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Explaining heterogeneity in utility functions by individual differences in preferred decision modes

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Explaining heterogeneity in utility functions by individual differences in preferred decision modes

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Abstract

The curvature of utility functions varies between people. We suggest that there exists a relationship between the mode in which a person usually makes a decision and the curvature of the individual utility function. In a deliberate decision mode, a decision-maker tends to have a nearly linear utility function. In an intuitive decision mode, the utility function is more curved. In our experiment the utility function is assessed with a lottery-based utility elicitation method and related to a measure that assesses the habitual preference for intuition and deliberation (Betsch, submitted). Results confirm that for people that habitually use the deliberate decision mode, the utility function is more linear than for people that habitually use the intuitive decision mode. The finding and its implications for the research on individual decision behavior in economics and psychology are discussed.

PsycINFO classification: 2360, 3120

JEL classification: D81, C91

Keywords: Utility function elicitation, risky decisions, intuition, value function, individual differences

1. Introduction

The question how people resolve decision problems under risk and uncertainty has been investigated in economics and psychology over decades. Theories of decision-making that dominate economic theory and that are rooted in the economics literature model choice as a maximization of preferences and assume that "agents behave as if optimizing some underlying preference function" (Starmer, 2000, p. 349); psychological research has been more concerned with modeling the processes that lead to decisions – Starmer subsumes the results of these efforts as "procedural theories" (p.350). The most widespread example of a fertilization between preference maximization approaches and procedural approaches is certainly Kahneman and Tversky's (cumulative) prospect theory ((C)PT, Tversky and Kahneman, 1979, 1992).

Many empirical studies on decision making under monetary risk find that humans are far from linear integration of weight and value in their solution of a risky decision problem and support directly the ideas put forward by Kahneman and Tversky (e.g., Abdellaoui, 2000; Gonzalez & Wu, 1999; Tversky & Fox, 1995). Specifically, these experimental studies show that individual value functions deviate from linearity in many cases; for most people they are inversely S-shaped, which is interpreted as risk averse decision behavior when gambling for monetary gains and risk seeking behavior in gambles with loss outcomes.

Additionally, various experiments have shown that the mode in which a decision is made, i.e. if a decision is made intuitively or deliberately, can strongly influence the decision outcome, post-choice satisfaction, the goodness of judgments and different other features of decision problems (e.g. Wilson & Schooler, 1991; Wilson et al., 1993; Betsch et al., in press). In this case, being intuitive does not mean a tendency to follow simple heuristics and cognitive shortcuts as put forward by Kahneman et al. (1982). Intuitive processing is rather captured as following instant, effortless evaluation processes (Hogarth, 2001), involving an automatic, affective good-bad like reaction. Various models capture the intuitive mode as complementary concept to a deliberate, effortful, planned and analytic way of taking decisions (e.g. Bargh, 1989; Chaiken, 1980; Epstein, 1983; Hogarth, 2001). Furthermore, there is strong evidence that individuals differ in the way they habitually use the intuitive or deliberate decision mode (e.g. Agor, 1994, Betsch, submitted; Langan-Fox & Shirley, 2003).

As recent research proposes, the decision mode can significantly influence the perception of value (Hsee & Rottenstreich, 2004, Exp. 1): Participants were confronted with comparative willingness-to-pay questions; when primed to evaluate their WTP by calculation (i.e. deliberation), participants' WTP varied significantly from the WTP after being primed to evaluate by feelings (i.e. by intuition). Although not directly tested in the experiments by Hsee & Rottenstreich, their findings substantiate the speculation that the more people use their feelings in the evaluation of the lotteries, the more the resulting value function is curved; conversely, people using calculation-based reasoning in their judgment should have a less curved value function[1].

The aforementioned findings suggest that habitual decision modes might influence people's decisions over monetary values; that is, they are related to the shape of

[1] Similar to these findings, the authors state in earlier work that the probability weighting function can be dependent on features of the lotteries such as the affect connected with the judged object: the weighting function was found to be more curved when the lotteries involved affect-rich in contrast to affect-poor goods (Rottenstreich & Hsee, 2001).

people's value function. We therefore hypothesize that there exists a testable relationship between the individuals' general tendency to behave rather deliberatively or intuitively and the way they evaluate monetary outcomes in risky decisions. We argue that intuitive people's subjective assessment should be more influenced by affective reactions (c.f. Loewenstein et al., 2001) than the subjective assessment of deliberate people. The subjective values of the latter group should correspond more closely to the stated monetary values presented in the experiment. Thus, keeping all other influences equal, such as an influence of individual assessment of probability values, individually preferred decision modes should account for differences in the individual utility functions in a systematic manner.

Concretely, our hypothesis claims that the monetary utility function of people with a preference for deliberate decision making deviates less from linearity than the one of non-deliberate decision makers. Conversely, the more people are intuitive when it comes to decision-making, the more their utility function should deviate from the linear form, i.e. the more it should be curved.

This hypothesis was tested in a lottery-based experiment. First, we assessed subjects' utility functions, based on a sequence of individually adapted lottery questions. Then, participants filled in an inventory that assessed their Preference for Intuition and Deliberation (PID, Betsch, submitted). Based on the lottery choices we were able to estimate an index for the curvature of the utility function. The test of our hypothesis is based on an analysis of the relationship between the curvature of individual utility functions and the individual preference for deliberation and intuition.

2. Method

Participants & Design

A total of 68 participants took part in the experiment. The study involved students of the University of Mannheim and was run in groups of about 17 students at a time. In this correlational design all participants were administered the same procedure described below. Based on the data from the preference for intuition and deliberation scale participants can be classified as dominantly deliberate or dominantly intuitive, allowing for a between-subjects comparison of the curvature.

Procedure

The entire experiment was run on computers using software written by the first author. A group of 5 subjects had participated in a pilot study which allowed for the adjustment of the software and the experimental protocol.

After subjects had entered the room they were told that they will repeatedly have to make decisions between two lotteries. The lotteries A and B were presented next to each other on the computer screen. Participants could indicate their choice by clicking on the respective button A or B on the computer screen. When they clicked on the button the next lottery appeared on the screen. The participants answered all lottery questions at their own pace. At the end of the experiment, the students answered the PID questionnaire on the computer screen. By clicking at one of five radio buttons they indicated their agreement with the statements. After the procedure the participants were thanked, debriefed, and dismissed.

In order to provide incentives and to enhance motivation, we informed subjects that after the session was over, one of the subjects participating in each experimental session was randomly selected to play for a real monetary pay-off based on his or her choices made in one of the lottery tasks. Since the outcomes of the lotteries were up to € 6000, we informed the subjects that the randomly selected person played for 1% of the positive outcomes (i.e. the gains) presented in the lotteries[2].

In the next section we describe the materials in more detail.

3. Materials

Value function elicitation

A value function assigns a subjective value to a stated (objective) value. To elicit such a function, it is necessary to elicit for every individual a number of points in the coordinate plane spanned between the stated and the subjective values (the utility of the stated values, for an illustration cf. figure 1).

*** insert figure 1 about here ***

Various methods exist to construct individual value functions, i.e. to assess these points, from observed decisions in a series of monetary gambles (Farquhar, 1984). Our elicitation mechanism is based on a method proposed by Abdellaoui (2000). In this method seven points are identified, $\{x_0, x_1, x_2, x_3, x_4, x_5, x_6\}$, from which the utility function can be estimated. This can be done for the gain domain and the loss domain,

[2] Furthermore, the experiment has included a price search task. Experimental results on the price search task are found in Schunk and Winter (2004).

resulting in two different parameters describing the utility function: alpha describes the utility function in the gain domain, beta in the risk domain.

To identify one single point x_i, participants had to make 5 decisions between lotteries. The lottery outcomes are adapted based on the prior decision of the subject, in order to determine - after 5 iterations - an outcome x_i that makes the subject indifferent between the lotteries A and B. This indifference is achieved as follows: If the subjects chooses lottery B, that is she prefers lottery B to lottery A, then the value of x_i is decreased, such that lottery B is less attractive. Conversely, if the subject prefers lottery A to lottery B, then the value of x_i is increased, such that lottery B gets more attractive. These steps are repeated 5 times for all elicited points x_i.

*** insert figure 2 about here ***

We now describe this procedure in detail: Individuals' utility function on the gain and on the loss domain is elicited using a series of 64 individually adapted lottery choice questions presented by the computer. Four of the lottery questions appear twice during the lottery elicitation process, providing the possibility to assess the preference reversal rate.

The method of utility function elicitation is based on the construction of so-called standard sequences of outcomes, $\{x_0, x_1, x_2, x_3, x_4, x_5, x_6\}$, i.e. monetary outcomes that are equally spaced in terms of their utility. In our design, we use a 5-step interval bisection procedure to determine an outcome x_1 that makes the subject indifferent between the lotteries A=(x_0, p; R, 1-p) and B=(x_1, p; r, 1-p) (see figure 2), where x_0, R, x_1

and r denote monetary payoffs of the lottery and p and (1-p) denote the probabilities of the respective payoffs (see figure 2). Here, we have 0§ $r< R<x_0< x_1$ and r, R and x_0 are held fixed. The answers to the first 5 presented lottery choice questions let us determine the desired x_1 which achieves indifference between lottery A and B, that is the subject is indifferent between lottery A and B.

In the next step of this procedure, that is the next 5 presented lotteries, we determine – again based on bisection - an x_2 that makes the subject indifferent between the lotteries (x_1, p; R, 1-p) and (x_2, p; r, 1-p). We continue this method until we have determined an x_6, that is, we have 5*6=30 lottery choice questions in total, plus two consistency check questions. Another 32 questions that follow the same logic explained above, are presented for the elicitation of the utility function on losses. Note that in our experiment, we have set R to 100 € and r to 0 €; x_0 has been set to 200 €[3]. These values are based on the suggestions of Abdellaoui (2000) and Wakker and Deneffe (1996). We start every 5-step bisection procedure for the elicitation of a *new* x_i with a value of $x_i=x_{i-1}+500$€. The interval, within which we determine the new x_i via bisection is then [x_{i-1}, x_{i-1} + 1000€]. Furthermore, p is set to 2/3 for all subjects and *for all lottery choices*, i.e. we exclude the perturbing effect of possibly different individual probability weighting functions for the construction of the utility function.

[3] For the loss domain, we used the negative of the above values as R, r and x_0, respectively.

Now, let u(·) denote the value- or utility-function on the gain or the loss domain and let w(·) denote the probability weighting function for the respective domain[4]. Then the constructed indifferences give pairs of equations of the following type:

$$w(p)\, u(x_i) + (1-w(p))\, u(R) \quad = \quad w(p)\, u(x_{i+1}) + (1-w(p))\, u(r) \qquad (1)$$

$$w(p)\, u(x_{i+1}) + (1-w(p))\, u(R) \quad = \quad w(p)\, u(x_{i+2}) + (1-w(p))\, u(r) \qquad (2)$$

From these two equations it follows:

$$u(x_{i+1}) - u(x_i) \quad = \quad u(x_{i+2}) - u(x_{i+1}) \qquad (3)$$

That is, in terms of utility, the trade-off of x_i for x_{i+1} is equivalent to the trade-off of x_{i+1} for x_{i+2}. We obtain a standard sequence of outcomes, $\{x_0, x_1, x_2, x_3, x_4, x_5, x_6\}$, which is –by construction- increasing for gains and decreasing for losses and which uniquely characterizes the individuals' utility function since the x_i are equally spaced in terms of their utility (see figure 1).

Following Tversky and Kahneman (1992), we assume a power utility function, which is "by far the most popular form for estimating money value" (Prelec, 2000):

$$u(x) = \begin{cases} x^{\alpha} & if\ x \geq 0 \\ -(-x)^{\beta} & if\ x < 0 \end{cases} \qquad (4)$$

α and β characterize the risk attitude of the individuals in the sense of a measure of proportional risk attitude (Eisenführ & Weber, 2003). Standard nonlinear least squares regression is used to estimate α and β, for gains and losses, respectively, in the above specification. A value of α and β equal to 1 denotes a linear utility function on gains and

[4] That is, we implicitly assume that individual preferences can be represented by, e.g., (Cumulative) Prospect Theory. Note, however, that the value function that we elicit is, indeed, a von-Neumann-Morgenstern utility function. Equation (3) holds also under Expected Utility Theory, as can be found by substituting p for w(p) in equations (1) and (2).

losses, respectively. If α is larger than 1, the utility function is convex and the individual is risk-seeking on gains, if α is smaller than one, the individual is risk-averse on gains, since the utility function is concave. For β, the results hold conversely. The absolute difference between the risk parameters, α and β, and 1 is a measure for the curvature of the utility function: The higher this measure, the more the utility function is curved, i.e. the more it deviates from a linear function (see figure 3). Therefore, we define: $a = | \alpha - 1 |$ and $b = | \beta - 1 |$ as indices for curvature, i.e. for the deviation of the particular utility functions from a linear function.

*** insert figure 3 about here ***

Linearity of the utility function means that people's subjective value of a risky monetary lottery is determined by the multiplication of the stated monetary value and its (weighted) probability. Holding the lottery probabilities constant, if people place subjective valuations on the stated monetary outcomes, the utility function becomes curved, i.e. it deviates from linearity. When people can gamble to win money, a majority of people actually prefers a sure payoff over a gamble, even if the two prospects, i.e. choice options in the lottery, have the same expected monetary values. This preference for the sure payoff is an example of a risk-averse decision and it is a consequence of people placing subjective valuations on the stated monetary outcomes. Under positive monetary outcomes, the observation of risk averse decisions leads to the construction of a concave utility function. The stronger the influence of subjective values, the more the decision deviates from the decision of an expected value maximizer.

Individual preference for intuition and deliberation (PID)

To assess people's preference to decide intuitively or deliberately we used the PID (Preference for Intuition and Deliberation) scale (Betsch, submitted). The questionnaire consists of 18 questions, 9 items assessing the preference for deliberation (PID-D), and 9 items assessing the individual preference for intuition (PID-I). On a 5-point scale, 1 indicating 'I don't agree', 5 indicating ' I totally agree', participants answered questions regarding their decision making habits. PID-D consists of items like 'I prefer making detailed plans to leaving things to chance' or 'I think before I act.' PID-I includes items like 'With most decisions it makes sense to rely on your feelings' or 'I carefully observe my deepest feelings'. In prior studies (total N > 2500; Betsch, submitted) the scale proved as reliable (Cronbach's α for PID-D varied between 0.78 and 0.84, for PID-I between 0.78 and 0.81), and the 2-dimensional structure was confirmed. The inventory captures a motive-like preference which is stable over time. A preference for a decision mode influences decision making especially in unconstrained situations (e.g. no time pressure, enough resources, etc.).

In a correlative validation study (Betsch, submitted, study 3) people scoring high on deliberation prove to be conscientious perfectionists with a high need for structure. They aim at maximizing rather than satisficing their decision outcome. Highly intuitive people are speedy decision makers and tend to score high on social and emotion-bound personality dimensions like extraversion, agreeableness, and openness for experience.

People prefer a strategy because they think it is the best strategy in a decision situation and not because they are especially good in or bad in logical thinking or they do or do not like thinking hard.

Based on the PID questionnaire each person can be classified as high or low intuitive and high and low deliberate. For most people one of the two strategies dominates the other. People with no preference may use the decision modes strongly dependent on the situation.

4. Results

From the total of 68 participants, 4 subjects are deleted from the sample[5]. These 4 subjects apparently did not take the utility elicitation part of the experiment seriously. The 64 subjects that we keep in the sample show a preference reversal rate of 21.9 % on gains and 23.4 % on losses in the utility function elicitation part of the experiment. This reversal rate is similar to other reversal rates reported elsewhere (Abdellaoui (2000): 17.9% and 13.7%; Camerer (1989): 26.5%; Starmer and Sugden (1989): 31.6%).
The median estimate of the utility functions on gains (α) is 0.89, with a mean standard error of the nonlinear least squares estimates of 0.055. In the loss domain β equals 0.90 (se = 0.058). Abdellaoui (2000) finds 0.89 and 0.92 for α and β, respectively. The coefficients of determination approach 1 (0.996 for α and 0.995 for β). In total, the

[5] Two of these subjects are outliers in terms of the time needed for the completion of the lottery questions: They needed less than 60 seconds for either the 32 lottery questions on gains or the 32 questions on losses - considerably less than the other participants in the experiment. The two other subjects are outliers in terms of the standard error of the coefficient estimates of the utility function: Their standard error of the coefficient estimate is more than one standard deviation larger than the standard errors of coefficient estimates for all the other subjects.

results regarding people's risk attitude are consistent with the predictions of prospect theory (Tversky and Kahneman, 1992) and subsequent work based on prospect theory.

Correlations with Preference for Intuitions and Deliberation (PID)

We hypothesized that the more deliberate a person is, the less curved the utility function should be; conversely, the more intuitive a person, the more curved the utility function. That is, we expect that both measures, $a = | \alpha - 1 |$ and $b = | \beta - 1 |$, are positively correlated with a preference for intuition and negatively correlated with a preference for deliberation.

As predicted, a high preference for deliberation was negatively related to the curvature in the gain (a) and in the loss domain (b): $r=-0.31$ ($p<0.01$) for a and $r=-0.24$ ($p<0.05$) for b. Thus, the more deliberate a decision maker, the less curved or the more linear was the utility function. Similarly, a high preference for intuition correlated positively with the curvature index. These effects hold only for the loss, but not the gain domain ($r=0.19$; $p<0.06$, and 0.09, ns. for b and a, respectively). The more intuitive a person was, the more curved was the utility function in the loss domain.

In two uni-ANOVAs with a and b as dependent variables we tested the proposed difference between intuitive and deliberate participants for significance. Participants were classified as intuitive when PID-I>PID-D and as deliberate when PID-D>PID-I. 4 participants with equal values on both scales were excluded. In the gain domain the index for curvature was $M_a=0.43$ ($sd=0.56$) for intuitives (N=17) and $M_a=.25$ ($sd=0.19$) for deliberates (N=43). The difference nearly approached significance ($F(1,58)=3.4$, $p<0.07$). In the loss domain the difference was not significant ($F<1.2$).

5. Discussion and Conclusion

In this experiment we showed that the curvature of individual value functions, assessed with an established elicitation method, is correlated with an individual preference for intuitive and deliberate decision-making. The more people prefer deliberate strategies the more linear is the utility function. On the contrary, the more intuitive a person is the more curved is the utility function. In an analysis of variance we find a close to significant effect showing that the index of curvature of the utility function is higher for intuitive than for deliberate people. We found empirical evidence for our hypothesis that a habitual individual-difference factor is systematically related to the observed differences in the curvature of individual utility functions.

Deliberate decision makers seem to perform "valuation by calculation" (Hsee & Rottenstreich, 2004). That is, when taking their lottery choice, they tend to calculate the expected value of the presented lotteries, i.e. they multiply the objective value of the lottery and its probability – which results in a nearly linear utility function. The data showed that people with a stronger preference for intuition attach a subjective valuation to the perceived objective values of the lotteries[6]. This translates into a more curved utility function. The results of our experiment confirm our hypothesis, derived from the findings by Hsee & Rottenstreich (2004), that habitual decision modes might influence people's decisions over monetary values.

The degree of curvature of the utility function is interpreted as the risk attitude of the decision maker. Our findings suggest that intuitive people use the affective risk

[6] Please note again that we have deliberately kept all probability values constant, such that the observed correlations do not result from differences in the perception or weighting of probabilities.

information contained in the lotteries when taking their decision. This affective influence might lead to the risk attitude: the feeling of risk is integrated in the judgment resulting in risk-averse or risk-seeking behavior. Deliberate people, on the contrary, seem to integrate only the stated values. It seems unlikely that deliberate people do not have any affective reactions to the lotteries. They might therefore abstract from this affective information and neglect it when making their judgment.

This interpretation of the observed relationship between habitual decision modes and lottery choice behavior is in line with other research: In Kaufmann's (2003) research, people were presented a list with returns of individual stocks, which differed in the total return and the variance of the return, i.e. the associated risk of the stock. People classified as intuitive based on the PID scale had a higher sensitivity towards the risk of the individual stocks than the rest of the sample. Similar to the findings in our study and consistent with the Risk-as-feelings-hypothesis (Loewenstein, et al., 2001), the risky stocks seem to trigger a feeling of risk that affects in particular intuitive people in their valuation of the lotteries.

Our findings have several implications for future research in psychology and economics. They suggest that individually stable traits might help explain observed economic behaviour, such as portfolio choice and stock market decisions. The findings might be of particular relevance in finance and insurance decisions, where the question whether there are stable individual differences in reasoning or decision making competence, has recently gained interest (see Parker and Fischhoff (2003), Stanovich and West (1998) and Stanovich and West (2000)), for example in the context of investor overconfidence models (Glaser et al., 2004).

Although affect and risk perception is increasingly considered in the literature, the focus has mostly been on the influence of mood or affective states on risky decision-making (e.g. Isen, Nygren, & Ashby, 1988; Mano, 1994; Wright & Bower, 1992). In this work we consider the impact of intuitive or deliberate decision making based on the idea that the information content used for a judgment varies with respect to the individually preferred decision mode. While deliberate people rather use the stated information, intuitives seem to process not only the stated values but also their subjective feeling of how safe or how good a lottery is. People using affective information, i.e. people with a preference for intuition, may be more prone to the effects of mood on their decisions in risky situations. This implies that further experimental set-ups should control for mood effects.

Our results suggest that people differ systematically in the way they solve risky decision problems, intuitive and deliberative processes and decision modes affect peoples' decisions. Further theoretical and empirical research on decision-making under risk and uncertainty will profit from considering different decision modes, for example by assessing individual preferences for intuition and deliberation.

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FIGURES

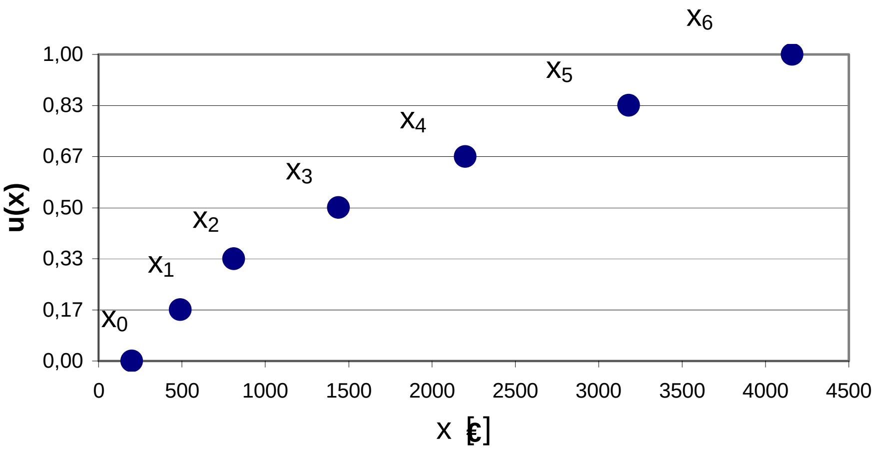

Figure 1: Utility function on gains for individual 1. The x_i are equally spaced in terms of their utility. This allows for the assessment of the curvature of the value function.

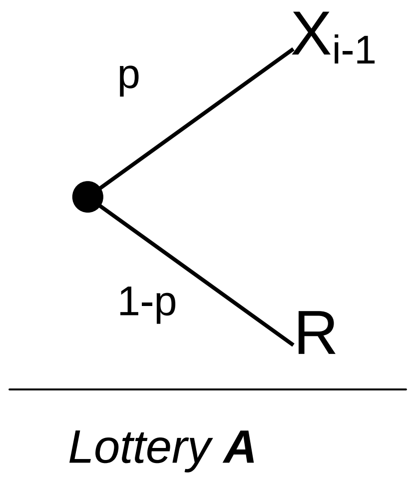

Figure 2: An example of the two presented lotteries.

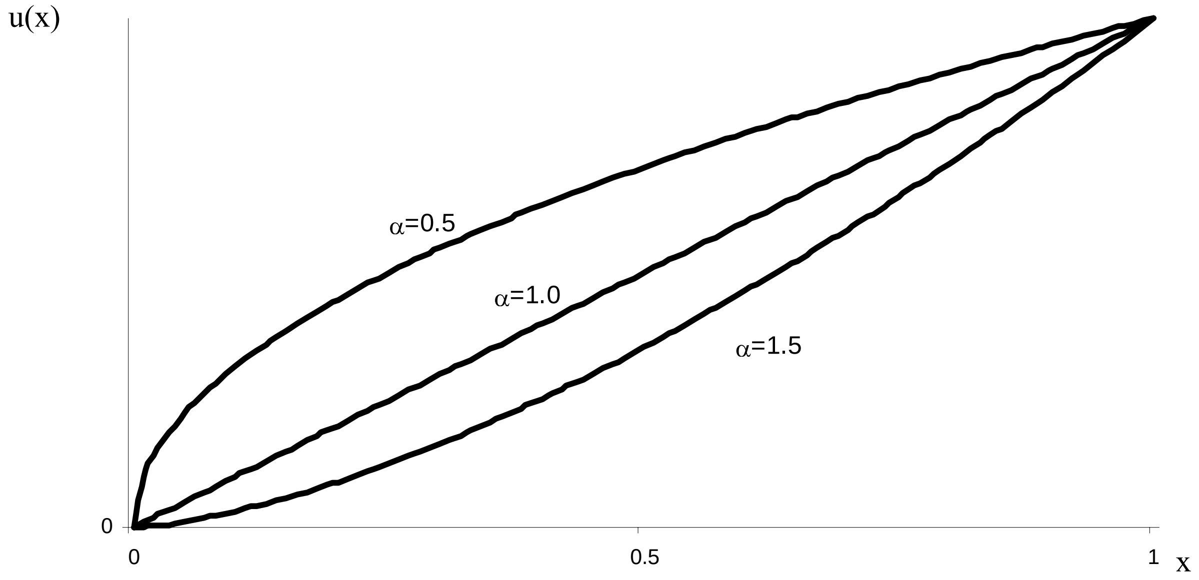

Figure 3: The utility function on gains for various values of α. The absolute difference between the parameter α and 1 is a measure for the curvature of the utility function

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