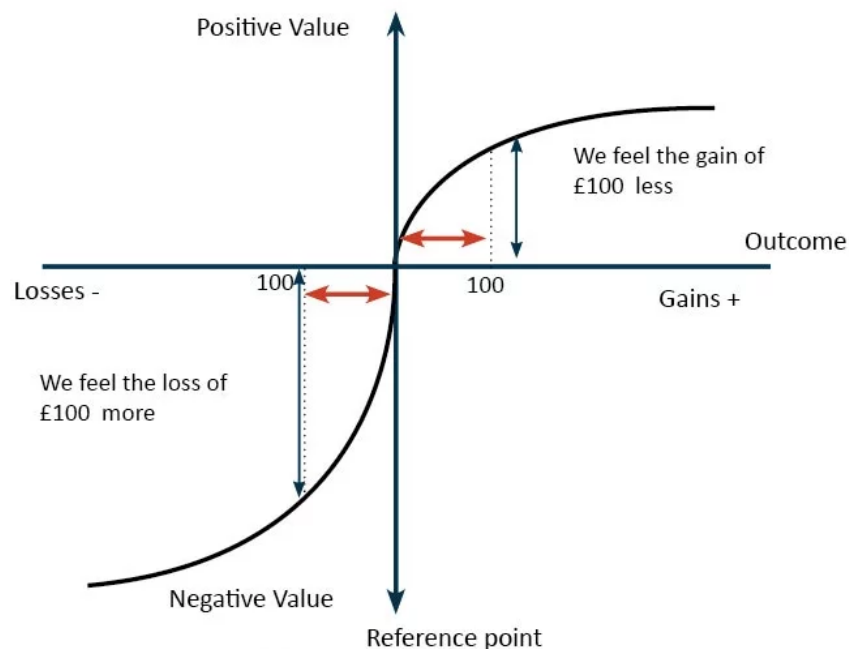
2 Theory

In 1979 Daniel Kahnemann and Amos Tversky published the article "Prospect Theory: An Analysis under Risk" in which they stated that under laboratory conditions people systematically violate the axioms of expected utility theory – the standard model of economists for decision-making under risk. Furthermore, they developed an alternative model of risk attitudes, called "prospect theory" (Barberis, 2013).

First of all, contrary to expected utility theory, prospect theory assumes that individuals derive utility from gains and losses relative to some reference point, rather than from final outcomes. In other words, the change of wealth or welfare is crucial, not the absolute level of it. Further essential features are the so-called (i) "certainty effect" and (ii) "isolation effect". The former (i) indicates that, in general, people tend to give greater weighting to outcomes that are considered

to be certain, relative to outcomes that are merely probable. Moreover, this overweighting of certainty contributes to risk aversion in the domain of gains and, conversely, risk seeking in the domain of losses – so people prefer a small certain gain over a probable larger gain and vice versa for losses. This resulting reversal of the preference order of prospects around 0 is referred to as reflection effect. These findings are not compatible with the notion that certainty is generally desirable, but rather imply that certainty increases the desirability of profits yet also the aversiveness of losses. The latter (ii) occurs when people have presented two options with the same outcome, but different routes to achieve the outcome. In this case, people are likely to cancel out similar information to lighten the cognitive load, and their conclusions will vary depending on how the options are framed (Kahneman and Tversky, 1979).

Figure 1: The Prospect Theory Value Function

Note: This is a typical value function where the horizontal axis represents the pound
(£) gain or loss, and the vertical axis, the utility value assigned to that gain or loss.
Source: Pettinger (2017).

Another cornerstone of Prospect Theory is the "value function", depicted in Figure 1, which illustrates the valuation of gains and losses relative to a given reference point. Furthermore, it captures "loss aversion", i.e. the idea that people tend to be much more sensitive to losses than to equivalent gains. This is represented in the value function by the higher slope in the negative range and by the fact that the value placed on a £100 gain is smaller in absolute magnitude than the value placed on a £100 loss, as can be seen in Figure 1. This goes back to the experience of Kahneman and Tversky (1979) that most people reject a 50:50 bet to win $110 or lose $100. This phenomenon can be explained by "narrow framing", which occurs when individuals evaluate a

risk separately from other concurrent risks (Barberis, 2013). Lastly, "diminishing sensitivity" is also embedded in the value function, implying that a change of £100 has a significantly greater effect on utility when it constitutes a large amount relative to the reference value – comparable to the concept of decreasing marginal utility.

Figure 2: The Prospect Theory Weighting Function
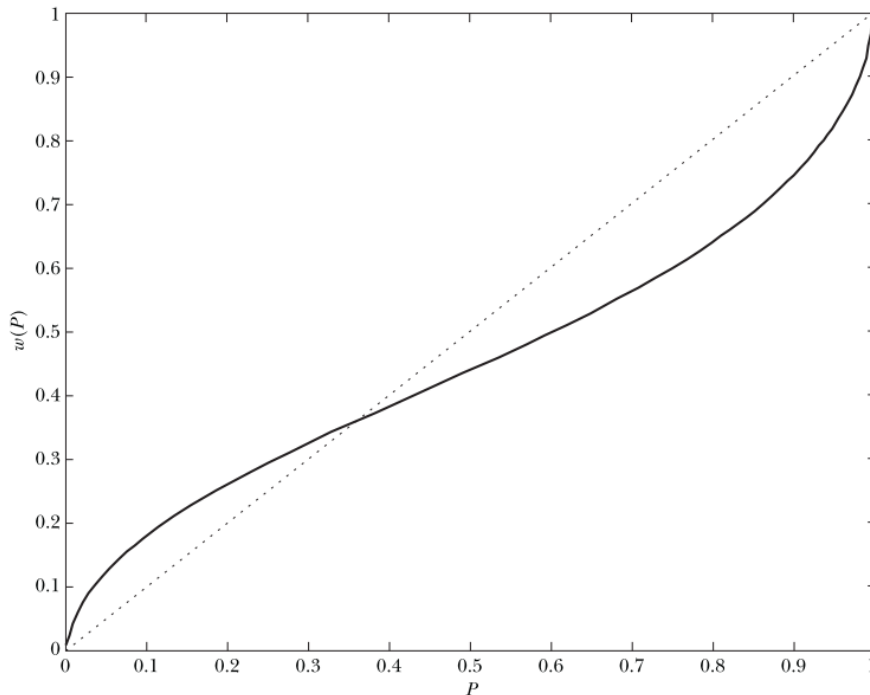
Note: The graph depicts the objective probability P on the horizontal axis and the weighted probability $w_{(P)}$ on the vertical axis.
Source: Barberis (2013).

The final component of prospect theory is "probability weighting", which was partially revised by Kahneman and Tversky (1992) in their more recent version of prospect theory, that is, cumulative prospective theory, enabling different weighting functions for gains and losses. Consequently, it is not objective probabilities that are decisive, but decision weights. In fact, they find that individuals tend to overweight low tail probabilities and underweight high tail probabilities. Figure 2 illustrates exactly this relative to a dotted 45-degree line, which represents the expected utility benchmark. Ultimately, there is another useful extension of Koszegi and Rabin (2006) in which expectations about outcomes serve as a substitute for the status quo as reference points. However, although there are further interesting enhancements, it would go beyond the scope of this paper to go into these in greater detail.

3 Empirical Evidence

There are numerous empirical studies which have examined the assumptions and implications of prospect theory. In the following, a selection of these is examined in the context of decision-making under risk.

3.1 Decision-making of experienced agents in a high-stakes context

A paper by Pope and Schweitzer (2011) examines field evidence of loss aversion based on the PGA Tour, an annual golf tournament series. In their study, they focus on the number of shots players require to complete a hole, known as putts. Subsequently, putts golfers attempted for par are compared with putts golfers attempted for scores different from par, in particular birdies.[1] The intuition behind this is the idea that players narrowly bracket on individual holes thus adopting par as their reference point – although not this reference point, but ultimately the overall tournament score is decisive – and consequently regard birdie putts as gain and par putts as loss. In fact, they found that golfers make their birdie putts on average about 2 percentage points less often than they make comparable par putts. This finding can be attributed to the risk shift implied by prospect theory towards higher risk aversion in the gain domain as opposed to the loss domain. Indeed, players hit their birdie putts less hard than their par putts, which is why birdie putts are more likely to be short of the hole – so there is some kind of trade-off between success rate and avoidance of difficult follow-up putts. This risk-averse behavior is consistent with the assumptions of prospect theory. To better visualize the magnitude of this effect: Without this risk-averse behavior, the expected tournament winnings of the top 20 golfers in 2007 would have been on average $640,000 higher. Moreover, the study explores some alternative explanations such as overconfidence or player heterogeneity, however, they omit the fact that, except for very few exceptions, only men play in the PGA Tour, so the results are not representative for women.

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[1]Par stands for the typical number of shots professional golfers take to complete a hole. Birdie means one shot less than par.

3.2 Decision-making of game show contestants in a high-stakes context

Post et al. (2008) investigate the decisions under risk of contestants in the TV game show "Deal or No Deal" as well as in related classroom experiments. The game show works as follows[2]: A contestant is shown 26 briefcases, each containing a hidden amount of money from 0.01 to 5,000,000 euros, whereupon the contestant selects a briefcase and possesses its unknown contents. Several briefcases are then opened in each round, revealing prizes that the participant can no longer receive. Furthermore, there is a bank offer, which is presented after each round and gives the contestant a choice between a certain amount of money and the possibility to continue playing. The bank offer hinges on the value of the unopened briefcases and the game will not end until the participant accepts a bank offer or chooses the content of his initially selected briefcase. They derive two main observations: Contestants' risk aversion appears to be declining after (i) previous expectations were thwarted by the opening of high-value briefcases, referred to as "break-even effect"; and after (ii) they were exceeded by the opening of low-value briefcases, referred to as "house-money effect". In fact, the break-even effect even leads to risk-seeking. This finding is consistent with the aforementioned extension of prospect theory by Koszegi and Rabin (2006) regarding the usage of expectations as reference point, as the subsequent results are coded as (i) loss or (ii) gain, respectively, depending on the preceding outcomes. They either take higher risks because they want to compensate for their paper losses or because they feel like they are playing with already won money. In their related classroom experiments, using an analogous design but lower stakes, it was also found that prior outcomes represent a greater driver for risk aversion than stakes. One point of criticism, nonetheless, is that the people participating in a game show are not necessarily representative of the population, but self-selected.

3.3 Risk-taking of Vietnamese villagers in the context of high relative stakes

Tanaka, Camerer, and Nguyen (2010) examine the risk and time preferences of individuals in Vietnamese villages and how these preferences relate to economic conditions. For this purpose, they conducted a field experiment in which randomly selected individuals from a group of previously interviewed households, differing in household income and median village income,

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[2]The subsequent design corresponds to the Dutch version. The format also exists in other countries, albeit slightly different, hence only the Dutch version will be further examined below.

participated. The experimental design is as follows: There are three series of pairwise lottery choices, A and B. The first two series consist of 14 choices with strictly positive pay-out values, the third series of 7 choices with potential negative outcomes. The first series is exemplarily shown in Table 1.

Table 1: Experimental Setup of Series 1

Option A		Option B		Expected payoff difference (A−B)
Series 1				
Balls 1–3	Balls 4–10	Ball 1	Balls 2–10	
40	10	68	5	7.7
40	10	75	5	7.0
40	10	83	5	6.0
40	10	93	5	5.2
40	10	106	5	3.9
40	10	125	5	2.0
40	10	150	5	−0.5
40	10	185	5	−4.0
40	10	220	5	−7.5
40	10	300	5	−15.5
40	10	400	5	−25.5
40	10	600	5	−45.5
40	10	1,000	5	−85.5
40	10	1,700	5	−155.5

Note: Values are stated in 1,000 dong.
Source: Tanaka, Camerer, and Nguyen (2010).

In Option A there are constant choices, while in Option B they shift over the course of the series, thereby changing the difference between the expected values of the two options. Participants have the opportunity to switch from A to B at any time, albeit only once. After completion of the three series, one of the choices is randomly selected and played with real money – the average experimental earning was 174,141 dong, about $11, which is roughly 6 to 9 days' wages for un-skilled workers. Their findings show that the mean village income is linked to risk preferences, i.e. people in poorer villages are more loss averse, however, they also note that household income is not correlated with risk preference. In general, most participants tend to loss aversion. The results indicate that irrespective of their economic background, individuals are present-biased – reflecting the phenomenon of narrow bracketing – and that their reference point depends rather on their local environment than on their personal economic situation. It may be criticized that the stake sizes were not varied more to test whether the stake size influences the decision-making of participants. Furthermore, 8 percent of the participants were illiterate and thus instructed by research assistants, which could possibly have led to unintentional interference.

3.4 Decision-making in the context of real-stakes compared to hypothetical-stakes

In their article, Rabin and Weizsäcker (2009) conduct a real-stakes and a hypothetical-stakes laboratory experiment replicating Tversky and Kahneman's original experiment. It's a relatively simple experiment: Participants face two distinct decisions, (i) firstly, a choice between a certain gain of £2.40 (A) and a 25% chance to win £10 or win nothing at all with a 75% chance (B), and (ii) secondly, a choice between a sure loss of £7.50 (C) and a 75% chance to lose £10 or to lose nothing at all with a 25% chance (D).[3] Regardless of whether the results are actually paid or not, about half of respondents choose A over B and slightly more than two-thirds choose D over C. This is consistent with the prediction of prospect theory about risk-seeking behavior in the loss range, however, it shows risk indifferent behavior in the gain range. Another interesting finding is that, both with and without actual payout, roughly 30% choose the combination AD, despite it being stochastically non-dominant, i.e. the combined distribution of BC equals AD plus a sure payout of £0.10. Then, in a supplementary question, the decision problem was merged and, as a result, the number of participants who chose AD fell to 0%. This clearly illustrates that individuals perceive the two decisions separately and not as a combined problem, which strongly indicates the existence of narrow bracketing. It could be criticized that no real losses are being investigated, as participants previously received £22. Considering narrow bracketing, this could perhaps be circumvented more effectively if the payment is made one week prior to the experiment rather than only a day before.

3.5 Risk-taking after realized losses compared to paper losses

An interesting study by Imas (2016) analyzed whether realized and paper losses have different effects on risk-taking. The participating students were endowed with $8 at the beginning of the experiment, followed by 4 rounds of investment decisions, and in each round they had to decide how much of $2 they wanted to invest in a lottery with a 1/6 chance to multiply the invested amount by seven. The participants were randomly divided into a realized or paper treatment. In the former, the participants' wealth positions were realized at the end of the third round, while in the latter they were not. This means for the former: In case of a loss, this amount was taken away

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[3]In the hypothetical payoff experiment, the values were hundredfolded. Additionally, all participants received a £22 show-up fee.

by the experimenter from their original $8. As a result, those who lost in the paper treatment subsequently increased their investment by $0.23 and those who lost in the realized treatment reduced it by $0.15. This implies that the assumption of risk-seeking behavior in the domain of losses only applies to paper losses, whereas not to realized losses. It could, however, be criticized that the effect of prior gains was not additionally examined, as this could have provided a more comprehensive assessment regarding the impact of the realization of outcomes.

4 Discussion

As illustrated by the preceding empirical papers, there are various approaches to examine the behavior of individuals under risk, differing in field and laboratory experiments, high and low-stake experiments, as well as real and hypothetical payouts. In general, core assumptions of prospect theory, such as loss aversion, narrow framing, and the idea of reference points, were largely confirmed. Particularly interesting regarding loss aversion was the result of Tanaka, Camerer, and Nguyen (2010) that people in poorer villages are more loss averse, yet household income has no impact on it. This indicates that the social environment may have a fairly strong influence on one's personal reference point. Furthermore, the studies revealed some differences regarding when individuals exhibit risk aversion and risk seeking. Most of the studies mentioned indicate that individuals are risk seeking in the domain of losses, however, the findings of Imas (2016) demonstrate that this may only be the case for paper losses whereas realized losses actually lead to risk aversion. Moreover, none of the studies – including Imas (2016) – investigated the effect of real losses, as it is challenging to test this in a laboratory setting since individuals are rather reluctant to participate in an experiment where they may lose money. However, it would be quite interesting to test in further studies whether this would lead to even greater risk aversion. In addition, the experiment of Rabin and Weizsäcker (2009) could not confirm risk averse behavior in the region of gains – nevertheless, the majority of studies is consistent with prospect theory in this respect. This finding of Rabin and Weizsäcker (2009) may be attributable to the small stake sizes in their experiment. Lastly, the results of Post et al. (2008) further imply that the effects of prior results have an even greater effect than differences in stake size.

5 Conclusion

In summary, the literature reviewed largely reflects the assumptions of prospect theory making it a helpful model to better understand to what extent prior outcomes, expectations and framing ultimately influence decision-making under risk. Furthermore, the question remains as to whether something should be done when people assess risk according to prospect theory and thus avoid, for example, important insurances due to annuities. Whether this behavior should be interpreted as mistake and therefore be changed is difficult to judge due to ethical concerns. Nevertheless, further research on aspects such as the exact influence of stake size, realized losses and cultural differences is still necessary.

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