# FOUNDATIONS OF UTILITY AND RISK

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## BOOK OF ABSTRACTS

# Cutting Queues: Customer and System Behaviour in a Repeated Game

Vasco F. Alves

## Abstract

This paper analyses the individual decisions taken by customers when deciding whether to join an M/M/1 queue where a subset of regular customers who interact repeatedly can both cut the queue and be overtaken once they join, by-passing occasional users. This is shown to be an equilibrium in repeated games with perfect public monitoring for sufficiently patient customers: regular customers allow other regular customers to overtake them as long as the long-term discounted pay-off of doing so exceeds the costs of giving this permission. This equilibrium is shown to exist, and to be possible to describe as regular customers forming a sub-queue under the Last Come First Served discipline, inside the regular FCFS queue. The expected sojourn time for customers under this discipline is obtained, and this is then used to obtain a threshold joining strategy for arrivals.

**Mean-Dispersion Representation of Multiple Priors Preferences with Monotone Continuous Set of Prior**

Eric Andre

**Abstract**

This paper proves that, under the condition of monotone continuity of the set of priors, general multiple priors preferences have a mean-dispersion representation, that is they are a function of a baseline expected utility evaluation according to a reference probability and of the dispersion of the expected utility around this baseline when the other priors are considered. When constant absolute uncertainty aversion is imposed, this result provide an infinite dimensional extension of Grant and Polak (2013) and show that the VEU preference functional representation of Siniscalchi (2009) has a wider reach while focusing on a specific family of adjustment factors that have links to statistical distances.

# The Common Ratio Effect with Objects and Money

Danae Arroyos-Calvera, Andrea Isoni, Graham Loomes and Rebecca McDonald

## Abstract

The common ratio effect (CRE) is a phenomenon that Allais (1953) and Kahneman and Tversky (1979) used to demonstrate that many people do not behave according to expected utility theory (EUT). In its classic form, the CRE shows that people reverse their preferences over two prospects when the probabilities of the nonzero payoffs are scaled down by the same factor. This is a violation of the independence axiom and has motivated the development of numerous alternative models of decision making. For the ratios of probabilities and payoffs used by Kahneman and Tversky, the CRE is robust when the payoffs are money amounts. However, using money amounts to simplify choices may prompt people to use decision rules that are not so readily available in their everyday decisions involving non-monetary consequences. Our aim was to test whether the CRE would occur when the payoffs are non-monetary rewards – in this case, consumer goods. In our experiment, participants first familiarised themselves with 10 objects. We elicited each participant's monetary equivalent of each of the goods. Then they were asked to make choices between lotteries, some of which offered goods as payoffs while others offered the stated money equivalents of those goods. The probabilities in these lotteries are the ones featured in most CRE studies: 1 and 0.8 for the 'scaled up' pair of alternatives and 0.25 and 0.2 for the 'scaled down' pair. The goods were chosen for each participant from the set of objects so that their stated money equivalents approximated the 3:4 ratio typical of the money amounts in the classic CRE experiments. Within the non-monetary treatments, we manipulated object similarity by using some pairs of goods that had common characteristics (alarm clocks with different additional features), and other pairs where the characteristics were rather different and more difficult to compare (such as an airbed and a toaster, or an alarm clock and a suitcase). This design allowed us to explore choice patterns for consequences that differ in nature, but that participants stated were equivalent in value. To our knowledge, this is the first study that elicits incentive compatible answers to these questions. We found that the CRE persisted for monetary consequences, but it was greatly weakened for similar goods and disappeared for dissimilar goods. The stronger tendency for people to choose the risky alternative in the scaled up questions with goods may be at least partially driving this. Because people may find it hard to compare and make trade-offs between multi-dimensional goods, they may need to focus much of their attention on the payoff dimension and take less account of the probabilities, with the result that they more often end up choosing the option with the better payoff. The differences in the ways that money and goods are processed may have important implications for the descriptive validity of EUT in non-monetary settings such as the elicitation of health state indices.

# Firm's Protection Against Disasters: Are Investment and Insurance Substitutes or Complements?

Giuseppe Attanasi, Laura Concina, Caroline Kamate and Valentina Rotondi

## Abstract

In this paper we use a controlled laboratory experiment to study firm's and insurer's behavior when the firm can invest so as to protect itself against potential technological or environmental damages. The probability of a catastrophic event is objective and firm's costly investment in protection reduces it. The firm can also buy an insurance with full or partial refund against the consequences of the catastrophic events. In the insurer-firm dynamic game, first the insurer decides which contract to propose to the firm. After having observed the proposed insurance contract, the firm decides whether or not to buy and whether or not to invest in the reduction of the probability of the catastrophic events. We aim at understanding whether investment in protection and insurance against negative consequences are substitutes or complements in the firm's risk management of catastrophic events. Our experimental results suggest that investment to reduce probability of damages and insurance against their negative consequences are in general substitutes. In partial accordance with our theoretical predictions, investment is chosen more frequently than insurance. This result is independent on whether the probability of damages is increasing or decreasing over time. Furthermore, investment and insurance show complementarity only when the probability of large damages is quite high and the firm has not previously experienced disasters. Insurers are driving these results, since they usually offer contracts with deductibles. This allows firms to care more about large damages with small probabilities.

# Measuring Multivariate Risk Preferences in the Health Domain

Arthur Attema, Olivier l'Haridon and Gijs van de Kuilen

## Abstract

Objectives. In univariate settings, higher order risk attitudes, such as prudence and temperance, have been shown to be an important component of preferences, not only in the monetary domain but also in the health care field. Recent theoretical studies have crossed higher-order risk attitudes and multivariate preferences to prevention choice. However, no experimental tests of these theoretical derivations have been performed thus far. This study investigates univariate and multivariate risk preferences for health and wealth. First, we obtain model-free measurements (in the sense that we do not assume that individuals maximize a behavioral model such as expected utility) of univariate higher order risk preferences for longevity. Second, we are the first to obtain model-free measurements of attitudes toward the correlation structure between health and wealth, as well as higher order preferences toward multivariate risks for health and wealth. Finally, we provide direct evidence on whether these preferences are sign dependent. Methods. In a laboratory experiment, we measure correlation attitude in health-wealth trade-offs, complemented by higher order risk attitudes. We use the risk apportionment technique proposed by Eeckhoudt and Schlesinger (2006) and extended by Ebert and van de Kuilen (2015). We elicit these risk preferences for both gains and losses, since prospect theory predicts potentially different risk attitudes for these domains. Finally, we assemble data on many socio-demographic characteristics including health anxiety. Our results indicate that univariate (higher order) risk preferences are comparable for health and money, but different between gains and losses. Subject switch from risk aversion for gains to risk seeking for losses. The same holds for multivariate risk preferences, where we find correlation aversion and cross-prudence for gains, and correlation seeking and cross-imprudence for losses. We do not find clear evidence for cross-temperance. Finally, these risk preferences are not or only weakly correlated to health-related behaviours, except for anxiety, which shows a clear positive association with risk apportionment. Discussion. The results imply that attitudes toward dependence structures are sign-dependent, but not domain-dependent. In particular, longevity and wealth are considered to be substitutes for gains, but complements for losses. Anxiety about health is positively related to risk apportionment in longevity.

# On Time Discounting, Impatience and Risk Aversion

Yonatan Aumann

## Abstract

Time discounting is a common assumption in economic literature. We (re)explore the foundations of such time preferences, focusing on the roles of impatience, on the one hand, and uncertainty, on the other. "Impatience" is defined as a preference for experiencing better states sooner rather than later, even if there is no uncertainty associated with the future. First, considering impatience, it has long been known that impatience may restrict the possible structure and level of risk aversion; e.g. it is known that under the standard (exponential) discounted utility formulation, the coefficient of relative risk aversion must be the inverse of the inter-temporal elasticity of substitution. We show that this restriction is very strong. We prove that, assuming some weak stationarity assumptions, for any impatient preference order over the sure outcomes there exists at most one possible extension of this order to a preference order over lotteries. So, the agent's risk attitude is uniquely and fully determined by her certainty preferences. As such, we argue, impatience is incompatible with a semantically meaningful notion of risk aversion as a separate consideration. (The result holds even for preferences over finite sequences.) If, on the other hand, there *is* uncertainty associated with the future, then, we show, time discounting necessarily emerges - under very general assumptions - even if the underlying certainty preferences are not impatient. We explore the structure of such discounted preferences, and, in particular, the association between risk aversion and discounting. We show that the exact discounting structure is determined by: (i) the level of uncertainty associated with the future, (ii) the level of risk aversion, and (iii) the decision maker's quality of life - past, present and (expected) future. We provide a simple functional form for the resulting time discounting structure, as a function of these determinants. The implications to life cycle preferences are discussed. For simplicity, the entire study remains within the classic expected utility framework.

# Three Layers of Uncertainty: An Experiment

Ilke Aydogan, Loic Berger, Valentina Bosetti and Ning Liu

## Abstract

Our study is an experimental exploration of Marinacci's [Marinacci M (2015) Model Uncertainty. Journal of the European Economic Association 13(6): 998-1076] theoretical framework for modelling uncertainty. Decision maker (DM) is assumed to consider a set of possible data generating mechanisms each inducing a probability model, but she does not know the true underlying mechanism. The framework gives rise to three distinct layers of uncertainty: (1) physical uncertainty, entailing inherent randomness within each data generating mechanism, (2) model uncertainty, entailing subjective uncertainty of the DM about the true probability model, and (3) model misspecification, arising from the assumption that the true probability model may not be included in the initial set of models. Using a novel experimental design, we measure individual attitudes toward the different layers of uncertainty and observe the distinct role of each layer in the well-known ambiguity attitudes. In addition to extending the previous empirical literature on the underlying processes behind ambiguity aversion – failure to reduce compound probabilities or distinctive attitudes toward unknown probabilities, to our knowledge, our study is also the first empirical study to point out to the potential role of model misspecification in decision under uncertainty.

**Reinvestigating Loss Aversion in the Cumulative Prospect Theory: The Effect of Probability Weighting**

Elzbieta Babula

**Abstract**

The behavioral concept of the prospect theory is widely recognized as the best available description of choice under risk, however the original algorithm introduced by Kahneman and Tversky (1979) was proved to have significant defects and is no longer used. Instead, the cumulative prospect theory (CPT) (Tversky & Kahneman 1992) is considered as adequate alternative algorithm. Yet, it is important to acknowledge the differences between those two concepts as well as their consequences. Among others, CPT introduces (i) the different probability weighting for gains and losses and (ii) presumption of probabilities symmetry about the reference point. The second fact is reflected in the probability weights calculated in such a way that for gains, comparisons to the reference point concern comparisons downward, and for losses, calculating cumulative probabilities involve comparisons upward to the reference point (Wakker 2010). Additionally, the recognized problem of prospect theory is the trade-off between parameters of a value function and a probability weighting function. This fact has focused our attention on the consequences of introducing the symmetry about the reference point into the probability weighting algorithm, on the parallel aspect of value function, meaning the loss aversion. In order to address the issue under consideration, we compared loss aversion parameter λ estimated by the CPT and by the rank-dependent utility theory (RDU), but in the RDU allowing for the different parameter value for gains and losses, CPT alike. Therefore, the only difference between the two specifications was the symmetry of probabilities about the reference point issue. Model estimations are based on the experimental data from incentivized repeated binary choice under risk experiment. To determine the relevant decision problems the HILO structure was used (Camerer 1995). Subjects of the experiment were undergraduate students. The stochastic specification was estimated by the ML of logit model. The results strongly confirm the expectation. Both specifications were estimated for each subject separately. For every valid specification based on CPT model, the specification based on RDU provided significantly higher value of loss aversion parameter λ. In CPT-based specifications there were no cases of λ exceeding 1 (what is interpreted as loss aversion), while such estimates of λ were obtained in over a half of RDU-based specifications. The results bring new insights into relation between original prospect theory and cumulative prospect theory in the context of behavioral foundations, such as loss aversion.

# Act-State Dependence, Moral Hazard, and State-Dependent Utility

Jean Baccelli

## Abstract

My paper focuses on the problem of state-dependent utility, i.e., the challenges posed by state-dependent utility to the behavioral identification of beliefs (see, e.g., Karni, 1996, "Probabilities and Beliefs"). Given the status of the revealed preference methodology in decision theory, this is a problem of special methodological importance. I examine two views that prevail in the current literature. The first view is that expected utility and non-expected utility are equally exposed to the problem of state-dependent utility (see, e.g., Nau 2001, "de Finetti Was Right", p. 101). Thus, the problem would challenge the behavioral identification of beliefs, whatever the form taken by the beliefs in question (e.g., a single classical probability function, a set of classical probability functions, a single non-classical probability function). The second view is that any solution to this problem must involve moral hazard, i.e., situations where the decision-maker can influence the resolution of the uncertainty to which she is exposed (see, e.g., Drèze & Rustichini 2004, "State-Dependent Utility Theory", p. 51). Thus, the problem would lead to the somewhat paradoxical conclusion that a decision-maker's choices reveal her beliefs only when the decision-maker chooses her beliefs. I show that the two views above must be rejected at once. Non-expected utility is less exposed than expected utility to the problem of state-dependent utility, and there are solutions to this problem that do not involve moral hazard. This can be shown by revisiting, technically and conceptually, work by Drèze from the late 50s. The key step consists in realizing that, observationally speaking, act-dependent probabilities, a.k.a. act-state dependence, can, but need not, indicate moral hazard. In fact, most non-expected utility models prove to depart from expected utility 'for reasons unrelated to moral hazard' exactly in that they operate with act-dependent, rather than act-independent, probability values (see, e.g., Chambers & Echenique 2016, Revealed Preference Theory, p. 126). This simple fact, together with standard linear algebra, leads to rejecting the two views above. In light of this rejection, I update the received methodological interpretation of the problem of state-dependent utility. There is some good news for the revealed preference methodology, because there are some (non-paradoxical) possibility results for the behavioral identification of beliefs. However, the good news is limited, because some earlier impossibility results are confirmed, especially as regards expected utility, where, due to state-dependent utility, the beliefs prove behaviorally unidentified. All in all, the problem of state-dependent utility is far more model-sensitive, and expected-utility-specific, than currently understood in the literature. The question "do choices reveal beliefs?" has no general answer that would apply whatever the form, or indeed the content, of the beliefs in question.

**Discrete Arrow-Pratt Indices for Risk and Uncertainty: Theory and Practical Implementation**

Aurelien Baillon and Olivier l'Haridon

**Abstract**

In this paper, we introduce new indices of utility curvature (risk attitude under expected utility) that are based on utility midpoints and can be directly measured when probabilities are unknown (uncertainty) or distorted. These indices are approximations of the Arrow-Pratt indices and share the same qualitative properties. Yet, they can be directly obtained from choices without measuring the full utility function nor the agent's subjective probabilities. Our new indices are therefore particularly suited to study agents' risk attitudes with respect to natural uncertainties, as often needed in applied studies. We propose a method to elicit the indices and illustrate it in an experiment. It allows us to test for CARA and CRRA utility under risk and under uncertainty.

# Time-Consistency of Optimal Investment under Smooth Ambiguity

Anne Balter, Antje Mahayni and Nikolaus Schweizer

## Abstract

We study portfolio choice in a Black-Scholes world under drift uncertainty. Preferences towards risk and ambiguity are modeled using the smooth ambiguity approach under a double power utility assumption and a normal distribution assumption on the unknown drift. Optimal investment in this setting is time-inconsistent: While utility is maximized by a pre-commitment strategy resembling the classical Merton solution, the investor's future selves prefer to constantly increase the riskiness of the strategy. In contrast, the optimal dynamically consistent investment strategy accounts for variations in the perceived severity of drift uncertainty, thus increasing the riskiness of the strategy gradually over time. We provide a detailed comparative analysis of the mechanics and interplay of ambiguity, myopia and optimal decisions in this setting. We show that an investor who pre-commits will regret that decision from some time point onwards, wishing that she had followed the dynamically consistent strategy. This "point of regret" always lies near the middle of the investment horizon. More specially, in a stylized model setup, we study the effects on the riskiness of investment decisions arising from introducing ambiguity. Intuitively, it is clear that an aversion against ambiguity makes the optimal investment decision less risky compared to a suitable benchmark without ambiguity. In addition, time inconsistency arises naturally if the perceived degree of ambiguity depends on the length of the investment horizon. When comparing the certainty equivalent growth rates (yields) of the strategies over the entire investment horizon, the dynamically consistent strategy suffers from two sources of sub-optimality. Part of the loss is due to overinvestment into the risky asset because the benchmark is discounted over increasingly shorter periods of time. The other part is due to a suboptimal investment schedule that arises as the investor has to balance her current behavior against later changes in perceived ambiguity which she already anticipates. Pre-commitment thus beats the dynamically consistent strategy from a time 0 perspective. Yet due to the continuously decreasing perceived ambiguity, there will always be a point of regret when the investor wishes she had not entered a (now suboptimal) pre-commitment in the beginning. We define the point of regret as the time point at which dynamically consistent investment beats old commitments. We find that there is always a time of regret and a time of no regret: The point of regret always occurs after the first 36% but before the last 29% of the investment horizon.

# Bell-Type Inequalities and the Role of Signaling in Decision Making

Irina Basieva, Ehtibar Dzhafarov, Victor Hernando Cervantes Botero and Andrei Khrennikov

## Abstract

Different types of contextuality in everyday decision making Human decision making is notably contextual. If two questions are asked simultaneously, the answers are certainly dependent. The dependence can be direct or indirect. The latter is trickier to notice and its role is often erroneously neglected. Our experiment was designed to mimic Popescu-Rohrlich (PR) boxes via restrictions often encountered in everyday decision making. For example, one may want to spend 100 dollars to buy two items, which limits possible choices to one expensive item and one cheap item. If we have three items, pairwise joint probability distribution (jpd) does not imply overall jpd. Pairwise correlations can violate Bell-type inequalities due to direct influence (signaling, dependence of expectation value of one item choice on the second question), and this is the situation which has been prevailing in cognitive experiments so far. Absence of a common classical probability space (or common jpd) and violation of Bell-type inequalities inspired usage of Quantum-like models in psychology, economics, and other areas. However, quantum mechanics does not allow for signaling. Interestingly, there is no signaling in PR boxes, either. In our demonstration we distinguish signaling from "pure" contextuality and show that both types are present in cognitive experiments. Generalized Bell-type inequalities accounting for non-zero signaling, recently derived by Dzhafarov and Kujala (2015) are violated in our experiment.

**Probability and Time Trade-off with Resolution Time**

Manel Baucells

**Abstract**

Many decisions contain the elements of risk and time; as well as the timing of when uncertainty can be resolved. We expect individuals not to be indifferent to the timing of resolution of uncertainty, if only for planning improvement reasons, as well as psychological factors such as anticipation, curiosity or anxiety. The literature on timing of resolution is mostly normative and fails to capture the observed violations of the independence axiom, decreasing impatience, and magnitude dependent discounting. We consider a reduced form setup, whereby the objects of choice are described along four dimensions: outcome (e.g., a monetary gain), probability, the time the outcome is received, and the time uncertainty resolves. Our first contribution is to propose a set of behaviorally sound axioms and derive its associated representation. Preferences are described by two discount rates, one utility function, and a probability weighting function. The first discount rate penalizes the passage of time before uncertainty is resolved, and the second penalizes time after uncertainty is resolved. If the first discount rate is larger than the second, then the individual will exhibit a preference for early resolution of uncertainty. We do not directly discount utility. Rather, discounted probabilities are transformed using a probability weighting function, which then multiplies utility. Our second contribution is the empirical validation and calibration of the preference model. We propose choices that conform with our setup and verify that the trade-offs between probability and time are quite consistent with our axioms. As a result, we obtain estimates of the discount rates before and after resolution and confirm the prediction that most individuals exhibit preference for early resolution. We also document significant magnitude effects. We estimate the resolution rate premium, or difference between the discount rate before resolution and the discount rate after resolution. The latter is the baseline discount rate under certainty, to which we add a resolution premium that increases discounting in the presence of risk.

**Range and Sign Dependent Utility for Risk and Time**

Manel Baucells, Mohammed Abdellaoui, Veronica Cappelli and Emmanuel Kemel

**Abstract**

We introduce range and sign dependent utility (RSU), an integrative behavioral model for uncertain cash flows. For gambles played today, the model departs from cumulative prospect theory, and can be seen as an extension of original prospect theory based on range, rather than rank. For single future payouts, the model agrees with hyperbolic discounting; whereas for multiple cash flows it takes a novel form. The model comes with a framing rule to set the range and the reference point, and three functions: a loss averse value function, an s-shaped range distortion function, and a subjective survival function for time. RSU jointly explains the classical Allais paradoxes, the Samuelson paradox for risk and time, the preference reversal phenomenon and, for time, decreasing impatience and magnitude effects. Replacing the cash flow stream by a utility stream for consumption produces a behavioral version of discounted expected utility.

# An Axiomatic Foundation of Entropic Preferences under Knightian Uncertainty

Stefan Baumgartner and John-Oliver Engler

**Abstract**

Knightian uncertainty denotes income lotteries with known payoffs over known states of nature, but unknown probabilities of these outcomes (Keynes 1921; Knight 1921). It is a deeper form of not-knowing-the future than risk (where probabilities of outcomes are known) or ambiguity (where people have some, possibly differing, beliefs about the likelihood of outcomes), but less deep than unawareness of payoffs (in some or all states) or unawareness of potential states of nature. In this paper, we provide an axiomatic foundation of preferences over lotteries with known payoffs over known states of nature and unknown probabilities of these outcomes ("Knightian uncertainty"). We elaborate the fundamental idea that preferences over Knightian lotteries can be represented by an entropy function (Lieb and Yngvason 1999) of these lotteries. Based on nine axioms on the preference relation and three assumptions on the set of lotteries, we show that there uniquely (up to linear-affine transformations) exists an additive and extensive real-valued function ("entropy function") that represents uncertainty preferences. It represents non-satiation and (constant) uncertainty aversion. As a concrete functional form, we propose a one-parameter function based on Renyi's (1961) generalized entropy. We demonstrate that this function has all the properties of a general uncertainty preference index, and we interpret the properties that it has in addition. We show that the parameter captures the degree of uncertainty aversion. We illustrate our preference function with a simple decision problem and relate it to existing decision rules under uncertainty (maximin, maximax, Hurwicz, risk-neutral and risk-averse Laplacian expected utility, minimum regret).

# Decision under Risk: Dispersion and Skewness

Oben Bayrak and John D. Hey

## Abstract

When people take decisions under risk, it is not only the expected utility that is important, but also the shape of the distribution of returns: clearly the dispersion is important, but also the skewness. For given mean and dispersion, decision-makers treat positively and negatively skewed prospect differently. This paper presents a new behaviourally-inspired model for decision making under risk, incorporating both dispersion and skewness. We run a horse-race of this new model against seven other models of decision-making under risk, and show that it outperforms many in terms of goodness of fit and, perhaps more importantly, predictive ability. It can incorporate the prominent anomalies of standard theory such as the Allais paradox, the valuation gap, and preference reversals.

# A Model of Adaptive Preferences

Arpita Bhattacharjee

## Abstract

Adaptive Preferences (AP) are typically defined as a specific case of endogenous preferences, that arise in response to an individual's perception of what is attainable. For Example, consider a poor uneducated woman in a patriarchal society such as that of India, who is a victim of domestic violence but comes to accept it as a part of life. In her perceived state of the world, this violence is something women have to put up with as a result of being dependent on men and having left her own family to move into her husband's home (Nussbaum 2001). Individual perceptions of the feasible opportunities could have been distorted owing to years of oppression, marginalization, rigid social structures and extreme social disciplining. Another example in this context is that of women's voluntary participation in female genital mutilation practiced in certain communities in Sub Saharan Africa. The machinery for analyses in mainstream economics has typically treated preferences as fixed, or "hard-wired". Furthermore, the methodological individualism in mainstream economics has been criticized for subsuming the idea of agency within the utility maximizing paradigm. Individuals however are not stagnant hollow entities devoid of context and it is an oversimplification to assume that a person is born with preferences that stay fixed over their lifetime, or that the scope of agency available to them does not directly affect their decision-making process. Moreover, in cases where individuals' behaviour seems to further perpetuate their deprivation, we should be cautious that the underlying preferences are most likely adaptive. This paper is an attempt to start a dialogue for incorporating a type of endogenous preferences – Adaptive Preferences (AP) – into the theory of preference and choice in economics. I construct a simple analytical framework that can be used to evaluate adaptive preferences where they exist, and infer policy lessons on how to tackle these "suspect" preferences. This framework, while maintaining the ultimate decision-maker status of individuals, situates them in context of their circumstances. In the model developed, preferences are shown to be acquired through an autonomous process of deliberation given an individual's beliefs about their access to opportunities, using a VNM expected utility framework that assigns `utility' to pairs of opportunity sets and preference ordering. If the individual believes that she faces a restricted opportunity set then she will choose to adapt her preferences according to what she perceives as her feasible set of opportunities. Subsequently, the framework is applied to case studies of Domestic Violence, and voluntary participation in Female Genital Mutilation, in highlighting how preferences are shaped under historically oppressive "gendered" structures and the consequences for women's choice and agency.

# How to Invest and Spend Wealth in Retirement? A Utility-Based Analysis

Servaas van Bilsen, Roger Laeven and Lans Bovenberg

## Abstract

This paper explores the optimal consumption and investment behavior of a retiree who derives utility from the ratio between his consumption and an endogenous habit. By developing a non-trivial linearization to the budget constraint, we obtain closed-form policies. This enables us to explicitly characterize how the preference parameters determine the optimal shock absorbing mechanism and investment strategy. We also consider an extension which decouples relative risk aversion from the elasticity of intertemporal substitution. We show that under this extension investments in risky assets decrease and median consumption no longer grows at unrealistically high rates at high ages.

**Investor Behaviour, Stock Prices and Corporate Reputation: An Experimental Approach**

Anna Blajer-Golebiewska

Abstract

Observing a growing literature on the impact of corporate reputation on stock prices, we noticed that it has still not yet been fully explored in the behavioural context. As a result, the aim of this study is to investigate whether corporate reputation is an important factor in investors' decision making processes when it comes to unexpected significant changes in stock prices. In our incentivised economic experiment we asked subjects to make decisions as investors in an artificial stock exchange. We manipulated information aiming to constitute a certain level of corporate reputation. Then, subjects faced an unexpected significant change in share price in the opposite direction (e.g. if a good corporate reputation was induced, then later the stock price decreased). We found male subjects increasing their marginal propensity to invest (MPI) when stock price decreased; in the case of female subjects, the average MPI was slightly higher when stock prices were unexpectedly falling. The subjects made different decisions depending whether they faced either an unexpected significant increase or decrease in stock prices. Thus, we ran two separate logistic regressions (n1=183 and n2=185). Our response variable was a change in the MPI (decrease or increase). In the case of an unexpected significant decrease in prices, the reported level of corporate reputation was a non-statistically significant predictor of changes in MPI. However, we found gender and the value of investment at the beginning of the experiment to be significant predictors. For male subjects, the odds of increasing their MPI were higher than for female subjects. The higher the amount of money invested at the beginning, the lower the increase in MPI reported at the end of experiment. Remaining variables (age, experience in investing, faith in intuition, risk attitude, time of decision-making process, investor's economic situation) were non-significant in the model. In the case of an unexpected significant increase in prices, the reported level of corporate reputation was a statistically significant predictor of changes in MPI, however, the effect was minor. In this model we also found gender and the value invested at the beginning of experiment to be significant predictors of changes in MPI. In contrast to the previous model, the odds of increasing MPI for male subjects were lower than for female subjects. Furthermore, we found that the odds of increasing MPI were higher for more risk-loving subjects and lower for subjects who needed more time to complete the experiment. To sum up, when prices unexpectedly decrease, investors do not take corporate reputation into consideration. When prices unexpectedly go up the effect of corporate reputation is minor. Investors rely more on the value already invested in shares of a company, and their decisions depend heavily on their risk attitude and gender. We believe our study to be a useful starting point for further investigation into this problem.

# Comparing Theories of Choice under Risk: Where Is The Reference Point?

Serge Blondel and May Attallah

**Abstract**

In the prospect theory, the reference point (RP) is 0. However, the RP could vary across the different choices. For example, in the problems of Kahneman and Tversky (1979), you certainly will prefer to have to choose between 3000 Israeli pounds for sure and 4000 with 80% of chances, than to choose between 3000 Israeli pounds with 25% or chances and 4000 with 20% of chances. In the first choice, your reference point must be higher, as assumed by Köszegi and Rabin (2006). We will use the data of Hey and Orme (HO, 1994). The data are experimental results where the subjects had to do binary choices. The probabilities were multiples of one-eight. The questions were presented in a random order. At the end of the experiment, one decision was played for real. 0, 10, 20 and 30 where the possible outcomes. The same 25 choices where proposed in 4 different Marshak-Machina triangles (0, 10, 20 or 0, 10, 30 or 0, 20, 30 or 10, 20, 30). Sure you prefer to be in the last triangle, and so the RP is not the same since you are sure to win at least I£10. When you analyze more deeply the HO data, you will see that the average gain is around I£15: then the subjects could consider I£0 and I£10 as losses, and I£20 and I£30 as gains. We observe a sort of reflection effect: when the subjects are sure to obtain at least I£10, they are risk seeking (31% have chosen the safer option) while when they are sure to obtain no more than I£20, they are risk averse (70% have chosen the safer option). Hey and Orme (1994) have compared various theories but the RP was 0 for prospect theory. We will redo the estimations with various hypotheses on the RP: 0, 10 or the expected value in the data set for instance. The results will be compared to the ones in the seminal paper of Hey and Orme. We will do the estimations subject by subject, for expected utility, prospect theory (Kahneman and Tversky 1979), and cumulative prospect theory (Tversky and Kahneman 1992). For both versions of prospect theory, we will try various RP.

# Social Preferences under Risk: On Exploiting Moral Wiggle Room

Abhinash Borah

## Abstract

We propose and axiomatize a decision model of social preferences under risk that considers decision makers (DMs) for whom generous behavior is driven largely by an egoistical desire to perceive themselves as prosocial, rather than by some deeper social commitment for concerns like fairness. Our decision model builds on the premise that such DMs seek to exploit moral wiggle room when deciding on the extent of their generosity. That is, whenever possible, they seek out situational justifications that allow them to behave more selfishly without concomitantly hurting their self-perception of being prosocial. We show that social situations of risk provide a natural scenario where such moral wiggle room can be exploited. Specifically, our decision model considers a set-up with a DM and one other individual. The critical insight that it captures is how the presence of risk may allow the DM to exploit the distinction between the other individual's ex post outcome and his ex-ante opportunity in a self-serving way, and think of herself as more prosocial than what is warranted by his actual outcome under her choice. That is, when the other individual receives an unfavorable (ex-post) outcome under a chosen lottery, the presence of (ex-ante) risk may allow the DM to think of herself as more prosocial than warranted by justifying that he had an opportunity to do much better under the lottery – as if telling herself, "Well, I intended better, but fate is to be blamed for his unfavorable outcome!" This, in turn, allows her to behave more selfishly in environments with risk than in those without it. We propose a representation of the DM's preferences that formalizes this way of exploiting moral wiggle room. We show that the representation can be derived from plausible axioms on behavior. Our key axiom uses the notion of an elation-disappointment decomposition (Gul 1991) to highlight a disparity in the DM's attitude towards risk that she faces compared to that faced by the other individual and ties her tendency to exploit moral wiggle room to this disparity. Our approach, in particular, our position on why opportunity concerns matter, contrasts with fairness-based models (e.g., Fudenberg and Levine 2012; Saito, 2013) that posit that individuals have a deep aversion to inequality of both outcomes and opportunities. We highlight the empirical content of the difference in the two approaches by showing that experimental evidence (e.g., Dana et al. 2007; Brock et al. 2013) that is inconsistent with the inequality aversion paradigm can be rationalized by our model. At the same time, evidence that has a natural interpretation of arising out of a concern for procedural fairness, like sharing chances in the probabilistic dictator game, can also be accommodated by our model. Therefore, the model provides a unified framework for understanding a wide array of the existing experimental evidence on generous behavior under risk.

# Choice via Social Influence

Abhinash Borah and Christopher Kops

## Abstract

We introduce a theory of socially influenced individual choices. The source of social influence on an individual are his reference groups. We think of a reference group as any group that an individual uses as a standard or benchmark for evaluating himself and his behavior. Our starting point is the premise that an individual's reference groups serve as filters through which he organizes his world and the choices he considers worth making. We want to understand how this influence psychologically constrains choices of decision makers (DMs). To do so, we develop a model in which we consider a society whose members may mutually socially influence each other owing to the salience that choices made within their reference groups have in their decision making process. Specifically, we introduce a choice procedure under which, in any choice problem, a DM considers only those alternatives that he can identify with at least one of his reference groups. From this "consideration set", he chooses the best alternative according to his preferences. We call this choice procedure choice via social influence (CSI). The key feature of the CSI procedure is that it is an interactive one with DMs' choices both being influenced by as well as influencing the choices of others. The procedure itself may be thought of as a steady state or fixed point of such a process of mutual social influence. Our key theoretical goal is to provide a behavioral characterization of the CSI choice procedure. That is, we investigate the following question: can an outside observer look at the choices of a group of individuals and verify whether their choices are subject to the type of social influence that the CSI procedure lays out? We identify a single condition on the DMs' choices that allows us to answer this question in the affirmative. We also investigate the question of the extent to which the key aspects of the CSI procedure – DMs' preferences and consideration sets – can be uniquely identified. We highlight the empirical content of our theory by showing how it can explain leading examples of social influence reported in the literature, including both instances of conformity and nonconformity. For instance, it can account for the pattern of choices in the famous Asch conformity experiments (Asch 1955). At the level of nonconformity, it can accommodate, for instance, a prominent experimental finding reported in the literature that we see greater diversity and variance in choices when these are made as part of a group as opposed to when these are made individually (Ariely and Levav 2000).

**Subjective State Space under Complete Uncertainty**

Dino Borie

**Abstract**

This paper discusses the definition of a subjective state space and corresponding choice sets that figure in the theory of decision making under uncertainty. We analyze the ranking of sets of lotteries as a modeling tool for choice under complete uncertainty. In this framework, the elements of the sets to be ranked are interpreted as possible outcomes under uncertainty, and the final (unique) choice from a set of possible lotteries is assumed to be made by the nature. A decision maker is characterized by two binary relations. The first reflects choices that are unaffected by the resolution of the uncertainty. The second relation models the choice made by the decision maker. In the context of decision under uncertainty, we propose axioms that the two relations might satisfy. These axioms allow to characterize the existence of a subjective state space and subjective acts independently of the final choice rule.

# Organizational Ethics, Narratives and Social Dysfunctions

Steven Bosworth and Dennis Snower

## Abstract

The paper explores the joint determination of economic output, wages, corporate culture, employees' ethical standards and monitoring intensity in an analysis of organizational dysfunction. The utility from economic activities can frequently be enhanced through unethical, socially harmful activity such as corruption. The ethical sensitivities of managers and their employees are shaped through their social interactions and thus organizational dysfunctions can arise. Such dysfunctions may be mitigated through changes in government policies or social norms. These changes become particularly effective if they encourage the managers and employees to adopt more ethical narratives. This narrative shift gives the managers and employees more ethical objectives, guiding their economic behaviors.

# Choice Correspondence and the Completeness Axiom: A Methodology and an Experiment

Elias Bouacida

## Abstract

The completeness of preferences is a widespread assumption in economics, despite its lack of normative appeal or empirical validation. A key in order to empirically study it is to elicit a choice correspondence, i.e., the possibility to choose several alternatives rather than a single alternative from a set. We build a methodology in order to elicit choice correspondences and give the conditions under which this elicitation properly reflects decision makers' preferences. We apply this methodology in an experiment. We find that 98.04% of the subjects chose more than one alternative at least once, and that only 42.04% of observed choices are singletons, which points to the relevance of studying the possibility of choosing non singleton sets. We find that 42.16% of elicited choice correspondences verify the weak axiom of revealed preferences, which implies that they verify the completeness assumption. We then proceed to assess Eliaz and Ok (2006)'s construction that assumes a notion of regularity on top of transitivity and show that it explains only 2.68% of our data. We then investigate various weaknesses of their construction, to assess which assumption fails, transitivity, regularity or completeness on our data. Transitivity is verified by 93.14% of subjects when restricting our data to binary choices, which points toward a failure of regularity rather than transitivity.

# Higher Order Risk Preferences for Gains and Losses

Paul van Bruggen and Han Bleichrodt

## Abstract

Higher order risk preferences such as prudence and temperance are important determinants of economic behaviour. Eeckhoudt and Schlesinger (2006) provide model-free definitions of higher order risk preferences through simple lottery pairs. Eeckhoudt et al. (2009) provide an intuition how higher order risk preferences might be related: they show that a preference for combining relatively good with relatively bad outcomes (where good and bad are defined according to stochastic dominance) leads iteratively to risk apportionment of any order. An individual who prefers combining good with bad would thus be risk averse, prudent and temperate. Crainich et al. (2013) show that by applying similar logic risk lovers should also be prudent but should be intemperate. The model-free definitions of Eeckhoudt and Schlesinger (2006) and the results of Eeckhoudt et al. (2009) have the important advantage that they can be used when expected utility is violated. One well-known violation of expected utility is reference dependence, leading to a reflection of risk preferences over the gain and loss domain (Kahneman and Tversky 1979, see for some recent findings e.g. Bruhin et al. 2010 and Abdellaoui et al. 2013). This empirical regularity is relevant for higher order risk preferences but has not yet received much attention in the literature. The typical reversal of second order risk attitudes may indicate that people have a preference for combining good with bad for gains but good with good for losses. Such a preference would imply a reflection effect for second and fourth order risk preferences. We perform a laboratory experiment where we measure higher order risk preferences under gains and losses. Losses were implemented by giving subjects an envelope containing an endowment (â,¬15) equal to their expected earnings on entering the lab, and by having all outcomes in the gain treatment be positive additions to this endowment, and all outcomes in the loss treatment negative additions to this endowment. 122 subjects participated in the experiment. They were presented with 12 tasks for each risk attitude in a given treatment to allow us to draw conclusions at the individual level. We find a reflection effect for higher order risk preferences: under gains, the majority of choices are risk averse, prudent and intemperate, whereas under losses the majority of choices are risk loving, imprudent and temperate. We do not find evidence that a preference for combining good with bad or good with good underlies higher order risk preferences: despite a greater frequency of risk lovers under losses than under gains, we find that temperance is also more common under losses than gains; we find no evidence that fourth order preferences on the individual level are related to second order risk preferences; and we find strong imprudence under losses.

# Is Communication Always Helpful?

Valeria Burdea

## Abstract

Can people distinguish between informative and uninformative communication and if so, can they use each one appropriately? Are there (hidden) costs in this process? Using a lab experiment, this study explores when communication helps and when it can harm. We focus on a one-shot seller-buyer environment with asymmetric information about the state of the world. In this setting there are two possible states – blue and red. The realized state is randomly determined by drawing a ball from an urn containing 3 balls of red or blue colour. The urn's distribution of colours is common knowledge. Preferences are such that the seller would like the buyer to always buy the red product. However, the buyer would only like to buy the red product if a red ball was drawn and the blue product if a blue ball was drawn. We implement four treatments across which two dimensions are varied: whether the seller is allowed to send a free-form text message to the buyer and the frequency of red balls in the urn. The red ball frequency can take two values: 2/3 and 1/3. By varying this frequency we implicitly vary the likelihood that the seller's preferred action coincides with the buyer's optimal one. Theoretically, in this game with seller state-independent preferences, only a babbling equilibrium exists. Hence, communication should have no effect and the buyer should always buy the red product in the 2/3 treatments but never in the 1/3 ones. Surprisingly, we find that communication is dissuasive and efficiency-decreasing when interests are more likely to be aligned but persuasive and efficiency-increasing when interests are more likely to conflict. Specifically, communication decreases the frequency of buyers choosing sellers' preferred action in the 2/3 case. In contrast, this frequency increases in the 1/3 case. Thus, communication reduces sellers' average payoff in the first scenario and increases it in the second. Buyers' average payoff is not significantly affected. These asymmetric effects cannot be accommodated by standard economic theory, beliefs about sellers' lying aversion or existing models of social preferences such as inequity aversion or efficiency concerns. Truthful blue-state reporting is not a good explanation either since sellers misreport these states as red in most cases. A possible explanation is that communication leads buyers to disregard the information regarding the frequency of red balls, basing their decision solely on the message sent by sellers. This strategy would pay off if sellers had high lying costs which does not seem to be the case in our experiment. Our findings raise concerns regarding the general effectiveness of communication as a tool to improve outcomes in negotiations. In addition, they suggest that when faced with both factual and social information, the latter has a stronger weight on people's decisions. From this perspective, this study could contribute to better understanding the recent advent and propagation of "fake news".

**Marijuana, Opioids, and Rationality**

Daniel R. Burghart

**Abstract**

Marijuana is often consumed as a recreational drug. While some US states have legalized marijuana, it remains prohibited by federal law. This prohibition is a form of paternalism that can be justified on economic grounds if individuals under the influence are incapable of rational behavior. Opioids are a growing cause of death in the US. This led the CDC to label opioid overdose as an epidemic and the president to declare it as a national public health emergency. A major risk factor for opioid overdose is dependence. Opioid dependence is a situation where the widely held assumption of consumer sovereignty has been called into question. Specifically, economists accept that interventionist policies can improve opioid dependent choosers' well-being. This line of thinking reflected in numerous modeling attempts all of which build on a foundation of rationality. The rationality assumption is, therefore, critical for any economic analysis aimed at informing policy discussions related to marijuana and opioids. It is not clear, however, whether rationality is preserved during the physiological states experienced by individuals influenced by these substances. This implies a clear role for experimental measurement. This presentation reports results from two experiments, both conducted in clinical settings, in which individuals are known to be influenced by these substances. The first experiment was a three session, within-subject, randomized, placebo-controlled experiment in which participants were orally administered THC, the main psychoactive component of marijuana, MDMA, the main psychoactive component of 'ecstasy', and a placebo. While intoxicated, participants chose between monetary payment and access to Facebook. The design of the experiment made possible an assessment of the acute effects of THC and MDMA on adherence to the generalized axiom of revealed preference (GARP), a necessary and sufficient condition for maximization of a well-behaved utility function. Choices made under the influence of THC and MDMA were all GARP compliant: Individuals acutely intoxicated with THC or MDMA satisfied the utility maximization hypothesis. The second experiment was a week-long, inpatient, within-subject study of opioid dependent individuals. Participants' pharmacological state was controlled through intravenous injections of an opioid agonist (morphine), an opioid antagonist (naloxone), and a placebo (saline). Following these injections participants chose amongst bundles of morphine and cash. The design of the task made possible an evaluation of GARP. Within each pharmacological state there were very high rates of GARP compliance. These results are consistent with assumptions made in economic models of addiction. Furthermore, these results support the utility maximization hypothesis even when choices are made by opioid-dependent choosers in the extreme states experienced by this population.

# Choice Process under Uncertainty: An Eye-Tracking Analysis

Irene Maria Buso

## Abstract

This work explores the features of the choice process under risk through an eye-tracking experiment: the research questions on which the experiment focuses are 1) the process model that fits better the process data both in small and large choice sets; 2) the differences in the choice process of fast and slow subjects, and the relation between the response time, final choice and the violation of standard axioms of rationality. Subjects are sequentially presented with 14 choices between 2 gambles and 14 choices between 10 gambles. Also, the two gamble sets are designed to study the Allais paradox. The data both in small and large sets fit the predictions of automatic integration models as Decision Field Theory and Parallel Constraint Satisfaction. Instead, data do not support Priority Heuristic and the standard maximization process assumed by the Expected Utility Theory and Cumulative Prospect Theory. In small and large sets there are similar eye movements, but in large sets subjects seem to simplify the choice process restricting the consideration set. In two gamble sets the slow responders do not rely on a deeper cognitive process than fast subjects according to the fixation duration analysis, but the two groups use different search strategies: slow subjects search information in a more systematic manner than fast ones. This evidence is against Rubinstein (2007, 2013, 2013) classification of slow subjects as deliberative and fast subjects as intuitive: they both rely on automatic processes of information integration. Also, in pairwise choices subjects who chose the risk-free options are significantly slower and show a greater degree of integration of probabilities and outcomes than subjects choosing the riskier options; however, the subjects that chose the less risky option in sets where the risk-free gamble was not available show the same process features as the subjects choosing the riskier option. These two latter findings to gather question the explanation of the Allais paradox by Kahneman and Tversky, that is certainty effect, since the subjects that should be mostly affected by the bias of overweighting the probabilities, that is those who choose the risk-free option, are the slower ones which search the information in the most systematic manner.

# Advantageous, but Intransitive, Preferences

David Butler and Pavlo Blavatskyy

## Abstract

Intransitive, but advantageous, decisions under risk The transitivity axiom is common to nearly all descriptive and normative utility theories of choice under risk. However, contrary to both intuition and common assumption, the little-known 'Steinhaus-Trybula paradox' (Steinhaus & Trybula 1959) proves the comparator 'stochastically greater than' is not always a transitive relation. We explore the implications of this result for theories of individual choice under risk, using multi-attribute lotteries. We create examples inspired by the paradox that are easily applicable to real life scenarios, such as preferences over financial portfolios. We then show when expansion and contraction consistency between choice-sets comprised of these objects, will not, nor should, hold. We extend our arguments to other popular justifications for transitivity, including the 'money pump' argument. An important implication of our findings is that, rather than modelling individuals as possessing a core utility function (whether transitive or intransitive), normally 'transitive' individuals can be 'intransitive' when choosing between the lotteries we identify, while remaining transitive for other choices. Put this way, intransitive preferences are as much a reaction to the bespoke parameters of the options in the choice set, as they are of the individuals making the decisions. This suggests neither a transitive nor intransitive 'core' utility function can accurately model preferences over all risky objects, without first restricting the intended domain of application. A recent experiment run by Stewart et al (2014) concluded: "The shape of the revealed utility function is, at least in part, a property of the question set and not the individual", a conclusion consistent with the implications of the Steinhaus-Trybula paradox. We conclude that, as the paradox suggests, intransitive preferences can lead to more preferred outcomes for the decision maker than they could have otherwise obtained by relying on transitivity, for lottery pairs with the necessary bespoke parameters.

**Telling the Other What One Knows? Mutual Cheap-Talk in Modified Acquiring-a-Company Experiments**

Daniela Di Cagno, Andrej Angelovski, Werner Guth and Francesca Marazzi

**Abstract**

Ever since Samuelson and Bazerman (1985) the Acquiring-a-Company game, AaC in the following, is a familiar experimental workhorse for studying the interaction of parties with affiliated evaluations and the winner's curse. We modify this paradigm to capture two-sided instead of only one-sided incomplete information. Although this could render the interaction a signaling game, as the seller could infer from the buyer's price proposal what the buyer privately knows, the theoretical analysis only reveals a pooling equilibrium. The other, behaviorally motivated, change is to allow for mutual cheap-talk. We refer to this modified setup as the mAAC-game. Either party can send true or false numerical message about what she privately knows (the seller the value for the buyer and the buyer the under-evaluation parameter of the seller). After the simultaneous message exchange, the buyer proposes a price which the seller can accept or reject. In our view, if both parties are privately aware of valuable information, mutual message exchange is more likely seen as a form of voluntary cooperation with free-riding as strategic misreporting. There are many constellations of what the seller and of what the buyer knows privately, namely the value of the company for the buyer, only known to the seller, and the under - evaluation parameter of the firm for the seller, only known to the buyer. We capture this richness of constellations by letting participants experience multiple rounds with randomly varying parameter constellations across rounds, i.e. parameter conditions are explored within subjects. The only between subject variation concerns whether the roles of buyer and seller are only once randomly assigned and constantly kept (two - population implementation, in evolutionary jargon) or in each round randomly anew assigned to participants (one - population implementation). In both treatments, we implement random pair formation in every round. The one - population condition appeals to hedge funds whose business it is to buy and sell companies, i.e. which experience both sides of the market and can learn from both their role-specific experiences. A further advantage of random role assignment is that participants encounter both roles and have to deal with both types of private information. Compared to this, the two - population condition features enterprises, e.g. multi-national firms, which mainly sell companies to adjust their sales portfolios, and other enterprises which want to acquire firms in order to complete their competences. Altogether this indicates that, in our view, both conditions have external validity.

**Uncertainty Aversion in Game Theory: Experimental Evidence**

Evan Calford

**Abstract**

This paper experimentally investigates the role of uncertainty (risk and ambiguity) aversion in normal form games. Theoretically, risk aversion will affect the utility value assigned to realize outcomes while ambiguity aversion affects the evaluation of strategies. In practice, however, utilities over outcomes are unobservable and the effects of risk and ambiguity are confounded. This paper introduces a novel methodology for identifying the effects of risk and ambiguity preferences on behavior in games in a laboratory environment. Furthermore, we also separate the effects of a subject's beliefs over her opponent's preferences from the effects of her own preferences. The results support the conjecture that both preferences over uncertainty and beliefs over opponent's preferences affect behavior in normal form games in a manner consistent with rationalizability.

# Multidimensional Attitudes in Intertemporal Choice

Veronica Cappelli

## Abstract

Many everyday decisions can be framed as choices between streams of multidimensional alternatives, be them in the form of bundles or multi-attribute outcomes. In a nutshell, the standard answer for assessing the value of these alternatives has traditionally been the following: to evaluate a generic, also multidimensional, consequence by means of a scalar index of utility and then discount this value. At the same time, there is by now substantial and robust evidence that decision makers may have dimension-specific attitudes. In particular, different categories of outcomes, or different attributes, may be discounted differently. This work provides behavioral foundations to such evidence by developing an axiomatic model of choice between streams of multidimensional alternatives. Our objective is to obtain an evaluation functional that takes into account the fact that not only utility but also discounting may be dimension specific. We further discuss several theoretical and empirical implications of this consideration and explore possible applications. When dimensions are criteria, the model hereby developed naturally contributes to the literature on multi-attribute utility theory, whose intertemporal dimension is still understudied. As a byproduct, when dimensions are interpreted as household members, we also provide alternative decision theoretic foundations to recently developed ex-ante social choice decision rules which allow for household member-specific Pareto weights, utility and discounting function, a feature of social preferences that has been deemed highly compatible with data on households' consumption. The aim of this paper is thus manifold. First of all, we provide a generalization and a parsimonious axiomatic foundation of a natural criterion for discounting multidimensional alternatives where every dimension of the consequence is allowed to be discounted by a different discount function, a consideration which has been growingly advocated in several fields, ranging from Psychology to Economics and Marketing. Building on this, we analyze the behavioral assumptions behind some of the most widely used specifications, thus obtaining their domain of applicability and identifying directions for further generalization.

# An Experimental Comparison of Two Market Institutions

Enrica Carbone, John Hey and Tibor Neugebauer

## Abstract

We study and compare, using experimental data, two general equilibrium models, the Lucas (1979) asset pricing model and the Bewley (1980) Cash-in-Advance (CIA), or forward, market model. These models are dynamic. In both models, agents receive a fluctuating perishable income over an infinite discrete lifetime. Given a concave utility function, in order to maximise lifetime utility, agents should smooth consumption. In the asset market they can do this only by buying and selling a durable asset (which pays a dividend); in the forward market, they can do this by trading in the forward market. Our primary interest is whether subjects under laboratory conditions manage to do as the theory says and smooth consumption across periods. A secondary interest is whether asset and forward markets are equally efficient in pricing trades in such a way that consumption smoothing is achieved. For the asset market we extend the experimental design of Crockett, Duffy and Izhakian (2017). In that design there are two kinds of agents, and the fluctuations in perishable income are (counter-) oscillatory. This means that when one type of agent has a high income the other has a low income. This, of course, is to make trading mutually beneficial. Our main extension is to three types of agent and cyclical fluctuations in income. Intertemporal utility maximization requires consumption smoothing through trading in the market. Once again, given a concave payment function, the theory states that optimising behaviour in the experiment is to consumption/payment smooth. We set up our forward market experiment to come up with the same predictions, so as to make the two markets comparable. As with any market experiment, we are interested in seeing whether the price converges to the equilibrium price. This is a direct implication of consumption-smoothing. Given the way that we have set up the two markets, with a stationary cyclical process, the equilibrium price is constant in both markets. In the theory, in the asset market the equilibrium price is simply the discounted value of the dividend. In the laboratory – where we apply the usual experimental 'trick' of replacing an infinite horizon with a constant discount factor by a random horizon story with a constant stopping probability – the equilibrium price is simply the expected value of the dividend. In the forward market the equilibrium price is simply one over the continuation probability. In the asset market subjects trade cash (tokens) for a long-lived asset that pays dividends at the beginning of each period; assets are non-perishable and can be traded. Cash is perishable (is consumed at the end of the period), income is in cash and it varies, consumption smoothing is the optimal strategy. Payment to the subjects was a function of end-of-period tokens holdings. In the forward market, cash (tokens) is perishable (is consumed at the end of the period), cash-in-advance can be traded for cash-later, cash at the beginning of

# Tax Audits as Scarecrows Evidence from a Large-Scale Field Experiment

Rodrigo Ceni, Marcelo Bergolo, Guillermo Cruces, Matias Giaccobasso and Ricardo Perez-Truglia

## Abstract

According to the canonical model of Allingham and Sandmo (1972), firms evade taxes by making a trade-off between a lower tax burden and higher expected penalties. However, there is still no consensus about whether real-world firms operate in this rational way. We conducted a large-scale field experiment, sending letters to over 20,000 firms that collectively pay over 200 million dollars in taxes per year. In our letters, we provided firms with exogenous but non-deceptive signals about key inputs for their evasion decisions, such as audit probabilities and penalty rates. We measure the effect of these signals on their subsequent perceptions about the auditing process, based on survey data, as well as on the actual taxes paid, according to administrative data. We find that firms do increase their tax compliance in response to information about audits. However, the patterns in these responses are inconsistent with utility maximization. The evidence suggests that, much like scarecrows frighten o birds, audits can be a significant deterrent for tax evaders even though they would be perceived as harmless by a rational optimizer.

# Losses Loom Larger Than Gains, Reference Dependent Preferences, and Global Loss Aversion in Ber

Godfrey Charles-Cadogan

## Abstract

Some analysts claim that Bernoulli's utility function is "reference-independent" and hence it is not able to generate a loss aversion index. This paper reveals otherwise. It proves that the geometry of Bernoulli's original utility function specification supports key elements of prospect theory that include reference dependence and a loss aversion index. It even provides a closed form global utility loss aversion index formula. Theory and evidence show that the formula follows a stable law, and it supports a Fisher z-transform test for loss aversion. Higher order approximation of Bernoulli's specification of preferences predicts that a risk averse but temperate agent would prefer a high kurtosis gamble to certainty equivalent if the payoff is sufficiently high. In contrast, prospect theory predicts that no agent should prefer that gamble in gain domain. In a nutshell, Bernoulli's utility function is alive and well. It supports several aspects of prospect theory's skewed S-shape value function for decision making under risk and uncertainty, and somewhat surprisingly it admits a global loss aversion index. Introduction A recent survey by Barberis (2013) describes Kahneman and Tversky (1979) original version of prospect theory (OPT), and its amendment, cumulative prospect theory (CPT) (Tversky and Kahneman 1992) thusly. "Prospect theory is still widely viewed as the best available description of how people evaluate risk in experimental settings", while duly noting that "there are relatively few well-known and broadly accepted applications of prospect theory in economics". However, papers by Birnbaum and Navarrete (1998); Birnbaum (2005, 2008) point out several deficiencies in CPT. In fact, Moscati (2016) references Gilboa and Marinacci (2013) to note that "it is not clear that a single theory of decision making under uncertainty will replace expected utility theory", and "even if a single paradigm will eventually emerge, it is probably too soon to tell which one it will be". Other models in the EUT class like regret theory (Loomes and Sugden 1982; Bell, 1982), disappointment aversion (Gul, 1991), and the more recent weak rank dependent utility (Charles-Cadogan 2016) have been able to explain, inter alia, phenomena like preference reversal, Allais paradox, and loss aversion that were once exclusively in the solution space of prospect theory. Indeed, experiments conducted by Hey and Orme (1994) found that EUT was upheld as a valid model of decision making for many subjects. To the extent that Bernoulli (1738) utility theory laid a foundation for Von Neumann and Morgenstern (1953) axiomatic EUT, it is interesting to know which elements of prospect theory (if any) are explained by Bernoulli's utility function. This paper shows that behavioural concepts like "losses loom larger than gains", reference dependent preferences, and a loss aversion index, are all supported by Bernoulli's utility function specification published almost 300 years ago.

# True Overconfidence, Revealed through Actions: An Experiment

Stephen Cheung and Lachlan Johnstone

**Abstract**

We report an experiment that infers true overconfidence in relative ability through actions, as opposed to reported beliefs. Subjects choose how to invest earnings from a skill task when the returns depend solely upon risk, or both risk and relative placement, enabling joint estimation of individual risk preferences and implied subjective beliefs of placing in the top half. We find evidence of aggregate overconfidence only in a treatment that receives minimal feedback on performance in a trial task. In treatments that receive more detailed feedback, aggregate overconfidence is not observed although identifiable segments of over- and under-confident individuals persist.

# The Willingness to Pay for Editing

Alessandra Cillo and Enrico De Giorgi

## Abstract

Normative models of decision making assume that decision makers evaluate their choice alternatives according to their payoff distributions. However, there is growing experimental evidence showing that decision makers mentally transform payoff distributions to simplify their choice problem. Indeed, Prospect Theory (Kahneman and Tversky 1979) distinguishes two phases in the choice process: an initial phase where choice alternatives are edited, the so-called editing phase, and a subsequent phase where edited choices are evaluated, the so-called evaluation phase. The literature on editing has mainly focused on two editing rules, i.e., segregation and aggregation. Segregation occurs when each alternative in the bundle is independently evaluated from the others. By contrast, aggregation occurs when the payoffs from the alternatives in the bundle are summed up together and only the overall payoff distribution is evaluated. Experimental results on editing are mixed. The main goal of this paper is to propose a new theoretical framework to study editing rules. Our framework combines the hedonic editing hypothesis of Thaler (1985) with the additional assumption that editing comports a cognitive effort. Therefore, some editing rules are unfeasible for some decision makers, despite these might lead to edited choice alternatives that yield a higher value. Our theoretical model predicts that the hedonic editing hypothesis holds among feasible editing rules. However, when the effort or cost to edit according to a rule is too high, the decision maker deviates from hedonic editing and applies simpler rules, despite these might lead to edited choice alternatives with lower values. Our theoretical framework also suggests that, in some cases, decision makers could benefit from having choice alternatives edited according to an (for them) unfeasible rule that yields a higher value. In this case, we define the notion of willingness to pay for editing, and show that, in our model, it decreases when the set of feasible rules becomes larger, i.e., the willingness to pay for editing is lower for more sophisticated decision makers. To test our theoretical predictions we run an experiment. We consider segregation and aggregation and show that the willingness to pay for segregation is generally close to zero, while the willingness to pay for aggregation is strictly positive, implying that aggregation is generally unfeasible. Moreover, we also find that for highly sophisticated subjects, the willingness to pay for aggregation is lower than for slightly sophisticated subjects, consistently with our prediction. Finally, we also find that the willingness to pay for editing depends on the risk profile of the choice alternatives.

# Cheap Talk under Ambiguity: The IPCC in Climate-Change Agreements

Philippe Colo

## Abstract

This paper explores the strategic influence of the Intergovernmental Panel on Climate Change (IPCC) on international environmental agreements (IEA). The IPCC is an intergovernmental body of scientists, under the supervision of the United Nations, dedicated to establishing the state of scientific knowledge on climate change. Among her tasks, she has to convey all scientifically certified models of climate change, allowing to understand the impact of green-house gas (GHG) emissions over the global temperature increase. IEA are where emission policies regarding climate change are negotiated between countries, and they can formally be seen as a game of contribution to a public bad (GHG) under uncertainty. More precisely, countries face a situation of model uncertainty, a situation in which different data generating mechanisms are plausible regarding global warming. This corresponds to a case of Knightian uncertainty, or ambiguity, where events do not have a precise, objective probability assignment. Consequently, the IPCC can have an important influence on the resulting IEA. Her task is one of strategic communication with the countries, through which she can act as a social planner. The confidence ranking the IPCC provides is done through confidence assessments, a self-determined qualitative notion, which can be seen as second order beliefs over prospective theories. As a consequence it is non certifiable information. Yet, it can serve her interest if properly chosen. In particular, the IPCC can behave as a social planner aiming at maximising the social welfare. The driving aspect of an IEA is free-riding: overall, the total level of emission will be higher than what would be socially optimal. As a consequence, the IPCC will systematically be biased with respect to the countries. This asymmetry of interests and the nature of the information conveyed makes the game played one of cheap talk À la Crawford and Sobel. In this paper, I assume that countries are max-min expected utility maximisers (MEU). This can be justified both on positive and normative terms. Since Ellsberg (1961), experimental results have supported the view that individuals exhibit ambiguity aversion. Equally, on the normative side, many authors, including Gilboa et al. (2016) and Gilboa (2009), have argued that ambiguity aversion is not necessarily less rational than Savage's subjective expected utility axioms. The MEU assumption on the countries preference is new to both the modeling of IEA and the cheap talk game over climate models. It allows me to derive a unique sequential equilibrium of the game. Whatever her type, at equilibrium, the IPCC will be credible in pointing out a subset of climate theories as the most likely. As a result, the agreement between countries will be reached on that basis. My results are to be read in normative terms. They show that it is possible for the IPCC to better the social welfare through the choice of her communication.

**More Money or More Certainty? Behaviour under Risk and Ambiguity in Stochastic Alternating-Offer Experiments**

Anna Conte, Werner Guth and Paul Pezanis-Christou

**Abstract**

We experimentally study a class of stochastic alternating-offer bargaining games in which the second (and final) stage of interaction follows the rules of a (private) impunity game. This strategic environment enables us to study and compare first-stage responder's behaviour under risk with first-stage proposer's behaviour under ambiguity, where the ambiguous situation is triggered by the second-stage action of the responder. We assess the dependence of proposers' and responders' reactions to the stakes at play and to the likelihood of future play on probability misperception and attitude to risk. A structural econometric analysis of the data collected reveals a remarkable similarity of proposers' and responders' behaviour which is predominantly driven by probability misperceptions.

# Optimal Stopping and Real Options under Volatility Ambiguity

Quentin Couanau

## Abstract

This paper studies optimal stopping problems in continuous time in which the decision maker (DM) perceives ambiguously the volatility of the process driving the payoff. We develop a general model to study problems involving timing decisions, such as the entry decision of a firm or the exercise rule of a financial option, when the DM is unable to pin down exactly the volatility of the underlying payoff process. We apply our results to firms' investment decisions under such volatility ambiguity in complete and incomplete markets and the exercise rule of American options. Our contribution is to provide general results to study Markovian optimal stopping problems under ambiguity and to apply these results to real options problems. In our general model, an ambiguity averse DM observes a payoff process and decides when to stop and get the payoff. The DM's beliefs are represented by a set of probability measures, in which each measure induces a volatility process for the payoff. The DM is unaware volatility of its payoff, but assumes that it can be any process that lies within certain bounds. The DM has maxmin preferences and evaluates each stopping strategy using the prior that yields the lowest possible payoff. An important point is that the set of priors that induce volatility ambiguity is non-dominated, that is, measures in this set do not agree on null events. This makes the usual tools of stochastic analysis of little use, in particular it calls for a careful definition of the conditional expectation process. To circumvent these difficulties, we use recent advances in non-linear expectation theory, which provides useful tools of stochastic analysis under volatility ambiguity. By carefully defining the set of priors and related conditional expectation, we can use previous results to characterize the optimal stopping time in terms of the suitably defined value function. Analogous to standard optimal stopping theory, stopping is optimal when the value function equals to the payoff process. We then characterize further the optimal stopping problem by proving a verification theorem. We show that the value function can be identified with the solution of a free-boundary problem, where the Hamilton-Jacobi-Bellman equation is nonlinear in its second order term. This result applies to optimal stopping problems with Markovian payoff, which encompasses a large class of problems in economics and finance. We then apply our results to irreversible investment decisions of firms in complete and incomplete markets. An increase in ambiguity induces a lower investment trigger and accelerates investment, contrary to the standard result in real option theory where uncertainty delays investment. When markets are incomplete and the investor cannot diversify his portfolio completely, the worst-case prior induces a path-dependent volatility process, and the investor changes his belief about the worst-case volatility.

# Assessing Choice Overload in a Complex Environment

Robin Cubitt, Chris Starmer and Joerg Weber

## Abstract

We study choice overload and subjects' performance in a new experimental paradigm. Choice overload, the notion that agents may be worse off with a larger choice set, has received considerable attention and publicity. But it is difficult to reconcile with standard economic theory (where an expanded choice set must weakly increase utility) or with the structure of retail markets (where the success of supermarkets and online retailers is often attributed to the range of options they offer). Replication studies and meta-analyses also cast doubt on the findings and generalizability of the existing choice overload literature. We investigate choice overload and its effect on subjects' choices systematically, using an experimental environment that brings potential advantages and disadvantages of large consideration sets to the fore. Our environment allows us to manipulate candidate determinants of choice overload. In a given round, subjects face a large array of multi-attribute objects of which they will ultimately select one. Attributes are numerical and initially hidden. Subjects have a fixed amount of time to investigate objects and make their selection. Across and within two studies, we manipulate the nature of the objects, the decision time available, and whether a "shortlist" size is selected by the subject or given exogenously. Study 1 provides suggestive evidence that subjects may choose shortlists that are so large as to impair their own decision making. To investigate the underlying causal mechanisms, Study 2 has 4 treatments with exogenous shortlist sizes 9, 14, 24 and 52. We also vary how attributes map to payoffs to investigate whether choice overload is more likely when agents have to 'consult' or 'construct' their preferences, rather than seeking "objectively best" options. The payoff from an option is either the average of its attributes, or a lottery constructed from those attributes. We assess a subject's performance by how well the ultimately chosen object matches her preferences, captured in the case of lotteries by Cumulative Prospect Theory parameters elicited in separate tasks. Each shortlist that subjects face is populated by a fresh random draw from a Grand Set of 1000 objects. A subject has performed 'well' in a given round the higher up the chosen object is on her ranking of the Grand Set (or, on a different measure, of the shortlist). Our main results from these studies suggest that, beyond a certain point, performance is negatively and significantly related to the size of the consideration set. In this range, subjects perform worse as the shortlist size increases and fail to take opportunities that the environment affords to protect themselves against this effect. This is strong support for choice overload. We also show that choice overload is more pronounced when objects are lotteries, requiring assessment by a subject's risk preferences, as compared to when objects have objectively fixed values.

# Traders' Success Depends on Their Smartness, Does Not It?

Anton Dek and Kateryna Kononova

## Abstract

In our study, we have analyzed if the order of traders' expectations affects on their behavior. The research has been done using a combination of Experimental Economics Methodology and Machine Learning Technologies. To analyze the depth of reasoning impact on traders' success we have collected the information about the executed orders in a crypto-exchange, which allowed gathering trades information in a non-anonymized way. We have retrieved the data on 17 trade pairs for the period from December 16, 2017, 13:49:00 (UTC) to January 30, 2018, 13:49:00 (UTC). The database of trades contains about 715,000 records. Then we have conducted the guessing game with those traders who made more than 15 deals within the studied period. 2,622 of such traders have been invited to participate in the survey; 273 answers have been received. The average guessed number was 39.74 and the winning number was 26.49. Most often participants were the 1st level depth of reasoning and the winners were the 2nd level depth of reasoning. Based on the traders' answers in Guessing Game and the information on their deals (trader's profit, number of trades and the arbitrage balance for all traded pairs), we have identified eight types of traders, in particular: "Jokers", "…*100 traders", "Focal point traders", "Traders of 1st level", "Traders of 2nd level", "Traders of 3rd level", "Nash traders", "Professionals". The analysis of the clusters shows that in general, the traders with higher order beliefs are more profitable than less smart ones. At the same time, "jokers" were not as simple as it would seem, these traders are rather competent in their peers and market understanding. They just did not bother answering. Despite average guess of "professionals" was close to the winning number, however, the variance of guesses for this clusters was too big, they guessed numbers from 5 to 53. This result indirectly confirms Keynes's hypothesis that professionals, no less than other market players, are prone to irrational behavior. This research allowed looking a bit deeper to traders' brain and understanding their peculiar properties a bit better. It gives food for thought while developing theoretical and empirical models of market prediction and makes us hardly think about public and private signal perception by traders and its impact on market dynamics.

# The Degree of Operating Leverage as the Reciprocal of the Margin of Safety: An Analysis on Op. Risk

Gianluca Fabrizio Delfino

## Abstract

My paper shows that, by expressing the degree of operating leverage (DOL) as a function of the margin of security (MS), it is possible to have a more precise understanding of the causes and consequences of operating risk. By mathematically showing that every managerial decision involves a trade-off between a more profitable or secure firm to manage, it is easy to demonstrate that both DOL and MS should be presented as measures of the effectiveness of a greater span of choices than those limited to the establishment of the management's desired cost structure. Following this argument, it is claimed that it is reductive to consider operating risk without mentioning the fundamental role that any industry plays in influencing the effects certain managerial decisions have on the riskiness of a firm. On one hand these effects are observed in the different value the break-even point assumes, which is mainly driven by the cost structure that emerges as a consequence of such decisions; on the other hand, they are observed in new, possible estimates of the expected sales, under the condition that management is perfectly able to make such predictions without incurring any bias. More generally, a definition of risk has been proposed that involves the existence of three dimensions: 1) the degree to which industries influence the effects of certain strategic decisions; 2) managerial choices, led by the firm's strategy; 3) the managerial capability of measuring the implications of such decisions on the expected sales. Under such a definition, it is claimed that measuring a firm's DOL (or MS) gives very poor information on its operating riskiness if such measurement is not compared with those of its peers. Such a comparison would give management key information on the consequences of its decisions on the firm's risk profile in any given time-frame, and therefore on its preference between a more profitable firm or a more secure firm to manage. Moreover, by researching any industry's possible DOLs (or MSs), it has been speculated that the variability of such ratios is directly proportionate to the variability of the industry's ROS. Empirical analysis should be conducted in order to verify such a statement. Subsequently, the analysis then draws attention to the way DOL and MS are measured, claiming that there is always a certain degree of bias when estimating their values. The reason for the presumed existence of a measurement bias is directly linked to the subjectivity for which sales are estimated. Such subjectivity is influenced by both exogenous and endogenous factors, which respectively depend on the sales volatility of the industry in which the firm operates, firm presence and managerial experience.

# The Description-Experience Gap in Cooperation

Dennie van Dolder, Ozan Isler and Orestis Kopsacheilis

## Abstract

The way in which information is obtained has been shown to affect subsequent decisions. Perhaps the best example of this is the Description-Experience (DE) gap in risky choice: people underweight rare events when they learn about probabilities through experiential sampling, but overweight rare events when probabilities are presented descriptively. Among the leading explanations for this discrepancy, sampling bias is by far the most prevalent one. Participants in experiential sampling collect small samples which tend to under-represent rare events. Despite the voluminous research on the DE gap in individual decision making, the question whether such a gap also exist in a social context has remained largely unexplored. In this paper, we investigate decision making under description and experience in the context of a one-shot Prisoner's Dilemma game. We manipulate participants' beliefs about the likelihood that their partner will cooperate by providing them with aggregate information on cooperation, either through description or experiential sampling. Such social information can be expected to be decision-relevant, as research has shown that a sizeable fraction of people is conditionally cooperative and want to match the cooperation of their partner. In a large online experiment, we indeed find that a majority of subjects cooperate more if their partner can be expected to do so. Interestingly, we find evidence for a DE gap in social decision making, but in the opposite direction from the one observed in risky choice: decisions from experience lead to an overweighting rather than an underweighting of rare events relative to decisions from description. This difference is not caused by sampling bias Furthermore, we find that categorizing subjects according to their cooperative preferences helps account for the heterogeneity in both information search and cooperation. Conditional co-operators exert more effort to acquire information from experience and are more sensitive to social information than free-riders and unconditional co-operators.

# Revealed Social Preferences

Arthur Dolgopolov and Mikhail Freer

## Abstract

We apply a revealed preference approach to develop tests for the observed behavior to be consistent with theories of social preferences. In particular, we provide revealed preference criteria for the observed set of choices to be consistent with inequality averse preferences and increasing benevolence preferences. We show that the tests constructed can be applied for the standard framework of linear budgets (akin to "dictator game") and to other games frequently used to study social preferences: ultimatum game, trust game and carrot-stick game. Other-regarding preferences assume that player "care" about payoffs of other players, moreover, this theory allows for both altruistic and envious preferences. Both inequality aversion and increasing benevolence are nested within other-regarding preferences. Inequality aversion assumes that players get some disutility if payoffs are unbalanced. Increasing benevolence assumes that a player's willingness to pay for an additional dollar received by another player increases in the player's own payoff. Test for inequality aversion preferences includes axiomatization of inequality measures. Moreover, choice of inequality measure does not have empirical content under linear budgets. However, inequality measures can be distinguished in the ultimatum and carrot-stick games. Hence, it is possible to test the "inequality aversion hypothesis" independent of parametric specification of the inequality measure as well as to find which specification is the appropriate explanation of observed behavior. Finally, we apply these tests to two experimental datasets on dictator games.

**States of Nature and States of Mind: A Generalised Theory of Decision-Making, with Appl. to HC Dev.**

Iain Embrey

**Abstract**

Canonical economic agents act so as to maximise a single, representative, utility function. However there is accumulating evidence that heterogeneity in thought-processes may be an important determinant of individual behaviour. This paper investigates the implications of a vector-valued generalisation of the Expected Utility paradigm, which permits agents either to deliberate as per homo-economics, or to act on impulse. Expected Utility theory is harnessed to provide both a descriptive model of deliberative decision making, and an as-if model of impulsive decision-making, but an individual- and situation-specific probability distribution determines which of these thought-processes will predominate. This generalised decision theory sits within the class of general random utility models that was formally defined by Manski (1977), although it is distinguished from existing theory in that it explicitly models the choice problem generating process. Traditional economic problems are well-served by the canonical Expected Utility Theory. Where one's objective is profit maximisation, it is reasonable to assume that all relevant motivations can be losslessly quantified by their projection onto a unidimensional utility scale. However, that 'single-self' assumption may not be valid in more general behavioural situations, since motivations such as compassion or desire may not be fully equivalent to an agent's willingness to pay for them. The generalised decision theory does not require that single-self assumption, because it does not impose any homogenous rule by which disparate motivations must be traded off. Thus, whilst the traditional Expected Utility theory provides a mathematically elegant description of traditional economic situations, the generalised theory provides a more parsimonious description of any behavioural situation that might be characterised by inherently incompatible motivations. This paper demonstrates that the generalised decision theory is of practical, as well as philosophical, interest. Under the generalised theory, an agent's actions are largely determined by their idiosyncratic propensity to act deliberatively. That propensity therefore constitutes the agent's fundamental non-cognitive ability, and so the generalised theory can explain the strong empirical relationships between non-cognitive abilities and a wide range of behavioural biases. In particular, this paper applies the generalised decision theory to explain: grossly suboptimal educational investment, the persistence of social inequalities, the crowding-out effect, the pervasive influence of non-cognitive ability on socio-economic outcomes, and the self-productivity and dynamic complementarity between cognitive and non-cognitive abilities. These results suggest that the generalised decision theory warrants further investigation.

# Effect of Front of Pack Labeling Nudges on Consumers' Food Choices and Decision-Making

Seda Erdem and Tony McCarthy

**Abstract**

The front-of-pack (FOP) nutrition labelling of food products is a scheme that includes information on the energy value and nutritional content of food products sold. By making such information available at the time of purchase, FOP labelling has the potential to reduce the information asymmetry between consumers and food. Although FOP labelling helps consumers make more informed choices by giving them the opportunity to compare various food products with respect to their nutritional and calorie information, there are inconsistencies between different nutrition labelling formats used. Moreover, there is relatively little evidence on the forms of FOP labelling that consumers find most useful and which format enables them to make healthier food choices. In particular, the evidence on what consumers focus on in FOP nutrition labels is relatively limited. This research fills this gap. This research investigates the effect of nutrition and calorie labelling on consumers' food choices by merging advanced discrete choice modelling approaches from economics with eye-tracking techniques and differential psychology. Such an integrated approach improves the understanding of choices and decision-making heuristics under different conditions. In particular, our research aims to shed light into: (1) the effect of nutrition labelling on consumer food choices and decision-making rules (e.g., attribute non-attendance); (2) the effect of different labelling formats (e.g., traffic lights, texts) on choices; and (3) how these two points differ across individuals (individual differences in preferences and decision-making rules). While the discrete choice experiments (DCE) allow us to investigate trade-off people make when choosing food products, the eye tracking experiments shed light on the influence of design dimensions of FOP nutrition labels on participants' choices by revealing where and for how long individuals fixate their gaze on the areas of interests on FOP nutrition labels (e.g., energy information, sugar content). More fixation means the area is more noticeable or more important to the viewer than other areas. Such information also helps understand consumers' decision-making heuristics, such as ignoring particular information on FOP nutrition labels or adopting simplification rules (e.g., eliminating or selecting by label content) using an eye-tracking device. The choice and eye tracking data are collected from student and non-student participants on-campus. Using discrete choice behavioural models that take into account individuals' attitudes, choices and eye-tracking information; we explain the effect of FOP nutrition labels on food choices and decision-making. The research findings show that consumers present heterogeneous preferences for label formats and tend to exhibit decision-making heuristics when making choices. While nudges clearly play a role in how long and where individuals look on labels, their impact on System 2 thinking seems to be low.

# Investigation of Borrowers' Cognitive Biases through the Analysis of a Hungarian Legal Measure

Réka Fazekas

## Abstract

The Decree 56/2014 of Hungarian Ministry for National Economy was issued in order to mitigate the risks of non-performing loans. I will analyse the method prescribed by it in terms of cognitive biases. Paragraph 6 contains instructions for a table presenting the risk of changes in income and FX rates to the consumer before signing the contract. I will argue that the aim of the paragraph is to reduce the risk of excessive indebtedness arising from present bias and overconfidence. However, in a closer look, the predetermined sample data may generate further distortions in the risk assessment of the consumers. I will show that data given in the calculation serve as an anchor in the risk assessment process, an especially low anchor from which the borrower has to adjust its own instalment to income ratio and can make a still suboptimal decision. I will point out also further problems of the risk presentation procedure springing from the difference between average and median income and from the difference between income and per capita income. The application of these concepts in the sample table is misleading if borrowers are prone to rely on availability heuristic and overconfidence in the decision process.

**The Impact of Future Uncertainty on Risk Taking and Time Discounting Behavior**

Helga Fehr-Duda

**Abstract**

It goes without saying that the future is inherently uncertain. In particular, something may go wrong before promised payoffs materialize. It has been shown theoretically that decision makers who they take this future uncertainty into account may be also be prone to hyperbolic discounting, delay-dependent risk tolerance and a preference for late resolution timing if their preferences for immediate risks are characterized by sub-proportionality (Halevy 2008; Epper and Fehr-Duda 2012). So far, there is some correlational evidence of a link between sub-proportionality and hyperbolic discounting at the level of individual behavior (Epper et al. 2009). However, that the perception of future uncertainty is actually a causal driving force of these patterns of behaviors has not been demonstrated to date. We will present supportive evidence for such a causal role of future uncertainty based on priming experiments in Greece and Switzerland.

# Convex Preferences Over Lotteries

Paul Joseph Feldman and John Rehbeck

## Abstract

There is now a plethora of theories over risk that compete with expected utility. In an effort to test these competing theories, we use a novel elicitation procedure and acquire choices from a convex lottery space. This procedure allows us to find clear refutations of expected utility risk preferences. Our preliminary analysis finds that individuals have price-over curves and Engel curves consistent with small deviations from a quasi-concave non-expected utility function. In other words, we find evidence in support of a preference for randomization. Future analysis will examine specific parametric models of various non-expected utility theories such as cautious expected utility, disappointment aversion, and prospect theory in an attempt to sort among theories.

# Shooting and Hitting the Bull's Eye in Risk and Uncertainty Modelling

K. Yerfi Fosu

## Abstract

The need for efficient fruitful scientific risk and uncertainty modelling has moved to the front burners of both theoretical and empirical researchers on the one hand, and practical policy decision-makers on the other. Indeed, the dawn of the current Twenty-First Century spawned seeds of risk and uncertainty in domestic economies of various countries and in the global economic system. Domestic economies continue to be more integrated among themselves and with the global economy, in terms of the international flows of products, factor inputs and financial resources. Among other things, the digital explosion of this century including the emergence shadow banks and cryptocurrencies like the bitcoin and international spillovers from the financial crisis of 2008 continues to confer increasing risk and uncertainties on economies. Neither the pioneers of risk sciences including J.B Williams in the United States (US) in 1938, Sir J. R Hicks in the United Kingdom in 1939, J. von Neumann and O. Morgenstern in the US in 1947, H. Markowitz in the US in 1952, K. J. Arrow in the US in 1964, nor P. A Samuelson and all other Nobel Laureates in Economic Sciences who have contributed to the nurturing of the past and current methodology of the science of risk and uncertainty including, the modelling of risk and uncertainty could have conceived the large magnitude and high speed of growth of risk and uncertainty which have characterised the Twenty-First Century. Their methodology, viz., the mean-standard deviation approach has served the scientific research and practical policy decision-making communities fairly well. However, this methodology is arguably incapable of dealing with the contemporary risk and uncertainty issues of the current century. The present study clearly delineates the limitations of the current methodology, while proposing an innovative methodology for addressing these limitations. Among other things, the present study demonstrates that in the current century characterised by high levels of risk and uncertainty relative to the total wealth of decision makers, higher moments of the relevant statistical distributions like skewness and kurtosis are relevant in decision making. Therefore, they should not be excluded from risk and uncertainty modelling as the current methodology does. Excluding them tends to overestimate or underestimate the directions of the effects of risk on factor and asset choice. The structure of risk conduct of decision makers is miscalculated, among other miscalculations and misplaced inferences. How to avoid such fallacies in logic in the scientifically fruitful modelling of risk and uncertainty is also provided herein. The policy implications of the results of this study are also discussed.

# On the Impact of Matching Outside Offers

Gail Gilboa Freedman, Ido Erev and Yefim Roth

## Abstract

Our analysis takes the point of view of employer who wants to increase the probability that her workers stay in their current job. The employer considers the option of rewarding workers who have an outside offer but stay. The influence of such "matching outside offers" policy is two-sided, as it motivates some workers to waive outside offers, but it can also motivate other workers to search for outside offers that might surprise them and lead them to leave. We study this problem in a simple abstraction of an interaction between employer and workers. At the beginning of the interaction, the employer chooses whether to reward outside offers by matching them. Next, workers choose between three strategies: Stay, Check, or Resign. Importantly, both Check and Resign have uncertain impact on the payoffs. The exact payoffs, to both sides, can be affected by rare events. Our analysis demonstrates that the impact of matching outside offers is highly sensitive to the situation in which the policy is applied. There are situations in which matching is predicted to be counterproductive if the agents maximize expected payoff, but effective if the agents tend to rely on small samples. In other situations, the opposite is true. To exemplify these two classes of situations, we conduct laboratory experiments where each participant play the role of a "worker". Participants' choices are tested with respect of two different payoffs paradigm, to evaluate the impact of a "matching outside offers" policy. Results show that matching outside offers is: Effective in a "reckless resign game", where in most cases Resign leads to a better payoff than Stay, but in rare cases it lead to regret. One job-hunting scenario with this structure involves situations in which meeting potential employers is typically rewarding but involves a small risk of being captured by a human trafficking network. Counterproductive in a "treasure-hunt resign game", where in most cases Resign leads to worse payoff than Stay, but in rare cases it lead to a very high reward. One job-hunting scenario with this structure involves situation in which workers try to develop a long-shot idea for a startup firm. Results show that subjects behave as if they rely on small samples even when they can use large samples. Moreover, this behavior emerges even when subjects could rely on the experience of other agents, by considering the outcomes of their decisions. This is a main contribution of our study over previous studies of the effect of experience. An interesting implication of the current work is in the context of questioning the value of behavioral analysis of economic behavior. Some critics argue that new variable may be observable in experimental settings, but are often unobservable when dealing with economic (field) data. We believe this critique does not apply in the current setting, as the derivation of the predictions of the naïve sampler model is not sensitive to "unobservable" variables.

# Revealed Markov Strategies

Mikhail Freer and Artur Dolgopolov

## Abstract

Repeated games explain real life phenomena including price wars, models of time consistency and risk sharing. At the same time, empirical (and experimental) studies of repeated games are hindered by vast strategy space. Further problems arise from the fact that there is no unique way to model the strategies in the repeated games and two different models co-exist. The first model assumes that strategy is a function of a history given some maximal memory. Second model assumes that strategy is a Moore automaton – a machine with set of states (each mapped into an action) that transitions between states conditional on the observed profile of actions. The paper provides methodology for partial identification of the strategies (for both models) based on the observed play. Moreover, we show that the minimum complexity of the strategy (for both models) required to explain the observed behavior can be efficiently found. In addition, we characterize the (strict) subset of Moore Automatons isomorphic to all the strategies of given finite memory. At the same time we show that space of history dependent strategies and Moore Automatons are observationally equivalent. That is, data set can be rationalized by a Moore automaton if and only if it can be rationalized by a history dependent strategy. We illustrate the approach by applying it to the experimental data on the repeated play in prisoner's dilemma. The approach ignores the existence of the payoffs in the game as well as requirements for the equilibrium behavior. However, it can serve as a basis for the further development of tighter identification of strategies based on the stricter assumptions. We illustrate this fact by constructing identification (and a test) for the observed play to be rationalizable with "monotone" strategy. Idea behind the "monotone" strategy is that the "crime" is followed up with the "punishment" and the costlier is the deviation from the "desired" (e.g. cooperative) outcome the more severe is the punishment for such deviation. Imposing further restrictions (e.g. best-responding behavior) would require combining the results in this paper with additional insights gained from the structure of a particular game. There is a significant body of literature which investigates the behavioral patterns in repeated games, which can be broadly classified in two categories. First category uses the strategy method to reveal a strategy of a player. That is, players are asked which action they would take given observed history. Second category fits a set of "reasonable" strategies to explain the observed behavior. Both approaches suffer from scalability issue – if the action space increases, the strategy space becomes intractable (even fixing the maximum complexity). That is, strategy method would require asking to many questions to the subject and the set of candidates "reasonable" strategies become too large. At the same time the approach offered here does not suffer from this problem.

# The Willingness to Pay for Health Improvements under Comorbidity Ambiguity

Yoichiro Fujii and Yusuke Osaki

## Abstract

Accumulated medical information is necessary to determine comorbidity risk between a primary disease and other diseases. However, medical decisions often have to be made without conclusive evidence because decision makers do not have sufficient information. By introducing ambiguity into potential comorbidities, we describe situations where individuals face potential comorbid threats from correlations between primary and secondary diseases. This paper examines conditions where the willingness to pay for health improvements increases with comorbidity ambiguities compared with the corresponding risk. We also extend this ambiguity to changes in the distribution of correlations, changes in willingness to pay based on ambiguity attitude, and changes in the severity of disease.

# Information Aggregation in Dynamic Markets Under Ambiguity

Spyros Galanis and Stelios Kotronis

## Abstract

This paper studies information aggregation in a dynamic trading model with partially informed and ambiguity averse traders. We show that separable securities, introduced by Ostrovsky (2012) in the context of expected utility, no longer aggregate information if some traders are ambiguity averse. More importantly, this failure comes not because traders are unable to reach a consensus about the price of the security, but because they eventually agree on the "wrong" price. As a result, it is impossible for an outside observer to know whether the equilibrium price reveals all information or just false information, unless she is confident that no trader has imprecise probabilities. We define a class of securities which strengthens separability and is robust to these considerations. In particular, we show that strongly separable securities characterize information aggregation in both strategic and non-strategic environments.

**Learning under Ambiguity When Information Acquisition Is Costly: An Experiment**

Konstantinos Georgalos and John Hey

**Abstract**

In the present study, we set up an economic experiment in order to test the model presented in Epstein and Ji (2017). Subjects in this experiment, face a modified 2-urn Ellsberg task and receive partial information via a computerised Brownian motion, in case they choose to sample from the ambiguous urn. In various treatments of the experiment, we exogenously vary the level of prior ambiguity, prior variance, signal variance and cost of learning in an effort to investigate their effects on optimal learning. The experimental design provides data suitable for parametric estimations via appropriate econometric techniques. This kind of structural analysis provides useful statistical inference, which in turn can be used in order to test the main theoretical assumptions of the underlying ambiguity model (i.e. maxmin preferences, forward looking decision making) compared to the Bayesian baseline model and alternative specifications. In our experiment, on top of the subjects' decisions, we also collect data on their response times, basic demographics, as well as measures from the cognitive reflection test which allow us to explore potential correlations between these measures and ambiguity aversion.

**A Cognitive Model of Strategic Deliberation and Decision Making**

Russell Golman and Sudeep Bhatia

**Abstract**

What are the cognitive mechanisms involved in game theoretic decision making? How do decision makers represent reward-interdependencies in strategic games, and how do they deliberate (intelligently, but perhaps imperfectly) about these interdependencies to generate choice? We use a cognitive model based on sequential sampling and dynamic preference accumulation to describe strategic deliberation with limited iterated reasoning. People may sometimes fail to anticipate each other's plans while making their own strategic choices. Our bidirectional evidence accumulation model describes both the formation of preferences for the strategies available to the decision maker and the formation of beliefs regarding the opponent's choices. The model makes predictions about individuals' choices in one-shot normal-form strategic games. Through processes of sequential sampling and accumulation, our model is able to intelligently reason through two-player strategic games, while also generating specific violations of Nash equilibrium typically observed in these games. Our model predicts realistic patterns of behavior across a wide set of games, including the traveler's dilemma, the 11-20 game, and an array of coordination and anti-coordination games, including some with salient strategy labels. Integrating cognitive modeling with behavioral game theory allows us to make better behavioral predictions about strategic choice, as well as to make novel predictions about correlations between choice and response time and about attention during deliberation. Our model shares the ingredients of stochastic sampling and dynamic accumulation with many existing accumulator models of preferential choice, but our incorporation of bidirectional feedback between preference formation and belief formation is new and critical for applying the accumulator model framework to strategic deliberation. Our model also has some similarities to existing behavioral game theory models, namely logit quantal response equilibrium and level-k reasoning, and we identify the shared elements and novel departures that allow our model to account for a larger set of observed behavioral patterns.

# Probability Distortions As Incentives

Victor Gonzalez-Jimenez

## Abstract

This paper introduces a novel incentive scheme designed to take advantage of the regularity that individuals distort probabilities. Under the proposed incentive scheme, a worker is incentivized to perform a productive task with a lottery that pays with some probability a monetary compensation based on her performance or nothing at all. The principal is able to choose this probability and she makes this decision before the worker performs the task. Thus, her choice could influence the worker's motivation. A theoretical framework and a laboratory experiment demonstrate that this incentive scheme outperforms standard performance-pay schemes that deliver, on expectation, the same monetary incentives. However, the probability at which the scheme is implemented is critical to its effectiveness. A small probability of performance compensation (10%) leads to higher performance than a standard performance-pay scheme, whereas medium and high probabilities (33.3% and 50%) yield no differences. I present evidence demonstrating that the degree at which individuals overweight small probabilities drives this performance boost.

# Risk-Taking in Roulette Wheel - Exploring the Influence of Gender, Education Stream and Co-Player

Dhriti Goyal and Kavita Vemuri

## Abstract

The present study explores 3 factors influencing risk-taking: a) gender b) co-player's gender and risk-taking trait and c) differences in students of humanities and engineering undergraduates. Ninety participants (45 male) in the age group 18-23 years played a fair game of the European roulette wheel. Sixty participants were from engineering (C1) and 30 from social sciences college (C2). The experiment was conducted in 3 rounds: R1: Participants played alone. Based on the DOSPERT self-report and the risk-taking trait a smaller subset (8 each) of low/high risk-takers were identified in each gender. R2: A within-gender study where dissimilar risk-takers co-played. R3: Opposite gender with same risk-taking behaviour as co-players. Each participant played 10 chances in each round. For the analysis, standard roulette wheel probabilities were considered and grouped into low (0.027, 0.054), high (0.324, 0.486) and medium (0.081, 0.108, 0.162) probability. The risk-taking ability was estimated by the average bet amount and frequency across all 10 chances as a function of the probability estimate of each bet. Statistical significance was calculated using Mann Whitney Wilcoxon Test. The self- report (p=0.0126; W=1322) and R1 (prob: 0.027, p=0.0098, W=1317.5) data show higher risk-taking behavior in male group. In R2, the high risk-taking male and low risk-taking female show increase in risky bets while the high-risk female displays decrease in risk-taking. In R3, similar risk-taking behaviour in both gender groups is noticed. On an average the low risk-taking female placed higher risk bets when co-playing with a male low risk-taker, whereas high risk-taker male showed decrease in risk taking. The comparative analysis on colleges show that participants of C2 exhibited higher risk-taking trait than C1 in R1 (prob: 0.027, p=0.000072, W=455.5; prob: 0.054, p=0.00038, w=720). In R2 and R3, the high risk-takers in C2 decrease the stake in the low-probability bets while C1 group exhibited an opposite trait. In conclusion, the behavioral results of the current study are consistent with previous reports of female population risk-aversion (Charness & Gneezy 2011; Eckel & Grossman 2002, 2008; Croson & Gneezy 2009; Byrnes et al. 1999) but both genders show deviation from expected behaviour traits with changes in game-play conditions. Interesting was the change in female risk-takers in the presence of co-players which necessitates a re-look at gender behavior stereotypes. Education and economic/financial stability afforded by professional degrees (C1) could explain the risk-aversion. A possible explanation (for C2) could be the theory (Wohl et al. 2013) that anticipation of poor economic prospects leads to higher risk-taking behaviour. Though risk-taking is task specific studying behaviour traits by factoring in educational domains and gender is crucial for composition of entrepreneurial teams where diversity and risk-taking are considered positive traits.

# Backward Induction and Empirical Complexity: A Mobile Experiment

Konrad Grabiszewski and Alex Horenstein

## Abstract

We experimentally analyze violations of backward induction using 27 trees. We rank trees by empirical complexity; that is, the percentage of subjects who do not behave in accordance with backward induction. As typical in the literature, we find that, in every tree, empirical complexity is more than 0%. However, given the richness of our data, we find more: empirical complexity is not the same in each tree but in fact ranges from 2% to 49%. In order to explain the variation in empirical complexity, we need to look beyond the typical explanations of deviations from backward induction that are found in the literature: it is necessary to look at the variation in tree structure. We find that expanding tree length (more rounds), rather than tree width (more actions), is the most important factor determining empirical complexity. Our data comes from an iOS/Android mobile game Blues and Reds that we developed for smartphones and tablets.

# Heuristic Modes of Decision Making and Survival in Financial Markets

Ani Guerdjikova and John Quiggin

## Abstract

We consider the impact of partial awareness in the form of a restriction of the state space on equilibrium allocations in financial markets. We consider a decision maker (DM) who is unaware of some of the possible states of the world, but is aware of his unawareness. We show, by extending the model of Grant and Quiggin (2015) the DM's perception of the state space can be represented by a partition of the original state space. Even if such a decision maker has correct information about the relative likelihoods of the events of which he is aware, his beliefs on the generated partition will be in general wrong. Furthermore, such a decision maker can be shown to behave as if he restricts his portfolio choice to a subset of the available assets with payoffs measurable w.r.t. his awareness partition and thus avoids "surprises". Such behavior implicitly follows a heuristic proposed by Gigerenzer (2014): "Never buy financial products you do not understand". We then study the effect of differential awareness on survival. We consider a financial market, in which all trades are executed at time 0, and in which agents can differ w.r.t. their level of awareness. We demonstrate that the heuristic to not invest into assets one does not understand allows the partially aware agent to survive, but only if his beliefs on his awareness partition are at least as close to the truth as the beliefs of a more aware agent with a finer partition. While examples of such beliefs are easy to generate when both agents are partially aware, in general, partially aware agents will have wrong beliefs and will thus disappear in the presence of fully aware agents with correct beliefs. In the last part of the paper, following Grant and Quiggin (2015), we introduce a second heuristic, aversion to unforeseen unfavorable surprises. An agent who uses this heuristic holds a minimal number of bonds in his portfolio. This heuristic allows us to establish survival of partially aware agents, regardless of whether their beliefs are correct. In this sense, aversion to unforeseen unfavorable surprises can be viewed as an ecologically rational heuristic. Asset prices in such an economy reflect the potentially incorrect beliefs of the fully aware agents and replicate the well-known equity premium puzzle.

# Overconfidence: Belief Bias or Ambiguity Attitude?

Cedric Gutierrez, Mohammed Abdellaoui and Han Bleichrodt

## Abstract

Overconfidence is one of the most widely documented biases affecting human decision making. For instance, overconfidence has been considered as a catalyst for bubbles in financial markets. In this paper, we concentrate on one type of overconfidence - overestimation of the decision maker's absolute abilities - where the agent is facing uncertainty about her abilities for which no exogenously given probabilities are available, i.e. ambiguity. We explore the extent to which overconfidence in such a context is a consequence of a distortion in the decision maker's beliefs about her abilities or of her attitudes towards ambiguity about those abilities. We performed an experiment that consisted of four tasks. The first task measured the subjects' performance on a 50-question non-verbal reasoning ability test. Subjects did not know their actual performance on the ability test until the experiment finished but some received partial feedback halfway through the test and at the end of the test. We told subjects in the positive information group their score on a subsample of questions on which they had performed well. By contrast, subjects in the negative information group received feedback on a subsample of questions on which they had performed poorly. Finally, subjects in the control group received no feedback. The remaining three tasks were choice-based. In the second task, we elicited subjects' beliefs about their performance on the ability test. This confirmed that subjects in the positive information group were overconfident and held too optimistic beliefs about their performance. Subjects in the control group were slightly under-confident and subjects in the negative information group even more so, holding beliefs that were too pessimistic. The remaining two tasks measured subjects' risk and ambiguity attitudes using bets on their performance on the ability test. Unlike most empirical evidence on ambiguity, the ambiguity in our study was endogenous and depended on subjects' own performance in the ability test. Overall, we mainly observed ambiguity seeking: even for very likely events, around 50% of the subjects were ambiguity seeking. This contrasts with empirical investigations using exogenous sources of uncertainty, which usually finds ambiguity aversion for likely events. Our main finding is that overconfidence is not only explained by a difference in beliefs, but also by a difference in ambiguity attitude. The positive information group was significantly more ambiguity seeking than the negative information group. The groups did not differ in terms of risk attitude or sensitivity to likelihood information. We found no difference between the positive information group and the control group suggesting that negative information makes people more ambiguity averse but positive information has no effect.

# Experimental Approach to Discrimination on the Basis of Nationality and Accent

Awatif Al Habsi, Yara Al Kahala, Mohammed Ali Taimur and Yara Abdulmajed

## Abstract

Discrimination threatens the manifestation of cohesion in society and can create inefficiencies in market outcomes. Studying trust is important in this context because it can be used to infer discrimination and as well as be used to reveal mechanisms that motivate the decision to trust. We implemented a trust game with three treatments in a lab-in-field experiment in Qatar to study. Whether interacting with a counterpart by listening to their accent and knowledge of their nationality impacted the levels of trust. In our control group, subjects played the trust game with no information about their counterpart. In the first treatment, they are directly informed that their counterpart is Egyptian before making their decision. In the second treatment, they hear a voice recording from their counterpart speaking in a distinct Egyptian dialect before making their decision. Our results show that hearing a voice increases trust between strangers, and that increased trust also depends on the vocal attributes of the counterpart. We find no evidence of discrimination against Egyptians in Qatar, as knowledge of nationality did not decrease the amount sent on average.

# Incentive to Persevere

Elif Incekara Hafalir, Grace Lee, Andrey Siah and Erte Xiao

## Abstract

To achieve success often requires persistent efforts. We conduct two randomized controlled trails to test the effectiveness of an all-or-nothing rewarding mechanism aimed at incentivising a full completion rate of repeated tasks over a period of time. We find the full completion rate under the all-or-nothing mechanism does not differ from that under the regular piece-rate mechanism. However, when given the option between the all-or-nothing and the piece rate mechanisms in a self-select treatment, a significant amount of participants chose the all-or-nothing mechanism in spite of the risk. The overall full completion rate is significantly higher in the self-select treatment than the piece rate condition. Our results highlight the importance of autonomy in incentivizing persistent efforts.

# A Definition of Perceived Ambiguity

Lorenz Hartmann

## Abstract

We introduce a multiple prior model in which perceived ambiguity is location invariant, i.e. two prior sets represent the same perceived ambiguity if they differ only in location within the probability simplex over the state space. We present the weakest axioms that allow a multiple prior representation with a constant-linear representation functional, a class that we refer to as Constant-Linear Multiple Prior (CLMP) preferences. We show that our definition of perceived ambiguity allows a straightforward application to games. Our equilibrium existence result for CLMP preferences in normal-form games generalizes existing results on ambiguous games.

# Attribute-Based Inferences in Subjective State Spaces

Yosuke Hashidate

## Abstract

This paper studies preferences over menus, and presents a theory of attribute-based inferences. In real life, people often find it difficult to make choices, due to the fact that there are various criterion for ranking alternatives such as attributes of alternatives. In attribute-based inferences, attributes are interpreted as criterion or dimensions for decision-making. It is widely recognized that attribute-based inferences can lead to systematic violations of rationality in economics. The Compromise effect (Simonson 1989) is a typical example in well-known behavioral regularities as violations of WARP (Weak Axiom of Revealed Preference), i.e., the consistency condition of choice correspondences. Since it is the difficult task to resolve the trade-off between attributes, the decision maker may be averse to the trade-off, and then choose a moderate alternative across attributes. We can interpret the Compromise effect as the result of reasoning in attribute-based inference. The motivation of this paper is to explore a cognitive foundation behind the Compromise effect. In this paper, we explore plausible new axioms for attribute-based inferences: Dominance, Dissatisfaction, and Contemplation. The key axiom is Dissatisfaction. Intuitively, the axiom says that the decision maker dislikes increasing the trade-off between attributes, when a new option is added. The main axioms, Dominance, Dissatisfaction, and Contemplation, along with other basic axioms, characterize a utility representation in attribute-based inferences. We show axiomatically that, in each menu, exploring the best option on the Pareto frontier in the attribute-based utility space is equivalent to exploring the optimal weight on the attribute space. The utility representation depicts the decision maker who determines the optimal weight on the objective attribute space to minimize the deviation from each attribute-best option (the di-satisficing-averse utility representation). As an extended analysis, this paper studies a pair of preferences over menus and choice correspondences to provide behavioral foundations for choice behaviors of the dis-satisficing-averse utility representation. This paper characterizes the choice correspondence, by relaxing WARP (Weak Axiom of Revealed Preference). Consequently, the Compromise effect can happen since the weight on the attribute space is reference-dependent.

**Revisiting Ellsberg and Machina's Paradoxes: A Two-Stage Evaluation Model under Ambiguity**

Ying He

**Abstract**

We revisit the Three-Color Ellsberg paradox by showing that although the preference pattern violates the sure-thing principle, it does satisfy the independence axiom under a weak assumption. Such an observation motivates us to develop a two- stage evaluation model for decision making under ambiguity. Events in state space are classified into ambiguous events and risky events. We define a special type of risky event called hedge, which only contains ambiguous events as its subset. In the first stage, a decision maker evaluates the sub-act restricted to a hedge according to a conditional subjective expected utility. Then, the conditional subjective expected utility is embedded into a subjective expected utility to represent preferences over acts defined on universal state space in the second stage. We show that our two- stage evaluation model can not only accommodate preferences in different versions of Ellsberg's paradoxes but also the preferences in paradoxes recent proposed in Machina (2009) and Machina (2014) that challenge the validity of many existing models for decision making under ambiguity. Finally, we propose a conjectured example where a seemly possible preference is inconsistent with KMM but allowed by our model. Based on this example, we further shed some light on why our approach can be more flexible in describing preferences without sacrificing the parsimony of the model.

# Probability Matching and Randomization in Lottery Choice and Games

Paul Healy, Marina Agranov and Kirby Nielsen

**Abstract**

Probability matching is an example of randomized choice that leads to stochastically dominated decisions. We also see randomization in games when no randomization is needed. In this paper we explore whether the sources of randomization are the same across various domains, and whether we can "shut off" randomization through various interventions.

# Cautious Stochastic Choice, Optimal Stopping and Deliberate Randomization

Vicky Henderson, David Hobson and Matthew Zeng

## Abstract

We study Cautious Stochastic Choice (CSC) agents facing optimal timing decisions in a dynamic setting. In an expected utility setting, the optimal strategy is always a threshold strategy – to stop/sell the first time the price process exits an interval. In contrast, we show that in the CSC setting, where the agent has a family of utility functions and is concerned with the worst case certainty equivalent, the optimal strategy may be of non-threshold form and may involve randomization. Our model is consistent with recent experimental evidence in dynamic setups whereby individuals do not play cut-off or threshold strategies.

# Encouraging Instructions Mimic the Impacts of Real Incentives

Noemï Herranz-Zarzoso and Chris Starmer

## Abstract

The prominent study by Holt and Laury (2002) revealed a striking difference between risk preferences revealed in hypothetical versus incentivised choices: risk aversion increased when real payoffs were scaled up, but the increase was not reflected in hypothetical choices. We will call this the Holt/Laury Effect (HLE). Holt and Laury interpret the HLE as suggesting that subjects cannot properly imagine how they would behave under high incentive conditions. Since the effect has been replicated in several papers (e.g., Harrison et al. 2004; Holt and Laury 2005), at face value the HLE sends a warning to experimental researchers that hypothetical choices may not reflect true preferences (at least where high stakes are concerned). We revisit the HLE via a new experiment designed to test an alternative interpretation of it. In particular, we test whether the sensitivity to payoff scale of purely hypothetical decisions depends on the motivational content of the background instructions. Our design features three treatments. Our 'baseline treatment' is a close replication of the Holt and Laury (2005) hypothetical treatment. In this treatment, subjects complete two Holt/Laury style tables which each involve 10 pairwise lottery choices. The only difference between the two tables is that the payoffs in one table are 20 times larger. Our treatments differ only in the background instructions provided to subjects. In the baseline treatment, we use instructions based very closely on Holt and Laury (2005). Our other two treatments differ from the baseline as follows: in the 'encouraging treatment' we added a sentence designed to encourage subjects to engage with the task. In the 'discouraging treatment', we added sentences to emphasise that payments were entirely hypothetical. As such, our experiment examines the impact of motivational primes on risk taking. We run our experiment with 415 MTurk subjects. In the baseline treatment, in line with the HLE we find no difference between the extent of risk taking for high and low payoff tables. In the encouraging treatment, we find that subjects take significantly less risk when (hypothetical) payoffs are scaled up and mean risk taking in this treatment (across high and low payoffs) is qualitatively very similar to incentivised behaviour in Holt/Laury (2005). Hence, we produce an analogue of the effect of incentives, but purely by a small adjustment to the instructions for hypothetical choice. Finally, and contrary to our initial expectation, we obtain a similar although weaker effect for 'discouraging instructions' whereby subjects also appear (slightly) more risk averse when payoffs are scaled up. We conclude that minor instructional variations in the motivation provided to subjects in purely hypothetical risky choices generate impact qualitatively similar to those induced by switching from hypothetical to real decisions.

# Behind the Veil of Ignorance: Risk Aversion or Inequality Aversion?

Jan Heufer, Jason Shachat and Yan Xu

**Abstract**

The trade-off between aggregate wealth and individual wealth inequality is a societal conundrum. At the individual level, a common framework to assess this trade-off is by the ranking of alternative societal wealth distributions in which a decision maker does not know her own position in the distribution but rather that she will equally likely assume any position in the distribution. This is known as the "Veil of Ignorance" (VoI). When she chooses a distribution from a set of possible distributions, her pure preference with respect to the aggregate wealth-inequity trade-off is confounded by her aversion to the risk generated by her choice over the distribution of her own wealth. We introduce a new experimental procedure to control for this risk aversion. Individuals are presented a series of paired choice tasks: one is the consumer problem of choosing a portfolio of Arrow-Debreu contingent claim assets over two equally likely states, one good and one bad, and the other is choosing the wealth profile of a two-person economy in which they are equally likely to be the rich or poor individual. "Income" and "prices" are the same within a paired set of tasks, thus the sets of distribution over one's own wealth is the same for both tasks. We find that almost all 92 subjects behave rationally or nearly rationally, with a high test power against random behavior. We find roughly equal numbers of experiment participants allocate more to the poor state than the bad state (revealing inequity aversion), equal allocations in the two tasks (revealing social indifference), and allocating less to the poor state than the good state (revealing inefficiency aversion). We find the aversions of unequal distribution behind VoI are not the same concept as risk aversions and that they are highly heterogeneous among subjects. A significant number of subjects demonstrate other-regarding preference in the sense of aversion for unequal distribution and of not being jealous when receiving low rewards. Further revealed preference analysis reveals clusters of individuals whose indifference curve are more/less convex in the risk setting versus the distribution one. The primary contributions of this paper are the elicitation and decomposition of individual preference over risk and social preference behind veil of ignorance. The novel experimental technique provides situations of splitting a pie in two environments and allows for the collection of rich individual data about preferences. The application of revealed preference techniques and structured parametric analysis allows us to probe relationships between risk attitude and social preference at the level of the individual decision maker, which provides additional interpretations and insights in studies on distributive justice, social preference, and public policy making.

**Extended Luce Rules**

Sean Horan

**Abstract**

A growing literature generalizes the classical model of random choice from Theorem 3 of Luce's monograph (1959) to accommodate zero probabilities. I establish the close connection between this literature and the very next result (Theorem 4) from Luce's monograph. In the process, I answer some long-standing questions about Luce's approach to zero probabilities; and generalize almost all of the results from the recent literature on extended Luce rules.

# Where Do Fairness Preferences Come From? Norm Transmission in a Teen Friendship Network

David Hugh-Jones and Jinnie Ooi

## Abstract

We report an experiment on transmission of fairness norms in a friendship network of 11-15 year olds. Experiment participants were able to observe a peer's allocations between two anonymous others. Observing others' choices affected both participants' own choices and their expressed fairness judgments. Rather than learning a new norm, participants decided which of two already known norms applied in the experimental situation. Systematic heterogeneity in fairness preferences may be related to how people choose to apply different norms, and these choices are affected by observing one's peers. We also use the social network to examine how social influence varies with friendship status and network position.

# Humans Reciprocate Intentional Harm by Discriminating Against Group Peers

David Hugh-Jones and Ro'i Zultan

## Abstract

The evolution of human intergroup conflict is a social science puzzle. Motivated by cycles of intergroup revenge in real-world conflicts, we experimentally test the hypothesis that humans practice group-based reciprocity: if someone harms or helps them, they harm or help other members of that person's group. Subjects played a trust game, then allocated money between other people. Senders whose partners returned more in the trust game gave more to that partner's group members. The effect was about half as large as the effect of direct reciprocity. Receivers' allocations to group members were not affected by their partners' play in the trust game, suggesting that group reciprocity was only triggered when the partner's intentions were unequivocal. We show conditions under which group reciprocity can evolve, and discuss its place in conflict among early humans.

# Robust Revealed Preference Characterization of Expected Utility

Taisuke Imai, Federico Echenique and Kota Saito

## Abstract

In the revealed preference literature, several measures of the severity of violations of the GARP have been proposed. The key idea behind some of these measures, such as the Critical Cost Efficiency Index (Afriat 1972; Varian 1990) and its variants, is to calculate how much we need to "shift down" budget lines in order to remove GARP-violating choices. However, the same idea does not work when we want to study the severity of violations of expected utility (EU) theory (von Neumann and Morgenstern 1947; Savage 1954). This paper presents a new approach to measure the deviation of observed choices from EU in a revealed-preference setup. Consider a decision maker (DM) who is presented with a portfolio problem where she has to allocate her budget among several state-contingent monetary acts. We observe a finite number of pairs of prices and portfolio choices. We first consider a model where an objective probability is given, but we allow the DM to have a (potentially different) belief for each decision problem. We can measure how much these beliefs deviate from the objective probability by calculating the ratio between odds ratio under these beliefs. We introduce a concept, "belief-perturbed objective expected utility (OEU) rationalization," which allows multiple beliefs such that the deviation from the objective probability is bounded by a given number. We introduce similar concepts, "price-perturbed OEU rationalization" and "utility-perturbed OEU rationalization," and show that these three concepts are equivalent given a bound. We also provide revealed-preference characterizations for these perturbed OEU rationalization concepts similar in spirit to axioms introduced in Echenique and Saito (2015). Furthermore, we introduce similar concepts in a model without an objective probability, "perturbed subjective expected utility (SEU) rationalization," and provide revealed preference characterizations for these as well. Even if a given choice data is not rationalized by OEU/SEU exactly, we may be able to do so by allowing some deviation captured by a bound e. The larger the bound e becomes, the easier the choice data to be rationalized by robust EU model. In a limiting case, we can always rationalize choice data. This motivates our new measure of deviation from OEU/SEU rationality, which is termed "minimal e" - the smallest bound e necessary to make OEU/SEU non-rational to be perturbed OEU/SEU rational. We apply our measure to data from three recent experiments: Choi et al. (2014), Carvalho et al. (2016), and Carvalho and Silverman (2017). We find that deviation from OEU exhibits substantial heterogeneity across participants and demographic groups, including age, education, employment status, cognitive ability, and income to some extent, in all of these three datasets.

# A Model of Indecision

Edwin Ip

## Abstract

I study a present biased decision maker who uses a commonly used thought process in decision making ("pros and cons") and suffers from anticipated regret. In a deterministic world with multiple attributes, I show that aversion to regret in such thought process can provide new explanations for a range of well-known behavioural irregularities, including choice avoidance (indecision), status quo bias, choice overload and decoy effects (attraction and compromise effects). In this paper, a decision maker evaluates an alternative by comparing each alternative, attribute by attribute, with all other alternatives that she would have to forgo. Such pairwise comparison between any two alternatives creates "pros" and "cons" along each attribute dimension. One alternative's "pro" is the other alternative's "con". Suppose the decision maker derives positive utility (rejoice) from the "pros" of an alternative and negative utility (regret) from the "cons" of an alternative, then an aversion to regret (weighing negative utility more than positive utility) may explain the aforementioned behavioural irregularities. I show that when one weighs "cons" more than "pros", then it can result in all possible alternatives giving an overall utility that is negative such that the decision maker will delay making a decision ("indecision"). Extending this, I show that under certain conditions regarding the distribution of alternatives and degree of regret aversion, having more alternatives in one's consideration set will result in indecision, a phenomenon commonly known as choice overload. However, choice overload should only occur in expectation if a decision maker is not aware of her regret aversion. A self-aware decision maker should anticipate choice overload and limit her search of alternatives accordingly or choose a smaller menu of alternatives. Finally, I show that various decoy effects can be accommodated by the model and provide some novel insights. Attraction effect may be explained by the inferior decoy adding regrets to one alternative but not the other. Whereas compromise effect may be explained by the middle alternative being the regret-minimising alternative. This model shows that when applied to a multi-attribute deterministic setting, regret aversion alone can coherently explain a variety of phenomena that were previously thought to be unrelated. The model can be applied to study a wide range of economic problems, including social preference, time preference and temptation. Given that the model only needs one parameter in addition to standard preference, it is very tractable and can also be used to model games to generate new insights into market outcomes.

# A Fuzzy Approach to Time Trade-Off Experiment in EQ-5D-3L Valuation

Michał Jakubczyk and Dominik Golicki

## Abstract

People rarely trade health; hence, health preferences may not be well formed. Time trade-off (TTO) method is often used to elicit utilities of health states but it allows only predefined answers, foregoing precision. We aimed to assess the possibility of eliciting the utilities in TTO as fuzzy numbers. A modified-TTO survey was run (convenience sample, n=184). Respondents (i) answered demography questions; (ii) self-rated own health with EQ-5D-3L descriptive system (health state is defined using five dimensions, each on three levels) and visual analogue scale, also indicating a range of equally/somewhat plausible answers (EPAS/SPAS); (iii) answered (after warm-up) ten TTO tasks (of 17 EQ-5D-3L states in two blocks). Apart from a standard, crisp valuation, the respondents provided EPAS and SPAS, which define the (dis)utility as a trapezoidal fuzzy number. The length of EPAS/SPAS was compared with the standard error of mean (SEM) for crisp valuations. The determinants of EPAS/SPAS length were identified. We built several types of models to identify dimensions impact on (dis)utility: (A, benchmark, panel, random effects) crisp disutility-crisp parameters; (B1, B2) fuzzy disutility-crisp parameters, based on either the compatibility criterion or the directed Hausdorff distance, respectively; four fuzzy-fuzzy models: naïvely modelling the lower/upper bounds of EPAS (C1), using various distances (C2 and C3), or modelling the middles and lengths of 1-cuts separately (C4). The average length of EPAS varied between 0.063 (state 21111) and 0.137 (11113), 2-6 times the length of SEM. When using dummies for dimensions only, the length of EPAS increases mostly with worsening the usual activities dimension (UA), worsening the state in general, and increasing differences in levels of individual dimensions. When modelling disutility, model A yields the following intercept and dis-utilities of consecutive dimensions (levels 2 and 3): 0.049, 0.061, 0.364, 0.095, 0.29, 0.125, 0.367, 0.063, 0.456, 0.082, and 0.278, with u(55555) = -0.8. Model B2 produces similar results: the impact of imprecision is little when crisp parameters are assumed; B1 is computationally demanding and results in unrealistically low dis-utilities. In C1, the ordering of parameters is non-intuitive in some dimensions/levels (greater values when modelling the lower than when modelling the upper bound). In C2 and C3, the largest imprecision is associated with UA and pain/discomfort. Counterintuitively, some parameters (e.g. for mobility) degenerate to zero-length intervals in C2 and C3; conveniently, not the case in C4. When eliciting health states utilities, the imprecision surpasses the stochastic uncertainty (increasing sample size will not help). Fuzzy methods allow inspection of mechanism driving imprecision, with separate location-length estimation (C4) being most promising approach; the inherent imprecision of the utility sho

# Re-running the Trolley - The Role of Probabilities and Probability Framing

Hauke Jelschen

## Abstract

Three studies assessed the influence of probabilities and probability framing on moral judgements in two iconic moral dilemmas. 550 participants judged several different versions of either the trolley dilemma, where a runaway trolley can be diverted to kill one instead of five, or the footbridge dilemma, where a single individual can be sacrificed to stop the trolley. Probabilities of the various outcomes were varied systematically and either positively framed (prob. of survival) or negatively framed (prob. of death). This resulted in four different sets of questions in each study, which itself differed by the way the probabilities were modified. Study 1 involved the certain death of the single person, while varying the probability of death of the five in case of no action. Starting with certain deaths, study 2 varied the probabilities of deaths while fixing the ratio of expected deaths. Study 3 started with a 50% probability that the five will die in case of no action and a certain death of the one in case the action is taken and varied probabilities in a way that preserves the ratio of expected deaths. Results confirm previous findings that perceived moral permissibility is generally higher in the trolley dilemma than in the footbridge dilemma with an exception occurring in study 3 when the dilemmas were negatively framed and the death of the single person was certain or close to certain. Results of study 1 show a clear trend in all four versions that individuals deem taking the action as less permissible as the probability of death of the five in case of no action declines. In study 2, no effect of simultaneous variation of probabilities occurred for trolley/positive, trolley/negative and footbridge/negative, yet a slight trend towards higher moral permissibility is observed in footbridge/positive as the probability of death is reduced. Results in study 3 differ substantially between dilemma types. While stated moral permissibility of diverting the trolley in both versions of the trolley dilemma increases substantially as the probabilities of deaths decline, no such trend is apparent in both versions of the footbridge dilemma. I do not find a systematic pattern of framing effects. Exceptions in this regard occur for low probability of death of the five in the footbridge dilemma in study 1, low probability of death in the footbridge dilemma in study 2 and moderate to low probabilities of death in the trolley dilemma in study 3. All of these characterized by higher stated moral permissibility in the positive frame. In total, results show that individuals seem to acknowledge consequentialist deliberations in moral decision making in a predictable way, i.e. they are influenced by the ratio of expected deaths, even in situations where deontological constraints might play a role. Yet, results of study 3 should foster awareness that the ratio of expected outcomes cannot reasonably be considered the sole determinant of moral decisions.

# Does Level-k Behavior Imply Level-k Thinking?

Ye Jin

## Abstract

The level-k literature classifies subjects into different Lk types by the reasoning steps they use in the games. But the observed level-k behavior is determined jointly by belief and reasoning ability. This study identifies the decisive factors that prevent people from using more depth of reasoning. It distinguishes between the "Lkb" players, who have high reasoning ability and best respond to the belief that the opponents reason $k \in 1$ steps (Lk belief), and the "Lka" players, who could use, at most, $k$ steps of reasoning. The separation utilizes a combination of simultaneous and sequential ring games. In the sequential games it requires more than $k$ reasoning steps to respond to Lk belief, so Lkb players still best respond but Lka would fail. Results show that around half of the L2 and L3 subjects are best responding to L2 or L3 belief, while the rest have reached their upper boundaries of reasoning. Additionally, subjects' CRT scores, a measure of their cognitive ability, support the separation of the two types. The findings suggest that both belief and reasoning ability could determine the observed levels, and thus one must be cautious when trying to infer belief or reasoning ability from the existing level-k data.

# Choices with Just-Noticeable Differences or Status Quo – Is There A (Noticeable) Difference?

Gavin Kader

## Abstract

I propose a choice theory that attempts to explain (potential) status quo bias (SQB) with the concept of just-noticeable differences (JNDs). SQB comes from an alternative/option which the agent holds in higher regard when decision-making (examples include current job, average consumption, default choice). In this setting, a status quo is used to eliminate other alternatives that are worse than it in some dimension of utility. In contrast, a JND is the minimal stimulus required to be able to compare/perceive change, first introduced by Luce (1956). If an agent has JND utility, this means that, with a positive JND, alternatives are imperfectly comparable/distinguishable. Masatlioglu & Ok (2005) is one of the most important and influential papers in the literature of axiomatising reference-dependent type utilities. Specifically, their paper provides a comprehensive understanding of SQB combining a behavioural viewpoint and axiomatic approach to achieve a utility representation. Although choice behaviour that is consistent with SQB may be represented by JND utility, the converse may not necessarily be true. Therefore, I propose an accompaniment to the literature by offering an alternative representation of SQB with the classic JND utility representation via minimal relaxing of the axioms that drive SQB behaviour, of which the SQB utility representation of Masatlioglu & Ok (2005) can be considered a special case.

**An Experimental Investigation of the Not So Tenuous Trade-Off between Risk and Incentives**

Alexandros Karakostas

**Abstract**

We conducted an experiment to test the relationship between risk and incentive intensity as this is described in the Incentive Intensity Principle of Holmstrom and Milgrom (1987). In contrast to previous findings, which have led the relationship to be described as 'tenuous' (Prendergast 1999), we find a clear negative relationship between risk and incentive intensity as predicted by the theory. The principals, on average, reduce the size of the piece rates they offer when there is increased risk and provide positive fixed wages, in line with theories of other regarding preferences. Furthermore, we find no relation between the variance in the performance and the effort choice of the agent and a strong positive relation between the effort choice of the agents' and the piece rates offered by principals, suggesting positive reciprocity. Lastly, we find evidence of social projection by the principals regarding the agents risk aversion levels.

# The Team Allocator Game: Allocation Power in Public Goods Games

Alexandros Karakostas

## Abstract

We analyze a modified linear, weakest-link and best-shot public goods game in which a distinguished team member, the team allocator, has property rights over the benefits from the public good and can distribute them among team members. These linear, weakest-link and best-shot team allocator games are intended to capture natural asymmetries in hierarchical teams facing social dilemmas, such as those which take place in work teams. Surprisingly, experimental results show that the introduction of a team allocator leads to pronounced cooperation in both linear and best-shot public-good games while it has no effect in the weakest-link public goods. The team allocator uses her allocation power to distribute benefits from the public good in a way that motivates people to contribute. As a result, team profits are higher in the linear team allocator game but not in the best-shot, where lack of coordination lead to welfare decreasing behavior for the team members. Remarkably, the institution bears no direct monetary costs.

# Comparative Study of Risk-Taking and Academic Performance using a Career Choice Simulator

Vivek Kaushal, Dhriti S. Goyal and Kavita Vemuri

## Abstract

We studied financial risk-decision behaviour with a career choice simulator to understand a) academic performance and risk, b) pressure of financial net-worth c) 'brand' image of place of work. The main objective to check the balance between logical choices in financial decisions. An interactive game-like app was designed and developed. The gameplay was designed to allow players to maximise net-worth by choosing a job from a set of available choices. Each job had two-forced choice options- an annual salary and a performance cutoff. The performance score for the job selected was generated at the end of each turn, e.g, if a user's performance was lower than the selected job's performance cut-off, the user was 'fired' and an amount of $100,000 was deducted from the net-worth leading to the next stage. Alternatively, if the performance score was higher, the salary amount was added to user's net-worth. Performance score at each stage was presented from a pre-defined set. There was a total of 15 stages divided into 3 rounds. The first round had two metrics, salary offered and performance cut-off. The second round included company names where a company with a perceived bigger brand value was added to the job with a higher risk. In the third round, the companies were reversed, i.e., one with a higher brand value was added to a lower risk job. The participants- 50 (25 with a GPA ≥ 8, and an equal number with a GPA < 8) sophomore computer science students' responses were recorded. Afterwards, they were asked to rank their preference for location, company and salary. Results show that the average net-worth of students with a GPA ≥ 8 was 30.7% greater than students with a GPA < 8. This could indicate that better academic grades results in a tendency to weigh risk-reward scenarios better. Students with lower GPA took 10.2% more risks, an interesting result that needs to be examined with respect to the effect of lower expectation from society and hence propensity for high risk behavior. Students with lower GPA also got fired 43.5% more, which can be seen in the above light or that the high performing students are better adept at taking smarter risks. 24 students ranked salary as the most important factor in choosing a job, followed by 16 for company, and 10 for location. Preference for company had 7% lower net-worth return. One can infer that allegiance to 'brands' interferes with the logical decision making. Contrary to expectations, no direct correlation was observed between net-worth of an individual and risk-taking, which indicated that the tendency to risk is independent of net-worth and people are inherently either high or low risk takers. The findings from this study highlights certain constraints of the educational and career choice expectation on Indian students. The data brings a unique testing tool for risk and goals adding to rational choice theory experiments.

# Robust Bidding and Revenue in Descending Price Auctions

Christian Kellner and Sarah Auster

## Abstract

We study the properties of Dutch auctions in an independent private value setting, where bidders face uncertainty over the type distribution of their opponents and evaluate their payoff by the worst case over a set of probabilistic scenarios. We characterize the equilibrium bidding function in this environment and show that the presence of uncertainty over the type distribution of opponents leads bidders to end the auction earlier at higher prices. Our main result shows that the Dutch auction generates more revenue than any of the other standard auction formats and thus provides an explanation for why descending price auctions are common practice in many real world situations.

# Tort Liability and Unawareness

David Kelsey, Surajeet Chakravarty and Joshua Teitelbaum

## Abstract

Abstract Unawareness is a form of bounded rationality in which a person fails to conceive all feasible acts or consequences or to perceive as feasible all conceivable act-consequence links. We study the implications of unawareness for tort law, where relevant examples include the discovery of a new product or technology (new act), of a new disease or injury (new consequence), or that a product can cause an injury (new link). We argue that negligence is superior to strict liability in a word with unawareness, because negligence, through the stipulation of due care standards, spreads awareness about the updated probability of harm.

# Signal Perception and Belief Updating

Emmanuel Kemel, Ilke Aydogan, Aurélien Baillon and Chen Li

## Abstract

In standard economic models, from game theory to macroeconomics, decision makers incorporate new information using the rational gold standard of belief updating: the Bayes' rule. Yet, studies from the psychology literature highlighted regular deviations from Bayesian updating. Such deviations include conservatism bias, when people fail to sufficiently incorporate new information, and confirmatory bias, when people misread contradicting signals as confirming. This paper introduces a model based on signal perception to study how people update their beliefs. By allowing perceived signals to deviate from actual signals, we identify two indices of deviation from Bayesian updating. The first measures confirmatory bias, the second measures conservatism. When these two biases hold, the indices correspond respectively to the probability that people miss signals and the probability that people misread contradicting signals. The indices can also measure the opposite patterns of bias: dis-confirmatory bias, when people misread confirming signals as contradictory and prior signal destruction when people fail to sufficiently account for past information. The model is a portable extension of Bayesian updating that can be incorporated in any model from macroeconomics or game theory by re-coding actual signals into perceived signals using our indices. We estimated this model in an incentivized experiment involving 157 subjects. Subjects received signals in the form of iid Bernoulli observations generated by a random device. Beliefs were measured before and after reception of signals, allowing to compute perceived signals and their deviation form received signals. A structural-equation econometric model was used to estimate our deviation-from-Bayesian-updating indices and their predictors. The subjects were conservative and acted as if they missed 65% of the signals they received. Also they exhibited confirmatory bias by misreading 17% of the signals contradicting their prior beliefs.

# Quantum-Like Model of Subjective Expected Utility

Andrei Khrennikov

## Abstract

During the recent years the quantum probabilistic (QP) approach to modeling of cognition and decision making (DM) under uncertainty has been really generating numerous publications. One of the main distinguishing features of this approach is the possibility to treat mutually incompatible (complementary) DM problems, e.g., questions, inside the common model based on QP. Experts in classical DM-theory were well aware about the existence of such problems, e.g., in the form of the disjunction, conjunction, and order effect, e.g., Tversky and Shafir since 1990s. The attempts to represent incompatible question in the classical probabilistic (CP) framework led to a number of paradoxes. The most known are the Allais (1953), Ellsberg (1961) and Machina (1982) paradoxes, but in their review Erev et al. count 35 basic paradoxes of classical DM-theory. The talk will contain a review on QP approach to DM, motivation and recent results, such as violation of Aumann's theorem and its new QP-version. Then we present a new general QP model of lottery selection under uncertainty. Subjective probability is described as QP. The values of the utility function for outcomes of two lotteries $A=(x_i, P_i)$ and $B=(y_i, Q_i)$ are represented by orthonormal bases in the belief-state space H, complex Hilbert space. Starting with the classical utility function, we define the comparison operator which is used for QP comparison of lotteries. The model describes the process of generation of subjective probabilities and behavioral factors play the crucial role in generation of deviation from CP-approach. Finally, we remark that ideologically the transition from CP to QP model of the process of DM is similar to the use of non-additive probability in DM. Comparison of QP and non-additive probability approaches will be presented as well.

# Mixing Propensity and Strategic Decision Making

Duk Gyoo Kim and Hee Chun Kim

## Abstract

This paper examines a link between an individual's strategic thinking in beauty contest games and (possibly non-rational) decision-making patterns in a non-strategic setting. Experimental evidence shows that subjects' strategic behavior, which used to be understood as a result of (possibly limited) cognitive iterations, is closely related to the non-strategic decision-making patterns. We claim that such a relationship partially explains conflicts of the previous reports on the strategic behaviors observed in the laboratory. We require attention to this relationship in that the assumption that individuals are rational in the decision-theoretic sense may create sizable misinterpretation of strategic behavior. Our goal is to examine how individuals' non-strategic 'and possibly non-rational' decision-making patterns over probabilistic events are related to their strategic ones. To analyze strategic observations, the main body of the literature has implicitly assumed that "individuals are rational in the decision-theoretic sense of choosing strategies that are best responses to consistent beliefs" (Crawford 2016), which we call decision-theoretic rationality. However, when subjects are asked to make repetitive decisions under uncertainty, experimental work shows that a significant amount of subjects do not make decisions to maximize their expected payoff, but match their decision frequencies to the probability of events, which is called probability matching (Rubinstein 2002). We introduce a broader notion of the probability matching as there could exist other decision-making patterns not captured in one set of repetitive decisions. We call this broad notion of individual tendency in repetitive decision makings as a mixing propensity, because such a tendency will result in mixed choices in the same environment. We claim without considering individuals' mixing propensity, it is challenging to map individuals' strategic behaviors to their underlying belief. The beauty contest game or its modified versions have been used to estimate individuals' cognitive levels and underlying belief about the population. To analyze experimental observations, previous studies implicitly share an assumption that every subject is equipped with decision-theoretic rationality. In other words, they assume that no subject has any sort of mixing propensity, which may create sizable misinterpretation: An individual who has a certain type of mixing propensity may show homogeneous choice patterns even when she has a heterogeneous belief, while an individual who has another mixing propensity may make heterogeneous choice patterns that fully reflect her heterogeneous belief when the best response to the belief is a probabilistic mixture of many choices. Naturally followed questions are whether the lack of consideration of mixing propensity deteriorates the previous studies' elicitation of the structure of beliefs, and if so, how severe it is.

# Economic and Psychological Incentives in Darts

Bouke Klein Teeselink, Rogier Potter van Loon, Martijn J. van den Assem and Dennie van Dolder

## Abstract

We examine the effects of economic and psychological incentives on the performance of darts players, using three large data sets of competitive darts matches. First, we analyze whether players perform better when the incentives to exert more effort are objectively higher due to higher benefits of throwing well or higher costs of throwing poorly. We find evidence that larger economic incentives indeed increase performance. Second, we examine if players perform better when they are slightly behind, assuming that loss aversion increases motivation in such cases. In contrast to earlier findings for golf and basketball, and in spite of our sizable data sets, we find no compelling evidence supporting this hypothesis.

# A Lack of Confidence: Risky Decisions Based on Sample Description and Experience

Ronald Klingebiel and Feibai Zhu

**Abstract**

Few real-life decisions afford the informational luxury of fully described probabilities, underscoring the usefulness of researching behavior in decisions based on sample experience. Our paper examines to what extent it is the sample or the experience that generates departures from the more commonly studied decisions based on description. We first replicate a conservative version of the canonical experiment design for testing description-experience gaps. Our results show some support for the notion that people behave as if they underweight small probabilities more often when decisions are based on sample experience. We then show that the greater underweighting is largely due to subjects receiving sample statistics, as opposed to fully specified probabilities. The gap to a lesser extent is due to subjects experiencing the iterative process of drawing the sample, as opposed to seeing a mere description of the same sample. Our research opens up avenues for future research into the causal drivers of the description-experience gap and offers a new experiment design for robust separation of its sample and experience components.

**Indecisiveness, Preference for Flexibility and A Unique Subjective State Space**

Nobuo Koida

**Abstract**

The objective of this study is to relate two major routes of addressing uncertainty, namely, indecisiveness and preference for flexibility. Specifically, we assume preferences over alternatives and over menus as primitives and axiomatize a joint representation of expected multi-utility (Dubra et al. 2004) and ordinal expected utility (Dekel et al. 2001), wherein the set of utility functions in the former is equivalent to the subjective state space in the latter. This result indicates that indecisiveness and preference for flexibility arise from the common underlying uncertainty about ex post tastes, that is, subjective state space, albeit they may appear differently. Our key axiom is dominance consistency, which requires that the addition of an alternative to a menu strictly improve the menu evaluation if and only if the alternative is un-dominated by the menu. The main result can be extended to a specific class of ordinal expected utility, such as the additive representation. The relationship between the preference over alternatives and the commitment ranking, and the one-directional implications of dominance consistency are also discussed.

# Active vs. Passive Risk-Taking

Christian König-Kersting, Johannes Lohse and Anna Merkel

## Abstract

Risk-taking plays an important role in economic decision making. Differences in real world risk-taking behavior are typically attributed to differences in the decision makers' risk preferences. In the past decades, economists and psychologists have developed several methods to measure such risk preferences and analyzed their predictive power for many real world risk-taking behaviors, such as gambling, stock market investments, smoking, fast food consumption, drug and alcohol abuse as well as participating in dangerous sports. These examples have in common that risk taking requires an active decision to engage in an activity that puts the decision maker at risk. For example, a decision maker who chooses to bet on the outcome of a horse race actively takes on a financial risk. In many other real world examples, however, risk is born by abstaining from taking an action. For example, a decision maker who does not attend regular medical screenings, bears a higher risk of mortal diseases. Similarly, not purchasing total permanent disability insurance increases the risk of getting into financial difficulties if the decision maker's ability to work in their trained profession is lost for medical reasons. In these situations, risk is born by inaction, i.e. by remaining passive and not taking actions to mitigate the exposure to risks. So far, the analysis of risk-taking behavior has largely concentrated on active risk-taking while the determinants of passive risk taking have been overlooked. Specifically, most elicitation tasks commonly used in experimental economics and psychology require participants to take action to increase their risk exposure. We conduct an economic laboratory experiment in which we systematically address this issue by allowing for passive risk taking. Participants face a series of two-outcome gain domain lotteries, similar to the ones introduced by Eckel and Grossman (2002, EHB). For each lottery, the participants can adjust the payoffs associated with each outcome towards more (less) risk in predetermined steps. In a between subject design, we vary whether participants have to take action to adjust the payoffs (and therefore the level of risk taken), or whether these adjustments take place automatically as long as the participant remains inactive. In addition, we vary the starting point of the adjustment process. That is, whether participants start the adjustment process from a safe lottery, which pays the same amount for both outcomes, or from a very risky lottery, which pays zero for one outcome and a high positive amount for the other one. We find strong starting point (or default) effects. Participants take more risk if they start the adjustment process from the riskiest lottery rather than from the safest one. We do not find any evidence of a pure mode of choice effect, i.e. whether participants need to take action or have to remain inactive to implement their preferred level of risk.

# The Impact of Middle Outcomes on Lottery Valuations

Krzysztof Kontek and Michael Birnbaum

## Abstract

This paper presents the results of two experiments that violate implications of Expected Utility (EU) and Cumulative Prospect Theories (CPT). First, some lotteries with three equally likely branches are valued more than a strictly better binary lottery, while others are valued less than a strictly worse binary lottery. These results violate coalescing and stochastic dominance implied by EU and CPT. Second, experimental data provide evidence that lottery valuations strongly depend on the value(s) of the middle monetary outcome(s); this contradicts the prediction of EU, and especially of CPT, which implies that middle outcomes receive lower weights than extreme outcomes. Both effects are replicated with four-branch lotteries, with different values of the highest outcome, and with subjects from both Poland and California. It is argued that violations of coalescing and stochastic dominance are related to each other, and they are both associated with apparent overweighting of middle outcomes. All this leads to self-contradiction when CPT is used to fit the data: the probability weighting function estimated using binary lotteries takes an inverse S-shape, contrary to an S-shape estimated using lotteries with three or four branches.

# Know Thyself – Am I A Risk-averse Person?

Tomasz Kopczewski and Iana Okhrimenko

## Abstract

This article is one of the publications with the common title Know thyself, which refers to one of the Socrates maxims. It is also the name of the teaching method based on the implementing ad hoc research to the process of teaching microeconomics. In this method, students participate in the researches as passive subjects and after the researches, they are encouraged to analyze their decisions. In this way, an instructor creates an information gap among students, a sense of deprivation - an unsatisfied need for knowledge the decisions taken. It can be a good background for creating science curiosity. Students explore the problem by themselves through doing problem sets based on the results of the research. At microeconomics lectures, the problems of choice under uncertainty are paid too little attention. Concentrating on the choice under risk is isolated from the real issues the students deal with on a daily basis. The storytelling of the topic has been inspired by the pull performed by financial institutions which aim is not to allow for overselling financial assets to individual clients: it would not be appropriate to sell too risky assets to the risk-averse individuals. The measure has an intriguing name: risk tolerance. The following question arises: can students have such a high-risk tolerance to be willing to pay for additional risk? This situation does not appear in any textbook. There are no examples of economic agents which are risk-lovers. The goal of performing a series of ad hoc researches was to show how easy the individual risk aversion measure can be manipulated by the way of problem presentation. This article has a structure that maps the various stages of work on ad hoc implementation of research on the individual measurement of risk aversion to the process of teaching. The first stage is devoted to determining the teaching objectives of introducing research, linking them to real economic problems, and creating storytelling. Concerning the Know Thyself principle, the lecturer should show the students that i) individuals are heterogeneous with respect to attitude towards risk ii) due to the presence of cognitive bias, the decisions may be inconsistent with the perceived risk attitudes. At the second stage, the research is conducted to obtain the data. The lecturer repeats the set of simple experiments to get different measure of risk aversion. A third stage, the results are used for the preparation of individualized materials for students, which are presented and discussed during the lecture. The last part is devoted to the technical aspects of material preparation. Applying this teaching method must be accompanied by the use of IT tools.

# A Theory of Reflective Choice

Christopher Kops

## Abstract

The standard framework in economics to model individual behavior is that of rational choice. It pervades all branches of economic theory, from macroeconomic models to key areas of microeconomic theory such as game theory, contract theory and general equilibrium theory. In this framework, individuals are assumed to be rational decision makers who have well-defined stable preferences and whose choices are the result of maximizing these preferences. An impressive body of choice data from lab experiments is, however, at odds with the internal consistency of choice preached by this theory. Findings from choice experiments of Loomes, Starmer and Sugden (1991) and Trueblood, Brown, Heathcote and Busemeyer (2013) highlight that over 60% of subjects show inconsistencies in their choices that take the form of choice cycles (Tversky 1969) or reversals like the attraction (Huber, Payne and Puto 1982) and compromise effect (Simonson 1989). In this paper, we present a simple mechanism that may lie behind these and other non-rational choice patterns: an aversion to last-ranked alternatives. It builds on the phenomenon of last-place aversion documented by Kuziemko, Buell, Reich and Norton (2014), according to which individuals don't want to be placed last with respect to some criterion that they deem important, and extends its general intuition to the domain of individual choices in the following way: When provided with a set of primitive orderings over alternatives that represent a set of evaluation criteria, a decision maker following our choice procedure will, if possible, avoid choosing any alternative which is ranked last among the available alternatives with respect to some such criterion. We show that our theory can accommodate the three choice patters above, a behavioral anomaly often called a difficult choice (Cherepanov, Feddersen and Sandroni 2013) and may even prove useful in explaining choice behavior in contexts where choice defaults are implemented (Johnson and Goldstein 2003) or choices of others can be taken as given as in leading examples of social influence reported in the literature inducing both conformity and nonconformity (Asch 1955). Furthermore, we provide a behavioral characterization for maximizing a single preference relation within our framework, identify the underlying parameters of our model, highlight applications of our choice procedure to voting theory and welfare analysis, and relate our work to the existing literature on theories of behavioral choice including, among others, the rational shortlist method of Manzini and Mariotti (2006), choice with limited attention of Masatlioglu, Nakajima and Ozbay (2012) and the model of overwhelming choice of Lleras, Masatlioglu, Nakajima and Ozbay (2017).

# Preferences under Ambiguity Without Event-Separability

Christopher Kops and Abhinash Borah

## Abstract

Subjective expected utility maximization requires a decision maker's preferences to be event-wise separable. However, as Ellsberg (1961) showed, in many situations of uncertainty, this may be too demanding a requirement for decision makers. Following Schmeidler (1989) and Gilboa-Schmeidler (1989), a series of decision models have been proposed for such ambiguity-sensitive decision makers that relax event-separability restrictions. A feature common to these models is that although preferences are not required to be event-wise separable over the domain of all acts, each of them identifies a subdomain on which event-separability still holds. In an important contribution, Machina (2009) has shown that such ambiguity-sensitive models may be susceptible to the same kind of difficulties that the Ellsberg paradox poses for subjective expected utility. In other words, the conflict between event-separability of preferences and ambiguity-sensitive behavior may be of a more serious nature than what these models can accommodate. As Machina writes "the phenomenon of ambiguity aversion is intrinsically one of nonseparable preferences across mutually exclusive events, and the models that exhibit full – or even partial – event-separability cannot capture all aspects of this phenomenon (Machina 2009: pp. 390)". Therefore, in modeling ambiguity-sensitive behavior, reliance on event-separability assumptions should be kept to the minimum and, if possible, done away with completely. In this paper, we attempt to implement the "Machina program" by proposing and axiomatically characterizing a representation of ambiguity-sensitive preferences that does away with event-separability restrictions completely. We show that even without any such separability restrictions, we are able to uniquely elicit baseline subjective probabilities for a decision maker. Under our representation of her preferences, any act is assessed by its subjective expected utility with respect to her baseline probabilities and a quasi-concave residual that captures her assessment of the act's exposure to ambiguity. The key innovation in our paper is to identify a collection of acts which we refer to as almost identical and complimentary acts (AIC). Two acts are AIC if they differ in only one state and are complementary (Siniscalchi 2009). Our key axiom essentially states that for any pair of AIC acts, the difference in the decision maker's assessment of these two acts is proportional to the difference in the expected utility of the two lotteries under them in the state in which they vary.

# A Horse Race between Cumulative Prospect Theory's Elicitation Methods

Orestis Kopsacheilis, Dennie van Dolder and Jörg Weber

## Abstract

Eliciting risk preferences is crucial for testing and applying economic models. Traditionally, measures of risk preferences focussed on expected utility. Much empirical evidence, however, suggests that people often violate expected utility, and Tversky and Kahneman's Cumulative Prospect Theory (CPT 1992) has emerged as the dominant descriptive model of risky choice. To facilitate its application, several methods to elicit its parameters have been proposed. Unfortunately, different methods lead to different estimates and it remains an open question which of the methods is to be preferred. In this paper, we design a systematic framework to 'horse-race' elicitation methods with an objective benchmark for performance: out-of-sample predictive power. Given that true preferences cannot be observed, the ability of measured preferences to predict future choices seems like a reasonable second-best criterion to evaluate estimation accuracy. Using our framework, we test three popular elicitation methods for CPT that we consider representative for the state-of-the-art. Two of our candidates operate through standard gambles and elicit certainty equivalents: the semi-parametric method of Abdellaoui et al. (2008) and the fully parametric one of Fehr-Duda et al (2006). The third method by Stott (2006) uses paired gambles and elicits binary choices between them. We apply these methods in a within-subject laboratory experiment. Each subject faces three decision sets that are used to elicit their preference parameters (one for each method) and two validation sets for out-of-sample predictions (one for standard gambles and one for pair gambles). Besides assessing which elicitation method works best, we also consider how predictive accuracy compares across estimation techniques. To this end, we estimate parameters using either standard Maximum Likelihood Estimation (MLE) or Bayesian Hierarchical Modelling (BHM), an estimation technique that moderates individual-level parameters with group-level information. Using MLE, we find that the standard gambles methods outperform the paired gambles method in terms of predictive power, both in the standard gamble and paired gamble validation sets. The two standard gamble methods perform roughly equally well. Furthermore, the standard gamble methods are substantially more time efficient than the paired gamble method. Using BHM instead of MLE improves performance overall, but especially that of the paired gamble method. We show that the improvement of the BHM is due to a 'shrinkage' of the estimated parameter spaces: the constraints imposed by BHM lead to less extreme parameters. The improved performance of the paired gamble method creates a 'home advantage'. Where previously the standard gamble method always scored best, now each method performs best in its own validation set. This suggest that researchers should select estimation procedure that closely match the decision context to which they want to extrapolate behaviour.

# An Explanation for the Equity Premium Puzzle Based on Differential Discounting for Gains and Losses

Jan S. Krause, Patrick Ring and Ulrich Schmidt

## Abstract

In this paper, we propose a novel explanation for the equity premium puzzle which is based on the assumption that individuals discount gains and losses differently. In a nutshell, our hypothesis is that individuals discount potential losses less than potential gains, and therefore require a premium for stocks beyond their risk attitudes. In two steps, we provide empirical evidence for the above outlined hypothesis. First, we show that the discount rate applicable to losses is lower compared to gains. In contrast to most of the existing literature, we apply an incentive mechanism that is not based on hypothetical choices, but tries to mimic real financial losses. Under this incentive mechanism, we find that losses, on average, are discounted negatively and gains positively. Second, we show that individuals become more loss averse when a mixed lottery is realized in the future rather than in the present, while their risk attitudes do not change for pure gain or loss lotteries. Given our first finding, differential discounting for gains and losses provides a plausible explanation for this effect and thereby an alternative explanation for the additional premium on stocks.

# Using Proper Scoring Rules to Measure Loss Aversion

Olivier L'Haridon, Craig Webb and Horst Zank

## Abstract

A pattern of behaviour widely observed in experiments is that, when an individual values an uncertain prospect, losses loom larger than corresponding gains. This has become referred to as Loss Aversion. This paper presents a new, simple and efficient technique for measuring the degree loss aversion at the individual level in experiments. We exploit a class of techniques called Proper Scoring Rules, previously used for eliciting subjective probabilities. Proper scoring rules are mechanisms suitable to be incentivised elicitation methods, which make them particularly useful in experimental designs. A class of scoring rules, the Mixed Payoff rules, are considered. If loss aversion holds then revelations of subjective probabilities inferred from these rules are distorted. By applying these rules in sequence with the Quadratic Rule in an experiment on choice under uncertainty, we show how such distortions can reveal an individual's coefficient of loss aversion. Results show that elicited loss aversion coefficients were much lower than the ones usually found in the literature. Heterogeneity in individual loss aversion was also found to be less pronounced than in previous experiments. These results suggest that scoring rules can be an efficient mechanism to attenuate loss averse behaviour in experiments.

# Impossibility Theorems for Menu Dependent Collective Preference Functionals

Somdeb Lahiri

## Abstract

We consider functions that assign to each evaluation profile a preference system or a list of menu dependent preferences. The rule by which such an assignment takes place is said to be a menu dependent collective preference functional (MDCPFL). We extend the concepts of invariance under individual cardinal transformations, weak Pareto, binary independence, weak dictatorship and veto power from the context of social welfare functionals to our framework of MDCPFL's. We consider admissible sets of evaluation profiles which are slightly more general than necessarily requiring that all evaluation profiles be admissible. We introduce the concepts of nested and nested* MDCPFL's. Our first result says that a nested MDCPFL which is invariant under individual transformations, globally weakly Paretian and satisfies global binary independence must be weakly dictatorial. Our second result says that a nested* MDCPFL which is invariant under individual transformations, globally weakly Paretian and satisfies global binary independence must have an individual/criterion that wields veto power.

**Producer Attitudes toward Output Price Risk: Experimental Evidence from the Lab and from the Field**

Yu Na Lee, Marc F. Bellemare and David R. Just

**Abstract**

In a seminal article, Sandmo (1971) showed that when faced with a risky output price, a risk-averse producer would in theory hedge against price risk by producing less than she would if she instead had been faced with a certain price equal to the mean of the risky price distribution. A number of policy instruments (e.g., administrative pricing, buffer stocks, marketing boards, and variable tariffs) as well as a substantial amount of research contributions are predicated on the idea that producers dislike price volatility. We test Sandmo's prediction experimentally, both in the lab with US college students and in the field with Peruvian farmers. We find no support for Sandmo's prediction, either in the restricted sample of risk-averse subjects when eliciting our subjects' risk preferences by way of Holt and Laury's (2002) list experiment, or in the whole sample. Looking at alternative explanations for our subjects' behavior, we find no support for the safety-first decision criterion or for the hypothesis that our subjects maximize expected profit rather than expected utility, but we find evidence in support of prospect theory. Our findings can help explain a number of puzzling stylized facts, such as the lack of demand for agricultural insurance even at actuarially fair prices in developed countries and the lack of demand for index insurance even when heavily discounted in developing countries.

# Climate Change Catastrophes and Insuring Decisions: A Study in the Presence of Ambiguity

Sara le Roux

## Abstract

There has been very little research to test whether ambiguity affects individuals' decisions to insure themselves against the catastrophic effects of climate change. This paper attempts to study how individuals respond to the availability of an insurance that would safeguard their interests if a climate change catastrophe occurred. Moreover, if such an insurance is available to them, do they insure themselves sufficiently? Further, the study investigates if increased information regarding the probability of the catastrophic event, leads to an increase in insurance subscriptions. Finally, policy implications for the State are investigated – Can State intervention in the form of a "nudge" ensure a better outcome?

# Revealed Privacy Preferences

Yi-Shan Lee and Roberto Weber

## Abstract

The development of effective privacy policies rests critically on the question of whether people are capable of engaging in rational tradeoffs regarding the use of their personal information. This study employs an economic approach to investigate the extent to which people's decisions regarding the sharing of personal information exhibit consistency with an underlying rational preference for privacy. We develop a novel experiment in which people allocate privacy levels between different personal information items, allowing us to classify people depending on whether their choices are consistent with the Generalized Axiom of Revealed Preference. We find more than 63 percent of subjects act consistently with a rational preference ordering when allocating privacy levels, despite the substantial heterogeneity of privacy attitudes. We further investigate the extent to which these revealed privacy preferences can be measured by monetary equivalents and whether preferences elicited over choices in our experiment have any predictive power for explaining real-world privacy behavior. We find that the classification of rationality from choices is also predictive of monetary tradeoffs: irrational types, on average, squander 260 percent more money than rational types through inconsistencies in their monetary valuations. Despite the presence of noise, monetary valuations still reflect the underlying privacy preferences, as more private types require significantly more compensation for sharing personal data. Finally, the measures of privacy preferences elicited in the laboratory are correlated with a widely-used question eliciting self-reported privacy concerns and with behavioral outcomes in different domains of daily-life personal information sharing. We conclude that, while there is considerable heterogeneity in privacy attitudes, a non-trivial proportion of individuals demonstrate systematic consistency with rationality when making privacy choices.

**Objection-Dependent Expected Utility: A Theory of Framing and Decision under Risk or Uncertainty**

Louis Levy-Garboua

**Abstract**

This paper presents a descriptive theory of expected utility which explains how lotteries are framed and processed, and how the frame and decision process impact the revealed preference. I consider decisions under risk or uncertainty among independent prospects by intuitively-rational decision makers who rely on evidence to decide and have a sequential perception of the objects of choice. If decision makers perceive sequentially dissonant evidence, they may be led to reverse their preference within the decision process. I describe here the process of decision of intuitively-rational decision makers who start with a context-free, expected utility (EU) prior. Whenever dominance cannot be observed, choosing the EU-preferred option always raises an objection, i.e. doubt, in a pairwise comparison. The role of framing is to reveal dominance or make the objection visible in order to test one's prior and reach a decision that one can feel "reasonably sure" of. However, objections are frame-dependent and so will be the revealed preference. I develop a Bayesian representation of the decision process based on the sequential perception of the prior EU preference and a visible objection to the latter. Individuals with doubt maximize an objection-dependent expected utility (ODU) conditional on their prior EU preference. The theory is applicable to decisions between two lotteries or more. All pairwise comparisons without dominance can be categorized in just two patterns: nested lotteries and overlapping lotteries. Nested lotteries exacerbate the dilemma between risk-taking and certainty by making the nested lottery appear relatively safe and by highlighting the objection to any prior preference, whereas overlapping lotteries may bring subjective certainty in decisions that are intrinsically risky by suggesting stochastic dominance or "quasi-stochastic dominance" if lotteries are similar. With this simple theory of framing under risk, all the anomalies of decision under risk exhibited by Kahneman and Tversky (1979) and a few more can be predicted with a single parameter in excess of risk aversion. It is shown in particular that the Allais paradox may result from the use of a nested-lotteries frame in presence of a sure outcome and an overlapping-lotteries frame exhibiting quasi-stochastic dominance in presence of two similar risky lotteries. Finally, a crucial test of this analysis and of the relevance of framing in the decision process is presented.

# Range and Sign Dependent Utility

Michal Lewandowski, Manel Baucells and Krzysztof Kontek

## Abstract

We propose a range and sign dependent preference model (RSU) to evaluate risky prospects, possibly with a temporal component. For lotteries played today, the model departs from cumulative prospect theory, but can be seen as an extension of original prospect theory after introducing an editing step. For delayed prospects, the model extends the probability and time trade-off model to multiple outcomes. The descriptive model is characterized by a loss averse value function, and an s-shaped canonical range function. The latter is sign dependent, and its inverse play a role similar to a probability weighting function. The model is linear in probabilities in each domain, and does not require sorting outcomes from highest to lowest. RSU is able to explain the four-fold pattern of risk preference, the Samuelson paradox, the Allais paradoxes and the preference reversal phenomenon. For temporal choices, RSU can explain decreasing impatience and sub-endurance (i.e., magnitude effects in discounting).

# Belief Polarization: The Role of Ambiguity Attitudes and Dynamic Consistency

Jiangyan Li, Jianying Qiu and Utz Weitzel

## Abstract

Existing studies pointed out the confirmatory bias (Rabin and Shrag, 1999) as the most commonly used explanation for the occurrence of belief polarization, i.e. a phenomenon that the disagreement between individuals becomes even further after a common observation. However, in a more recent study by Baliga, Hanany and Klibanoff (2013), the polarization of beliefs has been explained from a completely new perspective. Specifically, the polarization of beliefs was explained as the result of dynamically consistent individuals dealing with the changed desire of hedging against the exposure to ambiguity after seeing a signal. In this paper, by designing an experiment in a way that satisfies the conditions mentioned by Baliga, Hanany and Klibanoff (2013) for belief polarization as close as possible, we examine the role of the two most essential conditions, individuals' ambiguity attitudes and the dynamic consistency condition played in explaining the occurrence of belief polarization in a lab experiment. However, we did not observe the occurrence of belief polarization as Baliga, Hanany and Klibanoff (2013) proposed. During the process of investigating the possible reasons why the belief polarization failed to occur in our experiment, we found a significant effect of the change of the hedging desire after a signal realized on the deviation from the Bayesian updating, which implies the crucial role played by individuals' ambiguity aversion and the dynamic consistency condition. Additionally, we found that the reason for the absence of belief polarization in our experiment is mainly due to the influence of risk aversion and another important element of ambiguity attitudes, a-insensitivity, when making the ex-ante optimal strategy contingently on a neutral signal.

# Bi-Criterion Preference and Variable Information Structures

Hualin Li

## Abstract

The decision making under uncertainty with variable information structures was addressed in this paper. The paper endeavours to explicitly invoke the information structures as preliminary of Anscombe-Aumann framework by proposing a class of uncertainty preferences conditioned by variable information structures on a relatively "small" domain; and attempts to establish the functional representation as well as its interpretative reasoning criteria under certain series of tractable axioms describing such class of preferences. In regarding the axiomatization, by introducing two sets of consistency axioms this paper manages to establish two main equivalences in terms of uniform representations of the class of preferences. The first representation is characterised by the classical von Neumann-Morgenstern index and a mixture integral of Choquet integral and summation with a unique capacity on the state space. In the second representation, the paper obtained a unique capacity and a unique probability measure on the state space as well as the von Neumann-Morgenstern index, where the index is integrated by a mixture integral of Choquet integral and expectation. Above all, both representations induce the same representation given a specific information structure, which is characterised by a unique probability measure on the sigma-algebra generated by the information structure and a unique class of capacities on each event given by the information structure. Our representations suggest that under variable information structures, our DM evaluates the choice objects as if she holds "bi-criterion", expressed by a unique capacity and a unique probability measure, and is ready to evaluates the informed part and uninformed part separately via corresponding criterion and the two criteria strictly obey their own "domains". By referring such bi-criterion as ambiguous criterion and unambiguous one, after the acquisition of information with a specified structure, our DM evaluates the anticipated pay-off conditioned on each informed event via ambiguous criterion and then consider the unconditioned pay-off via the unambiguous criterion based on the obtained information on the occurrence of events, i.e. informed events. Associated with such interpretation, our specification of information structures allows the model to highlight one of the main implication of the paper: the uncertainty preference even reveals certain dependency on the very fact that "being informed". Finally, as a worth-mentioning point, although this paper did manage to establish a certain linkage of the unique capacity and the unique probability measure, however, one is still not able to explicitly isolate the causality between them. In other words, one could not rigidly assert whether the information acquisition modifies the uncertainty attitude of DM or the uncertainty attitude of DM determines the interpretation of perceived information, even in the "as-if" sense.

# Measuring Ambiguity Attitudes for All (Natural) Events: A Theoretical Foundation

Chen Li, Aurélien Baillon and Peter P. Wakker

## Abstract

A difficulty for measuring ambiguity attitudes is that one should control for subjective beliefs that are usually unknown. Hence, measurements so far focused on artificially created events, using Ellsberg urns or experimenter-created probability intervals, where beliefs can be calibrated by a symmetry of events. However, ambiguity is a rich domain, and ambiguity attitudes may be different for natural events concerning real-life uncertainties than for artificial urns. We introduce a technique that enables measuring ambiguity attitudes for natural events, even though these events lack the aforementioned symmetry. Key to our technique is that a symmetry at the level of sets of events (balancedness) can provide a hedge against unknown beliefs and, hence, the required control. Our measures are flexible and can be applied to all sources of uncertainty, are directly observable from revealed preferences, are valid under many ambiguity theories, and generalize and unify many existing measures. In particular, our measures allow for violations of expected utility under risk.

**Can Visual Nudge Influence People's Financial Decision Making? Evidence from A Discrete Choice Experiment**

Hanjin Li

**Abstract**

Credit card is one of the most commonly used payment options today, but choosing a suitable one seems to be lacking enough attention from consumers. Nearly nine millions people in the UK are over-indebted and over half of them have difficulty in addressing their debt problems (Financial Conduct Authority, 2014). Various factors are causing this, including the lack of financial knowledge and literacy, and difficulty in understanding the financial costs and consequences of their choices. This research investigates how to best communicate financial costs to consumers. To do so, we developed three treatments where we presented financial costs of not paying credit card debts on time in different ways. The ways of explaining financial costs in the three treatments are numeric methods, APR (Annual Percentage Rate) and monthly costs/interests, and visual risk scale representing the level of APR. The visual risk scale can be considered as an educative nudge, which according to Sunstein (2016), could strengthen people's capability of making judgements and better choices. In this research, the visual risk scale guides consumers to make better credit card choices (in this case low-cost). The research utilises discrete choice experiments to elicit preferences for credit cards where credit cards are presented with their characteristics, such as cost, interest-free term, and rewards. The web-based discrete choice survey also includes questions on financial literacy, attitudes and consumers' preferences for repayment options of credit card debt. Our findings show that consumer perceives financial cost differently and how variation in their preferences.

# Common Ratio Effect, Behavioural Axioms and Preference for Randomization

Zhihua Li

## Abstract

Expected utility is the normative standard in decision under risk. The common ratio effect (CRE) is one robust pattern of choice showing that people's actual behaviour deviates from expected utility theory (EUT). Numerous non-expected utility theories have been proposed to explain the CRE and other systematic departures from Allais paradox. Many such theories are deterministic, although some probabilistic accounts have also been suggested. This paper examines several possible explanations, both deterministic and probabilistic. Cubitt et al (1998) investigated the CRE by testing four underlying principles of EUT in a well-designed experiment. They found that violations of "timing independence" or "consequentialism" can be used to explain CRE. A recent paper by Schmidt and Seidl (2014) proposed that CRE is due to violation of coalescing instead of compound independence or failures of the reduction of compound lotteries axiom (RCLA). However, a possible limitation of these papers is that they only focused on the conventional choice pair used in many CRE experiments. We conducted an experiment in which the CRE and the independence axiom was tested with four different sets of choice parameters. We also tested the betweenness axiom and RCLA in the four sets of choices. Moreover, each choice in the experiment was repeated twice to allow us to investigate the role of probabilistic choice and possible preference for deliberate randomization. All the choices in the experiment were represented in an innovative way intended to reduce issues arising from the description-experience gap, displaying the coloured-balls-in-a-bag mechanism for resolving the uncertainty rather than just summarising the probability-payoff information verbally. Using the conventional parameters, the CRE was replicated (favouring the sure option in the original pair but the risky option in the scaled-down pair). In these cases, violation of the independence axiom best explained the CRE. But when we used less conventional parameters, we found a great deal more consistency between related pairs of choices. Violations of RCLA and of the betweenness axiom were relatively few and unsystematic. Imprecision also seems to contribute to the CRE pattern because we see many subjects switching their preference back and forth when making choices in the conventional choice pair. Further analysis of the data showed no evidence of any great preference for deliberate randomization.

# The Use of Base Rate As A Function of Base Rate Uncertainty

Jiangyan Li, Jianying Qiu and Utz Weitzel

## Abstract

In a seminal experimental study by Kahneman and Tversky (1973), individuals was found to neglect or underweight the base rate information while overweight the more specific information, which was dubbed as base rate neglect. After the seminal study, the tendency of neglecting base rate has been found in a great deal of research. However, with more and more subsequent research, opinions concerning the use of base rate started to become polarized. Except for the already existed results of base rate neglect, an increasing number of researchers started to believe that the base rates are not always neglected. Instead, there exist factors that could explain how base rates would be considered (Koehler 1996). One aspect of the factors concerns the representation form of base rates. Specifically, base rates were found to be used more in tasks that were presented to sensitize people to base rates. Additionally, the perceived quality of base rates has been found to be the other aspect of factors that could influence the use of base rate. For example, researchers found that base rates that were perceived as more reliable, relevant, and representative than the new information would be considered more as well. Apart from the two aspects, this paper points to the base rate uncertainty-i.e. ambiguity-as another factor that could influence individuals' use of base rates. Since in a real world, it is always very difficult to know the exact base rate, the extra goal of hedging against ambiguity under ambiguity would then make the use of base rate become complicated and also different from that under risk. To investigate how the uncertainty on base rates influences the use of base rates, we designed an experiment in which the base rates were learned by subjects from the feedback of sampling experience. By manipulating the sampling size, a treatment factor concerning the amount of uncertainty on base rate was created. More specifically, in the treatment with a smaller amount of base rate uncertainty (treatment S hereafter), 25% out of the whole sample was allowed to reveal to know the base rates while this proportion increased to 75% in the treatment with a larger amount of uncertainty on base rate (treatment L hereafter). Our results suggested a significantly larger use of base rates in treatment L than in treatment S. Additionally, we also found a significantly negative correlation between the extent of ambiguity aversion and the use of base rates. This confirms our speculation that under ambiguity the desire of hedging against ambiguity becomes another factor that has an effect on the use of base rates.

# Recursive Random Utility and Ambiguity Aversion

Shuo Li Liu and Erli Cai

## Abstract

Stochastic choice functionals of a menu of Savage's or Anscombe and Aumann's acts is modeled by relaxing the von Neumann' continuity axiom and Savage's P6. Intuitively, the decision maker will intentionally randomize their choice, if they do not ignore the extreme events with small probability. Random utility representation is characterized as a special case of the stochastic choice model with additional axioms. The implied random utility representation accommodates Allais' Paradox, and the respective recursive random utility representation accommodates Ellsberg's and Machina's paradoxes. In addition, we show that our framework could explain Raiffa's counterexample and paradoxes that violates Luce's IIA condition and random expected utility. Extensions include the modeling the groups as the DM. The model predicts that 1) smaller groups are more ambiguity averse; 2) groups with less communication tend to be more ambiguity-averse; 3) groups with majoritarian decision rule are more ambiguity-averse than groups with utilitarianism rules.

# Imprecise Preferences and Beliefs in Simple Games

Graham Loomes, Andrea Isoni, Daniel Navarro-Martinez and David Butler

## Abstract

The individual decision-making literature has provided extensive evidence that preferences are often imprecise. We extend the study of imprecision to the preferences and beliefs of the players of simple simultaneous games. We show that the vast majority of participants report varying degrees of imprecision in their preferences and beliefs. This imprecision is systematically related to choices and beliefs. Preferences are more imprecise when choices are more variable, and beliefs are more imprecise when they are less extreme. The likelihood of players choosing strategies that constitute best responses to their stated beliefs is higher for less imprecise preferences and beliefs.

# Diagnosing the Causes of Intertemporal Preference Reversals

Graham Loomes and Zhihua Li

## Abstract

Intertemporal preference reversals arise when individuals choose a 'smaller sooner' (SS) option (e.g. receiving £1,600 in 18 months' time) over a 'larger later' (LL) option (£2,500 in 5 years' time) in a straight choice between the two, but place a higher value on the LL option when asked to state a direct present value equivalent for each option separately. Tversky et al. (1990) diagnosed these reversals as being primarily due to overvaluing the LL option in the direct valuation task, as well as undervaluing the SS option some degree relative to the values implied by their choices. They detected some degree of intransitivity but considered it to be a relatively minor contributor. We revisited this phenomenon, changing the experimental design in various ways. First, instead of relying on a single preselected present value amount to compare with each future option, we examined choices between each option and a range of present amounts so as to more accurately estimate each individual's present value for SS and for LL when each was inferred from binary choices rather than elicited by a direct valuation question. Second, we used choice lists as well as binary choices and direct valuations to provide another means of elicitation. Third, we repeated the various binary choices, the choice lists and the direct valuation questions several times in order to get some measure of the degree of variability and imprecision in peoples responses to each type of question and in order to be able to base our diagnosis on measures of central tendency rather than on single observations which may be more volatile. Even after allowing for the considerable variability and imprecision in many peoples stated preferences, we found high levels of intertemporal preference reversals. However, we disagree with Tversky et al. about the causes of the majority of these reversals, which we ascribe to substantial levels of intransitivity in respondents' binary choices as well as differential overpricing of both options relative to the values inferred from their choices.

# Motivated Overconfidence: Theory and Evidence

Mingye Ma

## Abstract

This paper examines the sources of overconfidence theoretically and empirically. The theoretical model in this paper allows the coexistence of two intrapersonal motives of overconfidence, consumption motive (i.e. savouring and anticipatory utility) and instrumental motive (i.e. motivational value of being optimistic). An empirical field study is conducted and the observed time-varying grade expectations held by students support the existence of instrumental motive, not consumption. In the first part of the paper, I propose a modified theoretical model of motivated overconfidence based on Benabou & Tirole (2002) and Koszegi (2006). Consistent with previous models, both consumption motive and instrumental motive lead to overconfident beliefs. However, my model contains two new features. First, there is a waiting stage where the agent is no longer able to change the already exerted effort level but still needs to wait for result realisation. Second, the cost for distorting beliefs is quadratic, and thus, it is increasingly more costly to hold more extreme beliefs. Consequently, agents start with overconfident beliefs to counteract the present temptation, and to savour positive feelings. Then beliefs drop but are overconfident during the waiting stage for anticipatory purpose before dropping down to the lowest level at the realisation stage. I test this model through an online field study in which undergraduate students were asked to submit their essay grade expectations multiple times. The data is complied with students inflating their expectations in order to pursue difficult goals in the face of self-control problems. In contrast, students do not inflate their beliefs for savouring.

# Endogenous Reference-dependent Utility with Probability Transformation

Sergé Mace and Le Lec Fabrice

## Abstract

Köszegi and Rabin (2007) has become the workhorse model for endogenous reference-dependent preferences. However, in its present form, it cannot explain some important stylized facts observed in the experimental/empirical literature, and in particular the fact that individuals seem to be overly sensitive to the changes from impossible to possible (possibility effect) or to the changes from possible to certain (certainty effect), and the risk attitudes that go along (risk-seeking behaviour for low probabilities of big gains and risk-aversion for low probabilities in the domain of losses). We propose here to relax the simplifying assumption, made by KÅ'szegi and Rabin (hereafter KR), that the stochastic reference point corresponds exactly to the lottery under consideration. This assumption implies that the weights given to each possible outcomes, used as reference points, correspond exactly to their probabilities, to capture the intuitive idea that the additional sensations of gains and losses of having one outcome for instance should be more intense if the individual had a high probability of obtaining the other outcomes. However, the fact that the decision-maker has rational beliefs about the lottery does not necessarily entail that her reference-point exactly mimics the lottery because the weights given to each possible outcome may also differ significantly from their probability for various psychological reasons. For instance, people may adopt some form of pessimism to prepare themselves psychologically to the possible occurrence of bad outcomes. They may set low expectations, not by changing their beliefs, i.e., reducing their subjective probability of the occurrence of favorable outcomes, but by directing their attention to the worst outcomes, thus putting less emphasis and weight on the good ones. This form of pessimism, identified in the psychological literature (Norem and Cantor 1986) helps the individual to reduce the loss sensation when bad outcomes occur and increases the gain sensation in case of more favorable outcomes. In this paper, we assume that the subjective stochastic reference point is a pessimistic transformation of the lottery under consideration. Under this assumption, we show that reference-dependent preferences can be represented by a rank-dependent utility function with inverted-S shape probability transformation, allowing the model to explain the previously mentioned stylized facts. The reasoning is carried on using the equivalence presented by Masatlioglu and Raymond (2016) between reference dependent preferences and rank-dependent expected utility, a result we extend to less stringent constraints and assumptions on parameters and functional forms. We show how this extends to pessimistic reference point and how it provides a flexible and frugal framework to account for decisions under risk usually assumed to stem from a direct distortion of probabilities.

# Why Do People Violate No-Trade Theorems? A Diagnostic Test

Jacopo Magnani and Ryan Oprea

## Abstract

Evidence from both the lab and field suggests that people frequently trade on the basis of private information in violation of no-trade theorems. Why? We report an experiment on a bilateral trading game designed to distinguish between two prominent explanations: relative overconfidence about private information (as emphasized in the behavioral finance literature) and limited strategic sophistication (as emphasized recently in the behavioral economics literature). Our experimental design takes a diagnostic approach, stripping these potential explanations away one-by-one over a series of treatments. We find that when both of these channels are available as explanations, subjects agree to trade in excess of 70% of the time. When we remove them all, violations of no-trade theorems disappear entirely. Treatment level analysis and structural estimation suggests that relative overconfidence and strategic sophistication both have large and roughly equal effects on motivating trade.

# Belief-Dependent Preferences and Reputation: Experimental Analysis of a Repeated Trust Game

Elena Manzoni, Giuseppe Attanasi, Pierpaolo Battigalli and Rosemarie Nagel

## Abstract

We study in a theoretical and experimental setting the relations between belief dependent preferences and reputation building in repeated trust games. We focus on the effect of guilt aversion. We express guilt sensitivity as a belief-dependent motivation as in Battigalli and Dufwenberg (2009). We put forward a model of reputation as in Kreps & Wilson (1981) and Kreps, Milgrom, Roberts and Wilson (1982) and show that the effect of reputation building in presence of guilt-averse players. In the experiment, we test players' behaviour in finitely repeated trust games, in which we elicit first-order and second-order beliefs at the beginning of each period. We elicit trustees' sensitivity to feelings and we transmit it to the paired truster. Our experimental results show that eliciting and transmitting these belief-dependent feelings and thus letting players play the almost complete information psychological game of trust leads to higher trust and cooperation both in a repeated context, with respect to the corresponding incomplete information game setting, without transmission of those feelings. In particular, transmission of trustee's reciprocity concerns does not lead to higher trust and cooperation. Conversely, trustee's guilt aversion transmission enhances the truster's cooperation.

# Utility and Procedures: What Came First?

Guy Mayraz and Yoram Halevy

## Abstract

We investigate experimentally the hypothesis that the domain of preferences is procedural rules. We present subjects with a set of portfolio choice problems among a number of Arrow securities spanning equally likely states. In one part of the experiment subjects make their choices on a case-by-case basis, as in Choi et al (2007). An important difference, however, is an innovative slider interface, which facilitates budget allocation among several accounts. The interface makes it easy to allocate the budget in full, while ensuring that choices respect monotonicity with respect to first order stochastic dominance. This allows us to scale the dimensionality of the problem while keeping the interface manageable. In another part of the experiment, subjects choose (design) a procedural rule from a set of rules designed to encompass the rules that subjects appear to use in similar experiments. In the third and final part of the experiment subjects choose between the two interfaces. If they choose the case-by-case interface they can choose portfolio allocations directly. If they choose the procedural rule interface they reuse the procedural rule they chose earlier in the experiment. The case-by-case interface supports all possible monotonic portfolio allocations. The procedural rule interface, by contrast, supports only a sparse subset of allocations that happen to be consistent with the limited set of procedural rules that subjects can choose from. Consequently, all subjects with preferences over portfolio allocations should weakly prefer the case-by-case decision interface, and those among them whose preferences do not coincide with the outcome of one of the procedural rules should have a strict preference for making case-by-case decisions. We document almost the opposite behavior. We ran the experiment with both Amazon Mechanical Turk and student subjects, and found that more than two thirds chose the investment rule. About a third of those chose a rule that coincides either with risk neutral preferences or with infinitely risk averse preferences; the other two thirds designed another, more nuanced rule. Interestingly, the choice of the procedural rule over case-by-case decisions is uncorrelated with the complexity of the decision problem, as measures by the number of states. If subjects were using the rule as a second-best approximation to maximizing a standard utility function, we would expect the preference for the rule interface to increase with the number of accounts. The fact that we do not see this suggests that subjects prefer the rule interface because they think in terms of procedural rules, and find the choice of procedural rule more natural.

# Wishful Thinking

Guy Mayraz

## Abstract

An experiment tested whether and in what circumstances people are more likely to believe an event simply because it makes them better off. Subjects observed a financial asset's historical price chart, and received both an accuracy bonus for predicting the price at some future point, and an unconditional award that was either increasing or decreasing in this price. Despite incentives for hedging, subjects gaining from high prices made significantly higher predictions than those gaining from low prices. The magnitude of the bias was smaller in charts with less subjective uncertainty, but was independent of the amount paid for accurate predictions.

# Incomplete Preferences and Translation Functions

Tigran Melkonyan, Robert Chambers and John Quiggin

## Abstract

Decision makers faced with an array of choices that are poorly understood or difficult to compare may experience "...sensations of indecision or vacillation, which we may be reluctant to identify with indifference" (Savage 1954). In such settings, a number of authors (Aumann 1962; Bewley 1986, 2002; Dubra, Maccheroni and Ok 2001; Mandler 2004; Baucells and Shapley 2008; Galabaatar and Karni 2013) have argued that it may be inappropriate to impose the completeness axiom on rational choice behavior. Very few attempts have been made to examine incomplete preference structures empirically. We are aware of only two such studies (Danan and Ziegelmeyer 2006 and Cettolin and Riedl 2016). We conjecture that one reason for this empirical paucity is the lack of empirically implementable tests possessing a solid theoretical foundation on which empirical analysis of incomplete preferences can be based. This paper examines incomplete preference structures in an axiomatic framework that relaxes independence. Our particular focus is on developing representation results and predictions that can be easily tested in a laboratory or field-experiment setting. That concern causes us to depart from the usual tradition in decision theory that focuses on obtaining `utility function' representations. Instead we focus our analysis on preference representations in terms of willingness-to-pay measures that fully characterize preferences and can be easily elicited empirically. In what follows, we first discuss briefly the existing theoretical literature on preference incompleteness in the absence of independence, and the empirical literature on examining preference incompleteness. Then we introduce the basic decision set-up and introduce and characterize the willingness-to-pay measures. These measures are then shown to characterize preferences exhaustively. Empirical tests for, and measures of, the comparability of two gambles, and for preference completeness, are then developed. The next section studies local approximations to incomplete preference structures. In particular, it is shown that any incomplete preference structure satisfying our fundamental axioms generates two local multiple-prior preference functionals that evaluate differential adjustments in gambles as would an individual with a multiple prior preference function. The essential idea is to extend Machina's (1982) notion of a local-utility function to our set up. The sets of priors defining these local multiple-prior preference functionals characterize the individual's local perception of ambiguity. After these local multiple-prior preference functionals are developed, Fenchel conjugation is used to induce incomplete multiple-prior functionals that globally represent `hulls' of arbitrary incomplete preferences that are consistent with, respectively, uncertainty aversion and mixture domination. The final section concludes.

# Dynamic Reference-Dependence in Students' Exam Performance and Effort Provision

Jingyi Meng

## Abstract

This paper studies the double-sided effects of aspiration level as a reference point for undergraduate students. My results show that students set targeted grades as their reference points and reveal loss aversion, evidenced by a significant discontinuity in their evaluations of performances at the achievement of targeted grades. On the other hand, targeted grades have positive effects on students' effort provision. Further dynamic analyses show that if a student fails to achieve his previous target, he is more likely to downward adjust his reference point, which leads to a subsequent reduction in effort provision. My results provide policy implications for educators to help students set appropriate targets to create incentives while not hurting their performance satisfaction.

# Does Executive Pay Matter? The Impact of Executives' Characteristics

Luc Meunier, François Desmoulins-lebeault and Jean-François Gajewski

## Abstract

Under principal-agent theory, agents are considered more risk-averse than their principal. For instance, shareholders are generally considered risk neutral as they can diversify their risk away. CEOs are generally more risk averse than shareholders because they fear losing their reputation and want to keep their positions. They are thus offered remuneration packages, often including stock-options that aim at incentivizing them toward higher risk-taking. However, if this view is theoretically coherent, it fails to explain why some CEOs take huge amounts of risk while others do not, despite similar incentive contracts. We hypothesize that some people are inherently more attracted to risk, due to both psychological and physiological variables, independently of the contract. We tested this hypothesis in an experimental setting. A hundred participants were randomly offered both a contract where incentives were mainly designed under the form of stock options and another one where incentives were assimilated to equity. They were then offered choices between two options differing in risk. We measured their risk-taking as the risk premium they asked to choose the riskier option. In addition, we measured both psychological variables, such as the BIG 5 and BIS/BAS and their salivary levels of testosterone and cortisol. Contract indeed appears as a strong determinant of risk-taking. Stock option contracts seem to push respondents toward a more risk neutral stance. However, psychological and physiological variables remain the main determinants of choice, both in term of predictive power and economic effect.

# Ellsberg meets Keynes at An Urn

Bin Miao, Chew Soohong and Songfa Zhong

## Abstract

Ellsberg (1961) and Keynes (1921) have proposed independently an urn with unknown composition of balls of two different colors in contrast with an urn with known 50-50 composition. Following Ellsberg's observation that betting on the known urn would generally be preferred to betting on the unknown urn (since the latter exhibits the quality of ambiguity involving multiple winning odds), such preference has been modelled in terms of weighing the worst possible outcome disproportionately or a compound lottery being worse than its reduction to a simple 50-50 lottery. By contrast, Keynes sees the unknown bet as an even-chance lottery based on less knowledge. Revisiting Keynes, Tversky and colleagues propose the notion of source preference based on an observed tendency for subjects to prefer betting on the temperature of a more familiar city than an unfamiliar one. Following recent evidence of a strong link between ambiguity attitude and attitude towards the reduction of compound lottery, this study examines how ambiguity and compound risk attitudes relate individually to attitude towards almost-objective even-chance bets based on whether the trailing digit of the temperature of a city is odd or even. In an experiment, we find significant associations of such source preference with ambiguity attitude and with compound risk attitude, besides replicating the known association between ambiguity and compound risk attitudes. Our findings point to the need for further theoretical development to account jointly for the observed non-neutrality towards ambiguity, compound risk, and almost-objective uncertainty arising from natural events, as well as the pairwise links among the different sources of uncertainty.

# A Coefficient of Risk Vulnerability

Peter G. Moffatt, Philomena M. Bacon and Anna Conte

## Abstract

Panel data from the German SOEP is used to test for risk vulnerability (RV) in the wider population. Two different survey responses are analysed: the response to the question about willingness-to-take risk in general; and the chosen investment in a hypothetical lottery. A convenient indicator of background risk is the VDAX index, an established measure of volatility in the German stock market. This is used as an explanatory variable in conjunction with HDAX, the stock market index, which proxies wealth. The impacts of these measures on risk attitude are identifiable by exploiting the time dimension of the panel, and matching survey months with corresponding observations from these time-varying factors. Both of the survey responses allow us to test for decreasing absolute risk aversion (DARA); in one case we find strong evidence of DARA, while in the other, we do not. Both survey responses also allow us to test for RV, and in both cases we find strong evidence. In the case of the hypothetical lottery response we are also able to estimate a "coefficient of risk vulnerability'' (CRV). This is defined as the absolute amount by which absolute risk aversion rises in response to a doubling of background risk. We estimate CRV to be between 1.48 and 1.82.

# The Endowment Effect in the Future: How Time Shapes Buying and Selling Prices

Daniel Navarro-Martinez and Shohei Yamamoto

## Abstract

It has been widely documented that people tend to give a higher value to objects just because they own them. This pattern has been called the endowment effect (Thaler 1980) and it is typically explained using the notion of loss aversion. The endowment effect is one of the most prominent phenomena in behavioral economics and it has important implications for a variety of situations related to buying and selling. However, virtually all research on this effect investigates transactions that take place in the present. This is a significant limitation, given that many real-world transactions have a temporal dimension. In many circumstances, people agree on a purchase or a sale and the transaction does not materialize until a later time in the future (e.g., in online buying and selling). In this paper, we explore how transaction timing affects the endowment effect. We conducted four experiments in which the transaction timing of different products was systematically changed for buyers and sellers. We found that delaying transactions into the future systematically increases the endowment effect across a variety of products, and we show that this pattern is produced by gains being discounted in time substantially more than losses.

# French GPs Lab-Test Prescription Behaviour and the Shape of the Utility Function under Risk

Antoine Nebout, Emmanuel Kemel and Bruno Ventelou

## Abstract

A recent stream of researches aim at linking data sourced from behavioural economics experiments with administrative records and/or other wide-ranging database. We report, in this paper, results of a behavioral survey of general practitioners (N=1568), linked with the reimbursement data-system of the French Social Security. More precisely, we investigated the actual utilization of laboratory tests by French GPs in relation to one of their fundamental behavioural characteristics, namely risk aversion. In particular, our GPs panel contains a specific elicitation module of risk attitudes with a series of incentive-compatible choices between risky prospects, which allows us to construct a structural equation model of GPs lab-test prescription behaviour using risk attitudes under Expected utility Theory (EUT) or Prospect Theory (PT) as explanatory variables. Data are analyzed under a two-stage structural equation model where the shape of the utility function measured from the behavioral module (stage 1) is considered as an explanatory variable for the prescription of biological tests (stage 2). Results show that lab-test prescription is positively associated with the concavity of the utility function: more risk aversion is associated with more lab-test utilization. This result is robust across several specifications of the utility function (CARA vs CRRA), and holds after controlling for probability distortion, and for observable characteristics related to the GPs (age and gender) and their patients (age). Such insight on the behavioral determinants of physician's decision-making is very important to understand variations in medical practices and better design policies aiming at reducing these variations, with potential implications for quality of healthcare, equity and efficiency.

# Deciding for Others: An Experimental Investigation of Preference for Shared Destiny

Antoine Nebout and Sabrina Teyssier

**Abstract**

In this paper, we present the results of an experiment on social choice under uncertainty. We use an experimental design where individuals make decisions for others by choosing between uncertain gains allocations for two other participants. We elicit equivalences between different types of allocations and reveal individual preferences for fairness and shared destiny as well as "other-regarding" risk attitudes. We find strong evidence of risk and inequality aversion for others and of preference for shared destiny. In particular, we calibrate a measure of preference for "shared destiny" at an individual level. We test and confirm that this measure does not depend on the gain and likelihood components of the uncertain allocations.

# How Does A Machine Learn to Gamble Responsibly?

Philip Newall and Arman Hassanniakalager

## Abstract

Responsible gambling messages are becoming increasingly prevalent (Reith 2008). Industry and academic sources agree that responsible gambling messages should inform gamblers on the odds of winning (Blaszczynski et al. 2011; Miller, Thomas, Smith, & Robinson 2016). It is surprising to us that reliable statistical information is missing from promotions for skill-based gambling forms, such as sports betting. British soccer fans are frequently advertised the odds of potential bets across TV, bookmaker shop windows, and online (Lopez-Gonzalez, Estévez, & Griffiths 2017; Newall 2015; Newall 2017). These adverts display no information to help consumers understand the often highly-variable statistical risks. This is unlike other public health domains, where for example calorie and alcohol unit labelling inform consumers at the point of sale of potential products' relative risks. This paper uses machine learning to investigate the minimum potential risks that a fully-informed and rational soccer bettor might face across three subtly-different bet types. Data for seven seasons of English Premier League soccer (the highest club competition in England) from 2010-2016 were used from two sources. Betting odds were downloaded from Oddsportal.com for the following bet types: 1X2, correct score, over/under, Asian handicap. These are the only gamble types for which a long time-series of historical prices was freely available. But importantly for the research question both the 1X2 and correct score gambles feature heavily in British gambling advertising (Newall 2015; Newall 2017). In-game statistics from football-data.co.uk constituted the other data source. Each team's recent performance was summarized as the number of goals scored and points earned over the previous five games. It was decided to use four seasons of learning for every season of prediction. Therefore, model performance was available for three seasons in total: 2014, 2015, and 2016. The first five games of each season were discarded to account for the fact that the teams' performance over the previous season will be poor predictors here. Results of the machine's per-bet arithmetic average return were as follows: 1X2 -2.32% Over/under -0.21% Correct score -17.71%. In conclusion, soccer gambles which may appear similar actually present gamblers with widely-varying statistical risks. A "responsible" gambler should bet no more than 1/7th as much on correct score gambles than three-outcome gambles, or 1/84th as much on correct score gambles as the over/under. Further analyses will be performed as this work continues, but preliminarily it appears that "gambling responsibly" in soccer depends to a surprisingly large degree on the type of gamble chosen. This is important given the prominence of correct score gambles in British gambling advertising (Newall 2015; Newall 2017).

**Stopping Behavior of Sophisticated and Naive Agents under Probability Distortion**

Adrien Nguyen-Huu, Yu-Jui Huang and Xunyu Zhou

**Abstract**

We consider the problem of stopping a diffusion process with a payoff functional involving probability distortion (CPT). The problem is inherently time-inconsistent as the level of distortion of a same event changes over time. We study stopping decisions of naive agents who reoptimize continuously in time, as well as equilibrium strategies of sophisticated agents who anticipate but lack control over their future selves' behaviors. We prove that any equilibrium can be obtained as a fixed point of an operator. That represents strategic reasoning that takes the future selves' behaviors into account. In particular, we show how such strategic reasoning may turn a naive agent into a sophisticated one. Finally, when the diffusion process is a geometric Brownian motion we derive stopping strategies of these two types of agent for various parameter specifications of the problem, illustrating rich behaviors beyond the extreme ones such as "never-stopping" or "never-starting".

# Information and Violations of the STP: An Experimental Consideration of Non-vanishing Ambiguity

Nicky Nicholls

## Abstract

This paper builds on earlier research by Nicholls, Romm and Zimper (2015) which found that violations of Savage's Sure Thing Principle (STP) do not decrease with information (operationalized by repeated balls drawn with replacement from an urn of uncertain composition) relative to a control group who received no information about the urn composition. We now report the results of an experiment designed to investigate two candidate explanations for the continued STP violations despite increasing information about the urn composition. The first candidate explanation is the ability of rank dependent utility (RDU) theory to account for STP violations. We use Harrison and Rutstrom's approach whereby a maximum likelihood estimation technique is used to analyze responses to a series of lottery questions. This technique allows us to broadly identify the utility and probability weighting function that best accounts for the choices made by each respondent on this series of questions. In this way, we classify decision makers as either RDU or expected utility (EU) decision makers. We note that although RDU decision makers do show more STP violations than EU decision makers, the RDU decision makers' violations decrease significantly as more information about the urn composition is revealed. This decrease in violations with information is not seen for EU decision makers, suggesting that information might impact decision making by altering probability weightings and not by impacting believed objective probabilities/proportions of balls in the urn. The second candidate explanation is based on Zimper and Ma's (2017) proposed modification to Epstein and Schneider's (2007) model of Bayesian learning with multiple priors. Zimper and Ma propose a stubbornness parameter whereby the decision maker uses a more cautious selection rule in testing the plausibility of his priors against observed data, such that he is more reluctant to dismiss priors even in light of statistical evidence. As such, depending on the selected parameter value, significant ambiguity might remain in the limit of this learning model. We elicit prior and posterior distributions over the proportion of blue balls in an urn where blue and yellow balls appear in unknown proportions. We find support for the existence of such a parameter in the persistence of significant ambiguity in posterior distributions, even after 40 ball draws have been experienced. However, removal of ambiguity (by revealing the proportions of balls in the urn) does not remove violations. Where ball proportions are revealed, we continue to see only slightly lower levels of STP violations (shown in Nicholls et al. to be equivalent to independence axiom violations when probabilities are known). This finding poses a continued challenge to the class of theories of decision making under uncertainty attributing STP violations to ambiguity aversion.

# Testing the Axiomatic Foundations of Risky Intertemporal Choice

Kirby Nielsen

## Abstract

We develop a model which describes lotteries over streams of time-dated payment lotteries. This allows us to study choice under uncertainty, intertemporal choice, and the combination of the two – risky intertemporal choice – all in one unified framework. We present axioms which characterize discounted expected utility, and and test these axioms experimentally. The experimental literature on risky intertemporal choice has focused more on the model's predictions rather than on the axiomatic foundation, so we take first steps in documenting the empirical validity and failures of these axioms. The experimental literature has detected systematic violations of the predictions of discounted expected utility. In the domain of risk, individuals frequently violate the Independence axiom, especially due to the "certainty effect" (Kahneman and Tversky, 1979 and the papers that followed). In the domain of intertemporal choice, individuals are typically found to be "present biased", where they disproportionately prefer present payments (Strotz 1955; Thaler 1981). Recent evidence suggests that present bias may result, in large part, from the certainty effect (Halevy 2008; Andreoni and Sprenger 2012; Epper et al. 2011). Since the present is certain while the future is inherently risky, a preference for current over future consumption may be a simple manifestation of the certainty effect in the face of a risky future. That is, individuals may not inherently prefer the present at all, but may simply prefer certainty which only obtains in the present. In particular, Andreoni and Sprenger (2012) demonstrate violations of DEU predictions in the neighborhood of certainty, but generally confirm DEU predictions away from certainty. Interestingly, despite the history of observed violations of EU and exponential discounting, Andreoni and Sprenger suggest DEU only will be violated under certainty. Very little work on risky intertemporal choice looks at the axiomatic foundation of DEU, but Andreoni and Sprenger's results suggest we should observe certainty effect-type violations of DEU axioms only when certainty is involved and not otherwise. Thus, axiomatic tests provide a novel way of identifying the effects of present bias and preference for certainty on risky intertemporal choice. We test these axioms using a laboratory experiment, focusing on the interaction between risk and certainty with present and future payments. We present subjects with payment streams and use incentive compatible procedures to elicit valuations (certainty equivalents and uncertainty equivalents) of these streams. Payment streams are chosen specifically to address issues pertaining to the certainty effect and present bias. Comparing valuations allows us to detect systematic violations of the axioms.

# Decisions When Options Are Risky and Skewed: Anticipation Vs Experience of Regret

Sima Ohadi and Jean Francois Gajewski

## Abstract

Regret is an emotion stemming from the comparison of outcomes of the chosen option and the unchosen one. Neural studies have shown that the same neural signal that mediates direct experience of regret also mediates the anticipation of regret. Therefore, when individuals experience regret, the corresponding signal compiles them to anticipate the emotion of regret influencing the subsequent decision making. With this in mind, we aim to investigate the effects of regret anticipation on consequent decisions for individuals who have already experienced regret. We control for personal and more importantly physiological characteristics that can potentially affect the experience of regret. We base our conceptual framework and consequent experimental design on Regret Theory proposed by Bell (1982) and Lommes and Sugden (1982). In this paper, we study time-varying preferences or consistency of risk preference for 102 participants who decide over risky gambling tasks and skewed options. We assume that anticipation and experience of regret can affect and change individuals' preferences for risk and skewness. The anticipation of regret is a factor that can alter the choice of risky position if it becomes more dominant than the risk preference. We test this hypothesis by designing lottery tasks that are predictable by regret theory and test it in an experimental setting. We design a manipulated gambling task that induces the feeling of regret and implies responsibility similar to previous studies to test how the emotion of regret can change individuals' decision behavior. The emotion of regret is induced by revealing information about the outcome of the chosen and unchosen gambles. We control for event-splitting effect, display biases and order effect that would confound the results. Our results show that the experience of regret would lead individuals to anticipate regret in a manner predicted by regret theory when they face risky options. Individuals are more likely to change their risky positions when they experience regret. Participants who chose a less risky option in the first stage are more likely to switch to a riskier option after experiencing regret. However, the effect of regret differs when options are skewed. When facing a positively skewed lottery and a zero-skewed lottery, individuals who chose the positively skewed option in the first stage are more likely to change their preference for zero skewness due to the effect of regret than those who preferred a zero-skewed position in the first place. Controlling for personal and physiological characteristics, we find that such variables can explain the changes in preferences for skewness better than the effect of regret. Experience of regret can initiate the anticipation of regret in risky options. While the effect of regret becomes limited when options are skewed.

# Dynamic Choice and Consistent Planning

Kemal Ozbek and Max Mihm

## Abstract

A consistent planner evaluates a dynamic decision problem by considering the changes she expects in her future tastes (or rankings), and how these will affect her decision making over time. Using preferences today over decision problems tomorrow, we provide an elicitation method that uniquely identifies a consistent planner's expected future rankings. The elicitation method reflects the idea that future rankings should be monotone with respect to a strict partial order defined in a general choice framework, and we argue that this ordering naturally arises in many applications. Our results also permit testing the agent's sophistication and naivety about beliefs on future rankings by comparing her elicited rankings with tomorrow's actual rankings. Moreover, the agent's optimism and pessimism on how indifferences will be resolved in the future can be identified in our choice framework. In particular, we show that a Strotzian consistent planner is the most optimistic, and a cautiously consistent planner is the most pessimistic one.

# Learning to Avoid Sub-Optimality: Experimental Evidence of Intermediate Advice

Noemi Pace, Daniela Di Cagno and Werner Guth

## Abstract

This paper attempts to assess whether learning through intermediate advice on portfolio choices contributes to avoid sub-optimality. This is a follow up of a previous experimental work aimed at identifying behavioral patterns and compare their average success considering several criteria of bounded rationality (Di Cagno et al. 2017). In this previous work, experimentally observed choice behavior in various decision tasks is used to assess heterogeneity in how individual participants respond to 15 randomly ordered portfolio choices. It provided systematic evidence of suboptimal choices even though with more experience participants improve their behavior. In this paper we report the results from a new experiment in which, concentrating on 15 generic parameter constellations used before, participants confront them all in three successive phases, each with an idiosyncratic order of the 15 cases with advice administered between phases. The advice inform participants that there is a generic range of risky investment levels in which a lower level does not harm one's payoff in one chance event but improves one's payoff in the other. We implement two different treatments. For the pure choice treatment (participants only select their risky investment level) advice is scheduled either between the first and the second or between the second and the third phase whereas only the early advice applies to the satisficing treatment (participants also form payoff aspirations for each chance event).

# Experimental Evidence on the Importance of Feedback on Performance

Paola Paiardini and Michalis Drouvelis

## Abstract

We report an experiment which explores how the quality of feedback affects workers' intrinsic motivation to perform a real-effort task. In our experiment, subjects received a fixed wage in order to perform the so-called encryption task, repeatedly for ten periods. We examine whether providing feedback on subjects' performance and more importantly, how the quality of such feedback affects their intrinsic motivation throughout the task. We consider three treatments: in the baseline treatment, subjects receive no feedback; whereas, in two other treatments, we offer feedback varying its quality (specific rank in the group vs. abstract rank in the group). We find significant differences in subjects' intrinsic motivation. Specifically, subjects work significantly harder in the treatment where subjects are provided with feedback about how they rank exactly in their group, highlighting the fact that subjects care about their relative performance. Their intrinsic motivation is significantly lower (and not statistically different between them) in the other two treatments, implying that offering no feedback is equivalent to offering bad quality performance feedback.

# Coordination Tightness and Group Size in Withdrawal Games

Luca Panaccione, Belotti Federico, Campioni Eloisa, Larocca Vittorio, Marazzi Francesca and Piano Mortari Andrea

## Abstract

In this work we analyse an experiment about a withdrawal game that is framed as a coordination game. Following the approach proposed by Diamond and Dybvig (1983) the game exhibits two Pareto ordered equilibria in pure strategies. In a first equilibrium all depositors decide not to withdraw, based on beliefs that none of them will withdraw. By so doing they achieve the Pareto efficient allocation. On the other hand, when depositors believe that all are going to withdraw then they will optimally choose to withdraw. Hence they will induce a run on bank's deposits which consists of the Pareto inefficient equilibrium. In the experiment, within a multi-round setting, we adopt a stranger-matching protocol to form multiple banks in each round. In each round, depositors are assigned to an experimental bank and have to decide whether or not to withdraw their resources. In the experiment, we have sessions that differ in terms of the size of the experimental banks, whereas within the same session the size of the experimental banks is kept constant. In particular, we focus on banks constituted by 5, 7 and 10 depositors. In order to frame a coordination problem that exhibits an appropriate stability with respect to changes of the size of the group, we measure the tightness of the coordination problem the players face with the share of players who have to withdraw in order to cause a switch in the best response of the players from not to withdraw to withdraw. We rely on this measure and we set-up games with different number of players that exhibit the same tightness regardless of the number of players involved in the game. We explore the determinants of the participants' decisions and of the participants' experimentation probabilities. A subject experiments if his withdawal decision differs with respect to the best response of the previous round. Our analysis show that the size of the bank is a key driver of the probability to withdraw and that depositors exhibit a process of decision-formation that is compatible with directional learning. On the other hand, the experimentation rates are mainly affected by the distance between the share of expected players who withdraw and the parameter that measures the coordination tightness. In the experiment we gather information about some individual characteristics of the participants: financial literacy, general knowledge, risk aversion and several demographic characteristics (among the others: sex, age, education). None of these characteristics has a relevant impact on the behaviour of the participants.

# Why Do People Say They Are Unsure? An Experimental Investigation

Yudistira Permana

## Abstract

A key assumption of mainstream economics is that people have well-defined preferences, and can state them precisely. This view is being challenged, often through experiments, leading to the increasingly-accepted notion that people may be unsure about their preferences, or at least are unable to state them with precision. A number of experiments have been conducted investigating the nature of, and the reasons for, such imprecision. One interesting design is that of Cubitt et al (2015) that allows subjects to state that they are unsure between two alternatives. I follow their design, but use a different payment scheme, which I feel helps to understand better the reasons why people might state that they are unsure. The key innovation is the way that a statement of unsureness is played out in the experiment: if a subject states that he or she is unsure whether he or she prefers A or B, then the experimenter will toss a fair coin to decide. I have four distinct stories and I compare their goodness-of-fit in explaining the data. The first story is that the decision-maker (DM) has convex preferences within the Marschak-Machina Triangle (MMT) and actually prefers a mixture of A and B; the second is that the DM simply makes a mistake; the third is that the DM cannot distinguish between A and B unless their difference exceeds some threshold; the fourth is that the DM actually prefers to delegate the choice (to the coin), shifting the 'responsibility' to the coin. My results show that the first and the third have the most empirical support. Further research is necessary to disentangle these two.

# Continuous SSB Representation of Preferences

Miroslav Pištěk

## Abstract

The theory of skew-symmetric bilinear (SSB) representation of preferences is a concise mathematical model of non-transitive decision-making that has been developed in a purely algebraic setting (Fishburn 1988; Kreweras 1961; Nikaido 1954). Thus, the existence of a maximal element in an infinite-dimensional case is in jeopardy. We resolve this issue by assuming (topological) continuity of preferences. Let P be a non-empty convex subset of a topological vector space, and > be a binary relation on P. The set of elements of P that are preferred to p is denoted U(p). Relation > is CONVEX if U(p) is convex for all p in P; > is COHERENT (with the topology of P) if for all p in P such that U(p) is non-empty, the closure of U(p) equals to the set of elements preferred or indifferent to p. Coherency seems to be a natural property of any preference relation on a topological space; convexity of preferences is indispensable to allow probabilistic interpretation of elements of P. For an UPPER SEMI-FISHBURN relation, i.e. a coherent and convex relation, we have shown that there exists a maximal element on any compact subset of P. A binary relation is LOWER SEMI-FISHBURN if its inverse is upper semi-Fishburn; a FISHBURN relation is lower and upper semi-Fishburn. A functional F defined on P x P is a SSB REPRESENTATION of > if F is SSB and F(p,q) > 0 iff p > q for all p,q in P. Next, we define a BALANCED relation by simplifying the axiom of symmetry (C3) in (Fishburn 1988). We have shown that a binary relation > on P is a balanced Fishburn relation iff it has a continuous SSB representation on P. Finally, for a compact Hausdorff space X we denote by P(X) the set of all (regular Borel) probabilistic measures on X, equipped with weak* topology (in the sense of functional analysis). Let > be a balanced Fishburn relation on X. Then, for a closed and convex subset K of P(X) there exists a maximal probabilistic measure with respect to > canonically extended to K. Thus we generalized previous existence results in this respect, c.f. Theorem 5 in Fishburn (1984).

# Behavioural Machine Learning

Ganna Pogrebna

## Abstract

In recent years, decision theory and behavioural science moves more and more in the direction of using large and complex datasets. While there are many empirical studies which apply decision-theoretic methodology to large field datasets, the literature on theoretical and methodological synergies between decision theory/behavioural science and computer science is very scarce. This talk will explore whether and to what extent decision-theoretic modelling can enhance machine learning algorithms. Specifically, I will consider models of imprecision and noise as well as attribute-based modelling from decision theory and present several examples detailing how these tools can be merged with existing machine learning algorithms to generate new insights into human behaviour. Comparing predictive and explanatory power of machine learning versus decision-theoretic modelling approaches, I will show examples when the two approaches outperform each other as well as when they can be combined producing powerful synergies.

# Aggregate Risk and the Pareto Principle

Luciano Pomatto and Nabil Al-Najjar

## Abstract

In the evaluation of public policies, a crucial distinction is between plans that involve purely idiosyncratic risk and policies that generate aggregate, correlated risk. While natural, this distinction is not captured by standard utilitarian aggregators. In this paper we revisit Harsanyi's (1955) celebrated theory of preferences aggregation and develop a parsimonious generalization of utilitarianism. The theory we propose can capture sensitivity to aggregated risk, it is apt for studying large populations and is characterized by two simple axioms of preferences aggregation.

# Evidence for the Confidence Heuristic in Common-Interest Games with Asymmetric Information

Briony D. Pulford, Andrew M. Colman, Eike K. Buabang and Eva M. Krockow

## Abstract

According to the confidence heuristic, when people communicate beliefs to one another, they generally express confidence proportional to their degree of certainty, based on their relevant knowledge, and recipients tend to judge the persuasiveness of the communication according to the confidence with which it is expressed. Thomas and McFadyen (1995), who introduced the heuristic as a purely theoretical proposal, also showed mathematically that the confidence heuristic permits efficient exchange of information between decision makers with common interests, and that it reliably implements optimal solutions to interactive decisions characterized by shared preferences – technically, common-interest games in which one outcome Pareto-dominates all other possible outcomes – and asymmetric information. Examples include life partners deciding between different houses to buy or politicians choosing between political leaders, where agreement is preferable to disagreement, and some jointly agreed alternatives are typically preferable to others, but the individuals involved have different information about the available alternatives. Previous experiments have investigated the confidence – persuasiveness aspect of the heuristic but not the full knowledge – persuasiveness hypothesis, and have focused on individual rather than collective decision making. We report 3 experiments to test the confidence heuristic using incentivized interactive decisions with financial outcomes in which participants attempted to identify target stimuli after conferring with a partner who was also seeking the right answer and who had either stronger or weaker information about the target. Experiment 1, using a facial identification task, confirmed the confidence heuristic and showed optimal joint decisions 60.5% of the time. Both quantitative and qualitative analyses were performed. The repeated-measures design controlled for individual differences influencing the results. Experiment 2, using geometric shapes as stimuli, found a much larger confidence heuristic effect yielding 85.8% optimal joint decisions. Experiment 3 found similar confidence heuristic effects (84.8% optimal joint decisions) through face-to-face and computer-mediated communication channels, suggesting that verbal rather than nonverbal communication drives the heuristic. The verbal protocols revealed that suggesting an answer first was typical of pair members with strong evidence, and this may therefore be a dominant cue that persuades. In our experiments, pair members with strong evidence tended to be more confident and more persuasive than their partners with weak evidence, confirming the complete knowledge – confidence – persuasiveness causal path implied by the heuristic in common-interest games with asymmetric information. Our results establish the confidence heuristic with dissimilar classes of stimuli and through different communication channels.

**Eliciting Consumers' Preferences for Risk Communication Strategies: A Discrete Choice Experiment**

Madalina Radu

**Abstract**

The communication of food safety and risk information to consumers plays an important role in public health policies. Studying how best to design effective communication strategies has been central to the policy-makers. A considerable amount of literature has investigated how effective public communication strategies should be. These studies showed that, when designing communication strategies, it is critical to consider consumers' risk perceptions, risk attitudes, intentions and behaviours. However, the majority of the previous food safety interventions highlighted that risk communication strategies were designed around the findings of technical risk assessments without addressing factors that might influence consumers' risk perceptions. Some of these factors include consumers' preferences for how to be informed about risks, their understanding of risks and consequences of not mitigating such risks. This study investigates consumers' preferences for communication campaigns regarding food safety risks and issues and how preferences vary with consumer characteristics and their food risk knowledge and perceptions. The data used for this research was collected via a web-based discrete choice survey. Employing probabilistic choice models, we analysed consumers' preferences, perceptions, food safety attitudes and decision-making processes. The results showed heterogeneity in consumers' preferences and highlighted the need for designing targeted communication strategies for effective health outcomes.

# The Importance of Risk in Economics From an Evolutionary Perspective

Nasir Rajah

## Abstract

Risk-tolerance is critical to economic activity. However, neoclassical economics has struggled to explain the irrational risk-taking of certain individuals; which has led to a lack of analytical tractability for economic activities, such as entrepreneurship. From an expected utility hypothesis perspective, entrepreneurship is not rational (Allais, 1979). Using the case of attention deficit hyperactivity (ADHD)-like behaviour I will argue that it is important to consider the integration of biology into economics in order to demonstrate that irrational behaviours are rational and beneficial from an evolutionary perspective, contingent upon the maturity of the economy. Human risk-tolerance is subject to evolutionary pressures and it is argued that the existence of ADHD-like behaviours was for risk-taking. These individuals display excessive risk-tolerance and different decision-making; i.e., a different utility function provided by an elevated motivational threshold. Evolutionary evidence suggests ADHD-like behaviours have been useful in past environments. They assisted humans in exiting the single point of origin, migrating to new lands and relaying this information to the largely risk-averse population. Thus, what appears to be irrational risk-taking in the modern concept is rational behaviour through the lens of evolutionary biology. For example, one is able to see that excess risk-tolerance maximises the individuals' utility through high risk activities and benefits wider society if risk-tolerance is beneficial in the economic climate. Scholars argue that ADHD as a disorder exists due to the shift to industrialised societies, as the environmental landscape has changed too quickly for evolution to be in equilibrium. A similar argument is found in the unified growth theory (UGT). According to the UGT, the risk-tolerant type, derived from ADHD, provides the initial advantage in advancing the economy, but the maturation of the economy favours the risk-averse type, deselecting the risk-tolerant type and reducing their presence in the population. This is because the division of labour in mature economies forces the repetition of tasks, which is ill-suited to the risk-tolerant type. Here it is proposed that the risk-tolerant type is not deselected in parallel with the advancement of economies. This is because the manner in which natural selection operates in humans is not necessarily a reduction of the unfavourable trait. Rather, the probability of success for the risk-tolerant trait in the environment decreases with the advancement of economies. Given their preference for risk and the lack of this in mature economies, the risk-tolerant type is at a disadvantage. As a result, they enter the lower echelon of society; subsequently effecting the social mobility of descendants. It may be argued that this is a new form of deselection that is not concerned with the removal of the unfavourable type, but the success of the risk-tolerant type.

# Solomon's Judgment Revisited

Roald Ramer

## Abstract

The task of an identification of the mother of the contested child has served as a test for the theory of mechanism design. However, over the years little attention has been given to the original Salomon's ploy. On the other end, none of the proposed mechanisms takes into account the recent insights from behavioral economics. This paper is a contribution to some of these issues, left until now largely unexplored. First, we argue that Solomon could have never intended to divide the child, and that the success of his scheme was mainly due to its incomplete specification. Also, he may not be accused of breaking his word, as become customary in the literature. A similar caveat holds for most auctions and contests in economic, social and political environments. Second, we construct a perfect information 2x2-game making use of the threat of a sword, where the litigants can be trusted to implement the truth-telling profile, whether it is a unique equilibrium but they do not know it, or whether they know that there is another equilibrium. We call such profiles robust equilibria, a notion akin to the risk dominant equilibria in the context of repeated interactions. Third, we investigate informational requirements allowing the court to identify the mother with a high probability by means of a 2x2-game making use of appropriate penalties and compensations. The range for these payments rendering truth-telling a unique equilibrium is much larger than generally believed. Such a mechanism could be used even when the success is not guaranteed. Fourth, we argue that two-steps mechanisms solvable by iterated elimination of weakly dominated strategies, proposed respectively by Olszewski and Mihara are not very likely to return the child with no cost to its mother in a realistic environment. Anything could happen if the mother cares about the fate of the child when not under her care, or the impostor enjoys making the mother to pay for her child. Fifth, we construct a mechanism using markets instead of auctions in subgames not reached at the unique subgame perfect equilibrium in pure strategies. The outcome of this equilibrium can be obtained by an iterated elimination of strategies which are never the best reply to the strategies not yet discarded. With appropriate large penalties, it will be the unique profile surviving iterated elimination of dominated strategies. Sixth, the mechanism returning the desired outcome at a unique equilibrium of some specified kind, need not be the best choice for the social planner – there is no guarantee that such an equilibrium will be reached. The planner needs to calculate the likely trade-off between the rate of success and the costs of a failure. Solomon's ploy could have the highest expected rate of success of all the mechanisms ever proposed, but it might not have been used in historical times. Nobody has tried to estimate which of the mechanisms depending on monetary transfers will be best in a realistic setting.

# Giving to Varying Numbers of Others

Matthew Robson and John Bone

## Abstract

Within a modified N person dictator game, we test the extent to which giving behaviour changes as the number of recipients varies. Using a within-subject design, in an incentivised laboratory experiment, individual-level preference parameters are estimated within five alternative utility functions. Both goodness-of-fit and predictive accuracy of each model are analysed, with the 'best' model identified for each individual. The Dirichlet distribution is proposed as a random behavioural model to rationalise noise; with parameters accounting for differential error arising from the complexity of decision problems. Results show that, on average, participants are willing to give more total payoffs to others as the number of players increase, but not maintain average payoffs to others. Extensive heterogeneity is found in individual preferences, with no model 'best' fitting all individuals.

# Assessing Axioms of Theories of Limited Attention

Nuttaporn Rochanahastin

## Abstract

It is very likely that many decisions in the individual choice setting are made without a complete or exhaustive deliberation process. One of the plausible explanations for this behaviour, that has recently received much recognition in economics, is that people have limited attention. This assumption has motivated many new theories, more and more of which are founded on axioms. This research experimentally test two of these new theories, those of Masatlioglu et al. (2012), and Lleras et al. (2017), which are based on the revealed preference framework. This paper uses standard choice data to determine the (relative) validity of their underlying axioms, compared to a benchmark of the violation rate given by random behaviour. The results show that Masatlioglu et al. (2012) appears to be the empirically more plausible weakening of WARP.

# Identification of Risk vs Ambiguity Aversion in Public Good Provision

Ismael Rodriguez-Iara, Iñigo Iturbe-Ormaetxe, Giovanni Ponti and Elisabet Rutstrom

## Abstract

We consider a simple model of public good provision as a stereotypical example of an individual decision problem under both risk and uncertainty. The risk component comes from the fact that the (privately observed) individual cost of contributing is an independent random drawn from a uniform distribution (and this fact is publicly known); while uncertainty is essentially strategic, in that group members have to form subjective beliefs over the others' contribution strategy. We design four experimental treatments in which we vary subjects' informational conditions to estimate two alternative models of individual decision making over uncertainty: i) one in which players form subjective beliefs over the overall uncertainty in the game, ii) the other in which risk and uncertainty are treated separately.

# Social Risk Attitudes for Health and Money

Kirsten Rohde and Ingrid Rohde

## Abstract

This paper studies attitudes towards social risks for health and money. In an experiment, subjects are asked to report their certainty equivalents of risks that are distributed over individuals in society. In every society, all individuals face the same risks. Societies differ in the correlation of the risks across individuals. The risks concern either life duration or money. We consider risks framed in terms of either gains or losses. The results shed light on people's attitudes towards risks and inequalities, and towards their willingness to be responsible for the outcomes of others.

# Quasi-Separable Preferences

Hendrik Rommeswinkel and Wei-zhi Qin

## Abstract

Advances in economic theory have made decision theoretic models increasingly complex. Utility functions often lack additive separability, which is a major obstacle for decision theoretic axiomatizations. We address this challenge by providing a representation theorem for utility functions of quasi-separable preferences of the form $u(x,y,z) = f(x,z) + g(y,z)$ on subsets of topological product spaces. These functions are additively separable only when holding $z$ fixed. We then generalize the result to spaces with more than three dimensions and provide axiomatizations for preferences with reference points as well as consumption preferences with dependence across time periods. Our results allow us to generalize the theory of additive representations to simplexes and surfaces.

# A Diagnosis on the Relationship between Equilibrium Play, Stated Beliefs and Best Responses

Ciril Bosch Rosa

## Abstract

Strategic games have two dimensions of difficulty for subjects in the laboratory. One is understanding the rules of the game and forming a best response to whatever beliefs they hold. The other is forming these beliefs correctly. Typically, these two dimensions cannot be disentangled as belief formation crucially depends on the understanding of the game. We present a variation of the Two Player Guessing Game (Grosskopf and Nagel 2008) which turns an otherwise strategic game into an individual decision-making task. This allows us to perform a within subject analysis of the decisions made for the same "game" with and without strategic uncertainty. The results show that subjects with a better score at the individual decision making task form more accurate beliefs of other player's choices, and better-respond to these beliefs. Additionally, we show that those who score higher at our new task modify their beliefs based on the population they play against. This suggests that out of equilibrium play is mostly driven by a limited understanding of the game mechanics.

# Do Regulatory Fintech Advancements Alienate Populations

Maya Haran Rosen and Orly Sade

## Abstract

Do Regulatory Fintech Advancements Alienate Less Financially Literate and Less Financially Confident Populations: An Investigation of the "Money Mountain" Campaign in Israel In 2013-2015, the Israeli insurance and long-term savings regulator reached out to the Israeli population, recommending the use of a new centralized website created by the regulator to help individuals find inactive retirement plans and withdraw inactive accounts. We find that the government's effort did not result in withdrawals from the majority of the accounts, and did not reach all subpopulations equally. Provident fund records indicate that those who took action and withdrew savings following the campaign lived in central locations that had higher socioeconomic rankings, and they were relatively older. Using survey data, we find evidence that the unemployed and those with low financial literacy and confidence in their knowledge of retirement planning were less likely to have been aware of the financial regulatory campaigns. It seems that confidence in one's financial knowledge is more important for financial action than objective literacy. The survey further shows the importance of gender, age, education, and immigration status. We conclude that less privileged populations were less likely to have been aware of the campaign, to have entered the website, and to have taken action based on the information. Using a controlled field experiment we also provide evidence that a more detailed and personal human intervention can be more successful in relaying financial information to underprivileged populations compared with wide media campaigns.

# Sequential Choice and Incentives

Maria J. Ruiz-Martos

## Abstract

Economics calls for monetary incentives to induce participants to exhibit truthful behaviour. This experiment investigates the effect of reducing incentives on dynamic choices, which encompass the individual and chance in a sequence of decisions. I compare preferences elicited with the commonly used random lottery incentive system (RLIS) to hypothetical choices in the specific dynamic choice framework of the common consequence effect (CCE). In addition, the RLIS is partially controlled for by eliciting with single choice individual preferences over the two CCE static choice problems, which allows to test RLIS-reduction procedure suggested by Holt (1986). Results cannot reject or accept the RLIS-reduction procedure and, overall, suggest that lessening incentives do not induce a systematic shift in preferences when emotional responses are not at stake.

# Random Lottery Incentive System in Dynamic Choice Experiments

Maria J. Ruiz-Martos

## Abstract

Cubitt, Starmer and Sugden (1998) pose a dynamic choice argument against the random lottery incentive system (RLIS). To wit, the RLIS relies on principles of dynamic choice. Thus, experimental research on the dynamic choice principles should be conducted in a single choice design. This study attempts to evaluate the empirical validity of their argument by quasi-replicating their single choice experiment in a RLIS design. Results suggest that one may use the RLIS in dynamic choice experiments.

**Dynamic Choice Behaviour and the Common Consequence Effect: Aggregate Versus Individual Level**

Maria J. Ruiz-Martos

**Abstract**

What should you do when confronting a sequence of decisions such that you make some choices and chance makes some others, i.e., a dynamic decision making problem under risk? Standard economic rationality requires you to look at the final choices, determine the preferred options, choose the sequence of decisions that lead to those and follow that sequence through to the end. That behaviour is implied by the conjunction of the dynamic choice principles of separability, dynamic consistency and reduction of compound lotteries. Experimental research on these dynamic choice principles has been developed within the common ratio effect theoretical framework. This paper experimentally investigates what subjects do when confronting such a problem within a new theoretical framework provided by the common consequence effect that manipulates the value of the foregone-consequence in the prior risks. Results suggest that reduction of compound lotteries holds throughout, whilst dynamic consistency and separability do not and their failure is related to the foregone-consequence.

# Updating Variational (Bewley) Preferences

Ana Santos and José Heleno Faro

## Abstract

In this paper first we study the problem of characterizing an update rule for the class of variational Bewley preferences. We show that under the standard dynamic consistency the updated preference still in the same class of preferences and the corresponding ambiguity index follows a generalization of the full Bayesian update. Then we study the problem of updating preferences when the decision maker is characterized by two binary relations. Given the empirical evidence for incomplete preference in the sense of variational Bewley preferences, the first unconditional relation satisfies a set of behavioral conditions consistent with this class of preferences. Motivated by the fact that on many occasions, the decision maker must be able to compare any pair of acts (forced choices), we investigate the problem of finding an ex-post complete, transitive, continuous and monotone preference that preserves the ambiguity attitude of the original unconditional one. We find that the ex-post relation must be given by a variational preference represented by the same affine utility function and the ambiguity index follows the same updating rule of variational Bewley preference. This extension is unique and characterizes a weak completion of the unconditional ex-ante preference. Also, our result can be viewed as a novel foundation for the full Bayesian updating of variational preferences.

# Risk and Rationality: Testing Salience Theory of Choice under Risk

Luis Santos-Pinto, Adrian Bruhin and Maha Manai

**Abstract**

Expected Utility Theory (EUT) fails as a descriptive model, as subjects' choices under risk systematically deviate from EUT predictions. These systematic deviations have spurred the development of various behavioral theories of choice under risk. Prospect Theory (PT), the most prominent behavioral alternative to EUT, relies mostly on reference dependence and diminishing sensitivity to explain how the deviations from EUT come about. In contrast, Salience Theory (ST), a recently proposed contestant, is based on local thinking and salience. It postulates that, due to cognitive limitations, subjects are local thinkers and focus their attention predominantly on salient states – i.e. states in which one payoff stands out relative to the payoffs of the alternatives. PT and ST often make similar predictions. However, ST offers some advantages over PT, as it naturally extends to deterministic consumer choice, describes the counter-cyclicality of risk premia on financial markets, and explains violations of transitivity that lead to preference reversals. In this paper, we experimentally test ST by exposing 283 subjects to a series of lottery choices that may trigger the Allais' paradox. To reliably discriminate between PT and ST, we exploit the fact that the valuation of a lottery is context-free in PT while it is context-dependent in ST. We vary the choices' context by altering the correlation structure of the lotteries' payoffs. This allows us to do three things. First, we provide non-parametric and structural evidence on the two theories' descrip-tive performance at the aggregate level. Second, we account for individual heterogeneity in a parsi-monious way and use a finite mixture model to classify subjects into EUT-, PT-, and ST-types. Third, we perform out-of-sample predictions about the frequency of preference reversals in a set of additional choices to assess the validity of our classification of subjects into types. Our experiment yields three main results. First, at the aggregate level, PT remains the best-fitting model while EUT and ST are both rejected. Second, however, the finite mixture model reveals considerable individual heterogeneity: PT is the best-fitting model for just 38% of subjects, while ST and EUT are the best-fitting models for 34% and 28% of subjects, respectively. Third, our out-of-sample analysis confirms this classification of subjects into types, as the ST-types exhibit significantly more preference reversals in the additional choices than the PT- and EUT-types.

# It's All About Gains: Risk Preferences and Problem Gambling

Ulrich Schmidt

## Abstract

Problem gambling is a serious socio-economic problem with an average prevalence ranging from 0.5 to 7.6% worldwide. Reported consequences include debt overload, social isolation, depression, and suicide. In this paper, we study financial risk preferences of problem gamblers including their risk attitudes in the gain and loss domain, their degree of loss aversion and their perception of probabilities. To our knowledge, this is the first study which provides a comprehensive analysis of their financial risk behavior in an incentivized task. Our findings indicate that problem gamblers are systematically more risk taking and less sensitive towards changes in probabilities in the gain domain only. Neither their degree of loss aversion nor their risk attitudes in the loss domain are significantly different from the controls. These novel insights provide an explanation why some individuals persist in gambling activities "despite their severe negative consequences", while the general population does not.

# Higher-Order Risk – An Application to Savings of the Poor in Bogota

Sebastian Schneider, Marcella Ibanez and Gerhard Reiner

## Abstract

Higher order risk preferences play an important role in economics, most prominently in the theory of saving under risk and uncertainty. Leland (1968) suggests that prudent individuals increase savings as a precautionary measure to react to income risk. To test this proposition we present a new experimental method to elicit higher order risk preferences. The method we propose uses a non-parametric estimation of the utility function using P-splines. Applying this method we can compute well-known theoretically derived measures of the intensities of prudence and risk aversion. We find comparable results to earlier studies with respect to classification of individuals as prudent or imprudent among a sample of poor households in Bogota. In addition, the results strongly support the theoretical prediction that income risk leads to increases in savings for prudent individuals. This suggests that this population group lacks alternative options to smooth consumption.

# Instantaneous Decisions

Amnon Schreiber

## Abstract

This paper analyzes decision-making problems that involve only infinitesimally short intervals of time. We call decisions of this type instantaneous decisions. Our main result is that in many instantaneous decisions, all investors agree on one order that reflects either riskiness or desirability of investments. In addition, we show that instantaneous decisions are similar to decisions taken by decision makers with exponential utilities with regard to normally distributed returns.

# Decision Making under Uncertainty: Economic Preferences Versus Psychological Personality Traits

David Schroder

## Abstract

Uncertainty is a fact of life. People constantly have to take decisions in uncertain environments. Examples include consumption, savings, and investment decisions, as well as education and employment choices. To better understand the important topic of decision making under uncertainty, both economists and psychologists have developed theories that identify key determinants of human behaviour in such situations. The workhorse model in economics is decision theory, which is usually built on some form of utility maximization. Utility theory combines information on various possible outcomes in uncertain situations with individual economic preference parameters, such as risk or ambiguity preferences. Psychologists, in contrast, have developed the concept of personality traits that affect outcomes in various domains of life. Besides the general and well-known so-called Big Five personality traits more specific psychological constructs have been proposed to assess individual responses to uncertain situations. These include, among others, ambiguity and uncertainty intolerance. With a few exceptions, the concepts used by economists and psychologists to explain human behaviour under uncertainty have been studied separately so far. The objective of this paper is therefore to analyse and compare economic preference measures and psychological personality traits that are designed to capture human attitudes towards uncertainty. In a first step, the relation between these two concepts is analysed by examining pairwise correlation patterns. In a second step, the study analyses to what extent these measures can explain human behaviour as measured by selected life outcomes. The analysis is based on an experimental data set of university students in London. Economic preferences towards uncertainty are captured by risk and ambiguity preferences. Following the tradition in experimental economics, these two preferences are measured using standard decision tasks with monetary incentives. Personality traits are measured with computer-based versions of the usual pencil-and-paper questionnaires used in personality psychology. For each subject, the concept of ambiguity intolerance is assessed using standard self-assessment scales. Besides, I measure other personality measures, such as the subjects' uncertainty intolerance, life orientation, optimism, self-esteem and cognitive ability. Life outcomes and behaviour of the subjects are also obtained using a computer-based questionnaire. This study shows that economic preferences and psychological personality traits designed to measure attitudes towards uncertainty are little related to each other. Rather than being substitutes, they can be considered distinct concepts. Furthermore, psychological personality traits are significantly more related to selected important life outcomes compared to economic preference parameters, and even partly subsume economic preferences.

# Rating the Quality of Portuguese Vinho Verde with Machine Learning Methods

Amílcar Serrão

## Abstract

The wine industry is a competitive business with a potential for great profit. There are many factors that contribute for the quality of wine. The chemical properties have a great impact on the quality of wine. As a consequence, all these factors have influence on the rating of the quality of wine. A great investment has been made in data collection, data mining and machine learning methods to assess wine preferences. Data Mining allows us to extract knowledge from raw data. Machine Learning methods have been applied to discover key differences in the chemical composition of wine, to identify the chemical factors that lead a wine to taste sweeter, and to rate the quality of wine. This research work uses regression trees and machine learning methods to develop a model capable of mimicking expert ratings of vinho verde (Portuguese wine) to identify the key factors that contribute to better-rated wines. These approaches are applied to vinho verde to support the oenologist's wine tasting evaluations and to identify the best oenologist's wine preferences through utility functions and confusion matrices. We are using a dataset donated to the UCI Machine Learning Data Repository by Cortez, Cerdeira, Almeida, Matos, and Reis. The dataset include information on 11 physicochemical characteristics of 4898 white wines and 1599 red wines. These evaluations are based in the experience and knowledge of the experts which are prone to subjective factors, and express the oenologist's wine preferences. The approaches for modelling wine data are regression trees which offer a simple way to identify the key factors that predicted the higher rated wines through the nodes in the tree diagram. The machine learning methods such as Support Vector Machines, K Nearest Neighbors, Artificial Neural Networks and Random Forest are compared to assess the prediction performance of the quality rating of vinho verde. This study uses utility functions and confusion matrices to compare how well the predicted values correspond to the true values and to analyze the consistency of oenologist's wine preferences. Model results for the root node in the tree diagram show that alcohol is the most relevant factor as a predictor of the highest rate of wine quality and has influence on the ratings of the quality of white and red wines. The next nodes in the tree diagram are the volatile acidity and the free sulfur dioxide. Finally, we surpassed the performance of the neural network model published by Cortez et al. using the Random Forest Model, and the oenologist's wine preferences are analyzed by estimated utility functions and confusion matrices to identify the best oenologist's wine preferences. The estimated utility functions perform better than the confusions matrices. This approach will be very important for the winemakers, because wine tasting might result in a better product as well as more objective, consistent, and fair ratings.

# Ordinal Utility Theory Is the Key to Decision Making under Ambiguity

Jack Stecher, Simon Grant and Patricia Rich

## Abstract

We provide a theory of decision under ambiguity in which the worst-case and best-case expected utility representations are sufficient statistics for a decision maker's preferences; we refer to the new utility functions as meta-utilities. Our approach, which generalizes many of the commonly used models, provides an ordinal value of these worst- and best-case expected utilities, mirroring the familiar ordinal utility functions over commodity baskets. Ambiguity attitude is simply the marginal rate of substitution in the meta-utility between worst-and best-case expected utilities. We identify necessary and sufficient conditions for the existence of a meta-utility representation of preferences. This theory can support new empirical insights: We first show that experimental research can use this approach to study interaction among heterogeneous agents. A second application demonstrates that the shape of the meta-utility function can explain an ambiguity averse agent's willingness to lend despite facing ambiguous default.

# Rational Imprecision: Information-Processing, Neural and Choice-Rule Perspectives

Kai Steverson, Adam Brandenburger and Paul Glimcher

## Abstract

People make mistakes. A rationally imprecise decision maker optimally balances the cost of reducing mistakes against the value of choosing correctly. In this paper we provide three different models of a rationally imprecise decision maker: an information-processing formulation, a neural implementation, and a choice-rule characterization. The information-processing formulation obtains rationally imprecise behavior by optimally balancing the values of potential outcomes against the cost of reducing stochasticity in choice, formulated entropically. The neural implementation derives rational imprecision from a neural computation, called normalization, which has been found to be involved in choice-related value representation in the brain. The choice-rule characterization yields rational imprecision from axioms that relax the classic Luce rule. Our relaxation of the Luce rule allows us to accommodate a wider range of observed behaviors, such as the violations of regularity seen in the attraction effect. The main result in this paper is an equivalence theorem which establishes that, despite their different vantage points, our three models are fully equivalent in terms of the behavior they imply. If observed behavior fits one of the models, then it must fit all three models. For example, any behavior arising from our neural-normalization computation can be rationalized as optimizing our information-procession formulation. These models can therefore be seen as offering complementary insights into the phenomenon of imperfectly precise human behavior by answering, respectively, the "why", the "how", and the "what" of our notion of rational imprecision. The information-processing formulation explains why mistakes arise, namely, because of the inescapable physical cost of reducing stochasticity in choice. The neural implementation explains how these mistakes can arise from a mechanism understood to be operative in the brain. The choice-rule characterization says exactly what behavior would be observed.

## Equal Sacrifice Taxation

John Stovall

**Abstract**

We characterize the family of equal sacrifice rules for the problem of fair taxation: every individual with positive net income sacrifices the same amount of utility relative to his/her respective gross income. Because we do not impose Symmetry or Strict Resource Monotonicity in our set of axioms, our family of rules allow for asymmetric and "constrained" versions of equal sacrifice. In addition, we show that when Linked Claims-Resource Monotonicity is added to the set of axioms, then this is equivalent to adding the requirement that every individual's utility function is concave.

# Utility Maximization with Sensory Limitations: Theory and Evidence

John Stovall, Lars Lefgren and Olga Stoddard

## Abstract

We reinterpret the utility representations pioneered by Strotz (1955) and extended by Gul and Pesendorfer (2001) in the self-control literature to consider the optimizing behavior of individuals who are exposed to many latent stimuli but prone to experience only the most salient one. We show that individuals with such preferences may find it optimal to engage in seemingly dysfunctional behavior such as self-harm. Our model also explains the behavior of individuals experiencing depression or trapped by multiple competing problems, as well as sheds light on the existence of first world problems. We present experimental evidence suggesting such preferences explain the behavior of more than two thirds of subjects exposed to single and multiple painful stimuli.

# A Simple Model to Explain S-Shaped Utility Functions

Martin Strobel

## Abstract

I prefer to have a poster, but I would also take a presentation. Sorry to state this here in the abstract, but the menu did not contain this preference. Best, Martin Abstract: We use the indirect evolutionary approach of Gueth and Yaari (1992) to investigate the evolution of risk preferences. In our model, agents are equipped with preferences over risk that can be expressed in a utility function. They face two different types of situations. In the first they do not have any influence on the outcome (nature decides). In the second they have the choice between a fixed outcome and a simple lottery. Agents choose the option that maximizes their utility. However, for the evolutionary success it is not the utility that is decisive but the outcomes (of both types of situations) and the agent's choice. We find support for the evolution of S-shaped utility functions, although there is no stable population. Some of the results can be shown analytically. Others require simulations. Exemplary story: Assume you were a bear somewhere up in the Rocky Mountains. The season has been extraordinary rich in food supply. The winter is approaching, and you are preparing for hibernation. You may choose between the following two options: a.) Stay up in the mountains and live from mushrooms and berries which there are still to find. This is meager but safe. b.) Go down to the valley to see whether you can hunt down a sheep or some poultry from one of the farms. This would mean rich food supply, but you face the chance of being shot by one of the farmers. Now consider the same choice for a bear which has seen a poor year, and which is in danger to starve during winter. It sounds plausible that the fat bear chooses to stay up in the mountains, while the skinny bear takes the risk and goes for meat.

# Deep Cooperation

David Strohmaier

## Abstract

The human capacities for cooperative interaction have attracted increasing attention in formal inquiries. The most prominent type of cooperation, going back to Robert Axelrod's ground-breaking work, is based on the expectation of future interaction and might be dubbed "reciprocity cooperation". I argue that reciprocity accounts have not exhaustively described the mechanisms for achieving cooperative interaction between humans. Deep cooperation, as I call the type of cooperation I introduce, exhibits greater robustness than reciprocity cooperation. This new type of cooperation deserves the label "deep", because it occurs not only on the level of acts, but on the underlying level of reasons and motivations. To model this feature, I draw on the framework of reason-based decision theory recently proposed by Franz Dietrich and Christian List. Reason-based decision theory is an extension of standard decision theory introducing an underlying set of motivationally salient properties, called "motivational state", which grounds the preferences of the agent. We can think of the properties in the motivational state as specifying the agent's motivating reasons. For example, the chocolate taste of a dessert can give Matilda a reason to eat it. In the terms of reason-based decision theory, Matilda's motivational state includes the property of chocolate taste. With their framework Dietrich and List can model certain kinds of preference change as resulting from a change of the motivational state that is a change in which properties are motivationally salient for the agent. Dietrich and List have already shown that a difference in motivational states can explain whether a game takes on the form of a Prisoner's Dilemma or a game in which the cooperative choice is dominant. However, as long as only private psychological mechanisms govern motivational states, hardly anything follows for how to achieve cooperation. We would have no social mechanism for a pro-cooperative transformation of the game. By allowing agents to affect each other's motivational states, I can use List and Dietrich's framework account for deep cooperation. I argue that the exchange of reasons can affect the preferences of interacting agents and draw for that purpose the theory of signaling proposed by David Lewis and further developed by Brian Skyrms. On my account of deep cooperation, the agents signal about how they might transform the game so that cooperative choice becomes likelier. My main thesis is that signaling about our reasons and their development, can lead to a pro-cooperative transformation of the effective games agents face. In virtue of this and transformation and in contrast to reciprocity cooperation, the mechanism of deep cooperation does not depend on the prospect of future games. Combining reason-based decision theory with signaling, we find a new type of cooperation deeply bound up with our nature as reason-givers and ready to alter our understanding of human interaction.

# Dynamic Screening with a Time-(In)consistent Agent

Alice Peng-Ju Su

## Abstract

A consumer may be dynamically inconsistent over goods that are demanded periodically without long-term commitment. Not only is the consumer's preference is his private information, his time-(in)consistency – how his preference differs dynamically – is also his private information. I study how this private information on time-(in)consistency interacts with the traditional screening problem in a contract theoretical principal-agent framework. Viewing time-(in)consistency as a change of preference (or not) from the current to the future, private information on time-(in)consistency is redundant for the consumer if in each period he has private information on his own preference. It is, however, non-negligible because it preserves the agent's future information advantage. With complete information on time-(in)consistency, truthful revelation of current preference implies symmetric information on the consumer's future preference. Without long-term commitment, the seller-principal is able to design in the future a contract that leaves no information rent to the consumer-agent. This distorts the consumer's current incentive to reveal information truthfully and thus distorts the current contract towards granting the potential information rent earlier to the consumer. With incomplete and asymmetric information on time-(in)-consistency, a truthful revelation of current preference does not alter the fact that the consumer has private information on his future preference. This restores the future rent-efficiency trade-off and relaxes current incentive compatibility, which results in a distortion of future efficiency and a possible improvement of current efficiency. In addition, time-(in)consistency is not distinguishable in the current period alone, so screening time-(in)consistency per se is not incentive compatible with only short-term commitment. Private information on time-(in)consistency improves the total information rent to the time-inconsistent agent due to the preservation of future information advantage. It lowers the total information rent to the time-consistent agent, because with the preserved future information advantage, the consumer lost his ability to extract the future information rent earlier. Besides the assumption of sophisticated agent, two forms of naiveté are studied. Whether the consumer is naive in the content or in the accuracy of his private information on time-(in)consistency, incentive compatibility is relaxed with a naive agent. The naive agent is not able to utilize his information advantage on time-(in)consistency as well as his sophisticated counterpart. The agent's naiveté thus benefits the principal.

# Stochastic Attention and Search

Elchin Suleymanov

## Abstract

Starting with the work of Kahneman & Tversky (1979) the idea that choices are reference dependent has gained significant traction. While numerous models of reference dependence have been developed, most existing models only address deterministic choice behavior. Since observed choices frequently exhibit randomness, it is important to understand the foundations for reference dependent random choice. To model reference dependent random choice, I assume that the Decision Maker (DM) has limited capacity to pay attention to all alternatives. Moreover, the DM's attention sets are directly influenced by her reference point. The main focus of this paper is four reference dependent random attention models: fixed independent consideration, logit consideration, fixed correlated consideration, and path dependent consideration. I show that the two key properties of fixed independent consideration are irrelevance of dominated alternatives (IDA) and ratio independence of dominant alternatives (RIDA). IDA states that if x is never abandoned for y when it is the reference point, then removing y from any choice set cannot affect the probability that x is chosen. RIDA states that if x is never abandoned for any other alternative in a given menu when it is the reference point, then removing x from the menu cannot affect the relative choice probability of any other two alternatives. Reference dependent random attention has a fixed independent consideration representation if and only if it has logit and fixed correlated consideration representations. While logit consideration preserved RIDA property of fixed independent consideration, fixed correlated consideration preserves IDA. The additional implication of logit consideration that is not captured by RIDA is decreasing odds for the reference alternative (DORA). DORA states that when a choice set is expanded by introducing alternatives which dominate the reference alternative, the odds for the reference alternative decreases at an increasing rate. On the other hand, fixed correlated consideration is characterized by IDA and decreasing propensity of choice for the reference alternative (DPCRA). The latter axiom states that when the choice set is expanded by introducing alternatives which dominate the reference alternative the probability that the reference alternative is chosen decreases at a decreasing rate. Finally, path dependent model violates both properties of fixed independent consideration. The key property of path dependent model is cumulative dominance effect (CDE) which provides a condition on the change in the probability that an alternative is chosen when all the alternatives dominating it are removed from the choice set. This paper contributes to the literature on reference dependent preferences and limited attention. The main contribution is to extend existing random attention models to reference dependent choice setting and also illustrate the relationship between these models.

# Measuring Preferences over Intertemporal Profiles: All-Sooner Effect and Magnitude Effect

Chen Sun

## Abstract

We develop a simple method for measuring intertemporal preferences: directly measuring preferences over intertemporal profiles, that is, combinations of outcomes at several points in time. The method is parameter-free, incentive compatible, independent of time horizon effects, and requires weak assumptions on preferences to be measured. By applying the method, we document two characteristics of preferences that cannot be captured by a classic discounting model. First, we find a disproportionate level of impatience in case it is possible to have all rewards on the earliest date (the all-sooner effect). The all-sooner effect is a different channel of impatience than discounting. Ignoring the all-sooner effect leads to overestimation of the discount rate and underestimation of the utility curvature. Second, we find that the discount factor is not affected by stakes, while the elasticity of intertemporal substitution is larger for higher stakes (channels of the magnitude effect). This suggests that estimation of discounting models will lead to biased parameters if the magnitude effect is ignored. We compare our empirical findings with the predictions of eight existing models in terms of the all-sooner effect and the two channels of the magnitude effect. The fixed-cost-of-delay model by Benhabib et al. (2010) predicts the all-sooner effect, and the costly-self-control model by Fudenberg and Levine (2006) predicts a magnitude effect on the utility curvature. We then propose a simple and flexible model which captures these two effects to facilitate parametric estimation in future studies.

# Can First-Order Stochastic Dominance Constrain Risk Attitudes?

Christian Tarsney

## Abstract

Standard decision theory holds that the rational response to uncertainty is expected value maximization (EVM). The dictum to maximize expected value provides seemingly indispensable practical guidance in many ordinary cases of decision-making under uncertainty. But EVM encounters a number of difficulties in cases involving very large finite or infinite magnitudes, where it yields conclusions that are either implausible, unhelpful, or both. In this paper, I argue that first-order stochastic dominance (SD) may provide an attractive alternative to EVM that avoids these problems with extreme payoffs, while capturing more of the ordinary, plausible implications of EVM than has previously been recognized. Simplifying slightly, option O1 stochastically dominates O2 iff for any possible outcome o, O1 offers a better chance than O2 of an outcome at least as desirable as o. On face, SD seems too weak to serve as a general theory of decision-making under uncertainty, since it places no constraints on an agent's risk attitudes. But, as I demonstrate, this is not necessarily so: When an agent starts off in a condition of background uncertainty about the value of her options representable by a probability distribution with exponential or heavier tails and a sufficiently large scale parameter, many expectation-maximizing gambles that would not stochastically dominate their alternatives "in a vacuum" (in the absence of any background uncertainty) turn out to do so in virtue of that background uncertainty. Thus, in the presence of background uncertainty, SD can effectively constrain risk attitudes. Nonetheless, even under these conditions, SD will generally not require agents to accept extreme gambles like Pascal's Mugging or the St. Petersburg Lottery, even when these gambles are expectation-maximizing. SD may therefore let us draw a principled line between ordinary expectation-maximizing gambles and "Pascalian" gambles involving minuscule probabilities of astronomical payoffs. Relatedly but more straightforwardly, SD avoids most of EVM's formal difficulties with infinite utilities. The sort of background uncertainty on which these results depend will plausibly characterize (at least) any agent who gives weight to aggregative consequentialist considerations, i.e., who measures the value of her options in part by the total amount of value in the resulting world. Because we should be deeply uncertain of the amount of value in world independent of our own actions (e.g., the number of sentient beings in the universe and average welfare per sentient being), aggregative consequentialist concerns can generate background uncertainty about the value of one's options with the requisite exponential-or-heavier tails and large scale parameter. At least for a large class of agents, then, SD may be able to act as a general principle of choice under uncertainty, explaining more of the apparent rational constraints on such choices than has previously been recognized.

# Beyond Majority Voting: Improving the Wisdom of Crowds

Benjamin Tereick

## Abstract

Techniques building on the wisdom of crowd, e.g. taking an average of many individual opinions, have shown impressive success in tasks as diverse as estimating the weight of an ox (Galton 1907), the location of a disappeared submarine (Surowiecki 2004) or the optimal solution to computationally hard combinatorial problems (Yi et al. 2012). On the other hand, crowd techniques can fall prey to group-think and ignore the expert knowledge of a specialized minority. Prelec et al. (2017) offer an approach which tries to make use both of individual expertise and the wisdom of the crowd. In its simplest form, their "Surprisingly Popular Algorithm" (SPA) considers a scenario in which respondents can choose between two answer options, one of which is correct. In addition to letting respondents choose one of the two options, the SPA asks respondents to predict the answers of others and subsequently picks the answer which is more commonly chosen than on average predicted. Empirically, the SPA yields better results than majority voting in six different areas of general knowledge and estimation tasks. The SPA is based on the assumption that when one statement out of two is correct, more respondents will believe it to be true. Prelec et al. (2017) prove that if respondents additionally update their own assumptions about the distribution of answers in a Bayesian fashion, the average prediction will provide a flexible threshold that is more reliable than the 50% threshold of majority voting, as long as there is a sufficient number of respondents. Generalizing the model of Prelec et al. (2017), I show that when the respondent pool is small, the SPA may perform worse than majority voting and that we can improve upon both methods by asking respondents directly for the appropriate threshold for each answer. I test both SPA and this newly derived "threshold method" in an experiment. Compatible with the idea that respondents act as approximate Bayesians, I find that both SPA and threshold method outperform majority voting and that average responses approximate correct conditional expectations well. However, respondents do not make use of all statistical information when asked for the optimal voting threshold. Rather, responses to the prediction and to the threshold question are markedly similar. The performance ranking of confidence-weighted majority voting, SPA and threshold method suggests a trade-off when using wisdom of crowd techniques. On the one hand, more complex questions can provide information on the underlying stochastic structure, which enables the SPA and threshold method to outperform majority voting. On the other hand however, more complex questions reduce the accuracy of the information provided by respondents, which prevents the threshold method from outperforming the SPA.

# Instrumental Rationality Without Separability

Johanna Thoma

## Abstract

Instrumental Rationality Without Separability This paper argues that instrumental rationality is more permissive than expected utility theory, and its core requirement, separability. Roughly, separability requires that a preference over two prospects should not be affected by what happens in states of the world that are not part of those prospects. The most compelling instrumentalist argument in favour of separability, most prominently presented by Hammond (1988), is that agents with non-separable preferences end up badly off by their own lights in some dynamic choice problems. They end up behaving in a way that is at odds with their initial assessment of the best course of action. And if they can, they will pay to bind themselves to that course of action, thereby making a sure loss by paying for something they could have had for free. Over time, those agents violate the supposedly uncontroversial requirement of state-wise dominance. I argue that this dynamic choice argument is ultimately unsuccessful because it equivocates between different notions of the standard of instrumental rationality, that is, different answers to the following question: When we speak of an agent doing well or badly by her own lights, and use this in an instrumentalist argument for some rationality principle, which of the agent's attitudes do we appeal to? In particular, what turns out to be the most relevant question for the success of the dynamic choice argument for separability is this: Are attitudes to uncertain prospects part of the standard of instrumental rationality, or do only attitudes to the possible outcomes of those prospects count? If attitudes to the uncertain prospects open to the agent at the time of action are part of the standard of instrumental rationality, agents with non-separable preferences will act in the allegedly problematic ways, but we cannot show that to be instrumentally irrational. If, however only attitudes to outcomes form the standard of instrumental rationality, we can show the allegedly problematic behaviour to indeed be instrumentally irrational, but agents with non-separable preferences need not act in that way. Either way, instrumental rationality turns out to be more permissive than expected utility theory claims.

# Risk Type Dispositions As An Explanatory Variable In Human Factor Risk

Geoff Trickey

## Abstract

We have data from 12,000 completions of a risk personality questionnaire researched in 20 industry sectors. Based on factor analysis of 23 risk themes extracted from the five-factor model of personality (FFM), the Risk Type Compass questionnaire generates a 360o spectrum of risk dispositions logically segmented into eight Risk Types. Orthogonal bi-polar scales provide the two axes for this circumflex model (reflecting emotional and cognitive decision making processes). The total sample shows symmetrical distribution of Risk Types and distinctive industry related differentiation. The eight Risk Types offer a taxonomic framework for the subjective, or human factors, side of the risk domain. This research contributes significantly to clarification of risk's labyrinthine complexity. Risk is a challenging field to navigate for two reasons. Firstly, it is boundless; risk attends every aspect of life - untied shoe laces, over fishing, straying into Russian airspace, smoking, using a weak password or the 'black swan' events addressed by the Blackett review. Secondly, there is no single metric with which to measure such a conglomerate entity and no all-embracing theory of risk – just 'chunks' of coherence. Making a distinction between subjective and objective risk is a helpful step towards coherence. Objective risk is the territory of actuaries, underwriters and H&S statistics. It is characterised by the counting of risk events, calculating probabilities and building predictive models - the core of risk science. Subjective risk is about the risk dispositions of individuals, their perception of risk, reaction to risk, and willingness to take risks. This has been viewed variously as elusive, unpredictable and inconvenient. The relationship between objective and subjective risk is complex, interactive and circular. Psychological research recognises personality as a frequent correlate of risk behaviour but has failed to appreciate the nature and extent of its contribution – largely due to issues about the definition of risk and the challenge of disentangling the nature and nurture of risk taking behaviour. The blue-print of subjective risk is embedded in personality – dispositions that influence the decision making that shapes a person's life trajectory and, potentially, that of their organisation. The extent to which any individual seeks excitement, is imaginative and distractible, or is detail conscious, systematic and rule bound, or is calm unemotional and imperturbable, or is fearful, apprehensive and cautious, reflects their risk disposition and impacts directly on the decisions they make. Effective applications span the finance sector and H&S. They range from boardroom to shop floor and focus on individuals, teams and risk culture. They involve traders, risk managers, wealth advisors, CROs, hedge funds, pension fund managers, investment boards and non-profits. Ongoing research involves pilots, Air Traffic Controllers, creatives and team sports.

# Ambiguity under Growing Awareness

Gerelt Tserenjigmid and Adam Dominiak

## Abstract

In this paper, we study choice under growing awareness in the wake of new discoveries. The decision maker's behavior is described by two preference relations, one before and one after new discoveries are made. As awareness grows, the original decision problem expands and so does the state space, requiring the decision maker's original preferences to be extended to a larger domain. The original preference admits a subjective expected utility representation. However, the new preference might display ambiguity aversion. We relate the new behavior to the old one by imposing two consistency notions between the initial and new beliefs. Unambiguity Consistency requires that the original states remain unambiguous while new states might be ambiguous. Likelihood Consistency requires that the relative likelihoods of the original states are preserved. Our first main result axiomatically characterizes a maxmin expected utility representation of the new preference that satisfies Unambiguity Consistency. In our second result, both consistency notions are satisfied. Moreover, we introduce a comparative notion of ambiguity aversion under growing awareness and characterize a parametric version of our model.

# Consumerism, Life-Satisfaction and Capabilities: The "Sour Grape" Effect

Annie Tubadji and Stephen Pratt

## Abstract

It is as important for a person to derive pleasure from one's actions, as it is to avoid pain from the actions and functionalities they cannot afford. This paper deals with the psychological mechanism of alleviating life-satisfaction deficiencies with more conspicuous consumption. Three types of choice, clearly chronologically arranged in time, are analyzed: formation of one's life satisfaction, the price of the room chosen for a particular travel and superstitious sensitivity towards being moved from your trip accommodation to a floor with a "fatal" number. To address the relationships among these three choices, we collected data from 800 individuals, half of them with Chinese residence, the other half belonging to the Western-culture. They were all travelers to Hong Kong and were asked a set of questions about their life-satisfaction, their trip and accommodation, and a series of culturally relevant for them superstitions. Using a recursive model, we find that people who are less satisfied with their life tend to stay at more expensive accommodations. These people are also the ones who are more prone to superstitious beliefs. Respectively, they exhibit having a higher trade-off between their unhappiness-alleviating consumption (the expensive accommodation) and its substitute on a fatal number floor. Furthermore, the mechanism for alleviating unhappy life through conspicuous consumption and the degree of proneness to magical beliefs are all locally specific. Yet, this is not due to cultural differences but more likely due to the different levels of life satisfaction and different capabilities for people across localities.

# Do Adolescents' Risk and Time Preferences Change When They Are Observed by Peers?

Agnieszka Tymula

## Abstract

Decisions made during adolescence and young adulthood have economic impact on people throughout their lives. It is now clear that teens and young adults more often than midlife adults make decisions that impair their own educational, health, and social outcomes, and their financial outcomes in the form of foregone future salary and retirement. Reckless behaviors come at a substantial financial burden to the society that bears the costs of hospitalization, preventive policies, and educational campaigns. The decisions that adolescents and young adults face such as whether to smoke, whether to have unprotected sex, and how much time to devote to studying are an outcome of complex interactions of an array of individual decision-making parameters; these include attitudes towards known and unknown risks, time preference, and the relative valuation of equally sized gains and losses. Importantly, most decisions, particularly in adolescence, are made not privately but in a social context. The presence of peers is often considered as the culprit in reckless behaviors. We designed a series of behavioral studies to disentangle whether adolescents' and young adults' risk attitudes, ambiguity attitudes, time preference or loss aversion are affected by the presence of peers. To date, 600 participants aged 12-25 years old participated in these behavioral studies. Each participant made a series of incentive compatible choices over risky and ambiguous gambles and between options that involve sooner smaller or later larger payments using three reward types: money, healthy and unhealthy food. Participants made choices in private and when observed by a peer. Our results suggest that common belief that adolescents and young adults become more risk taking in the presence of peers may be wrong if we define risk attitudes as in economic theory. Instead, young adults' and adolescents' time preferences seem to be affected by observation.

# Characterizing All Single-Peaked Random Utility Models and Their Relatives

Kremena Valkanova

## Abstract

Random utility models (RUMs) are one of the most common ways to rationalize stochastic choice. However, the multiplicity of RUM representations of a stochastic choice function makes it problematic to infer whether the preferences generating the observed choice behavior fulfill certain properties of interest or not. We characterize stochastic choice functions for which all RUM representations share identical properties on the set of preferences, focusing on single-peaked RUMs and related models. We show that stochastic choice functions satisfying two simple and intuitive properties - the classical regularity and Apesteguia, Ballerster and Lu (2017)'s centrality property - are only rationalized by weakly single-peaked RUMs, a novel property encompassing single-peakedness and single-crossing. We provide extensions on single-peaked and single-dipped RUMs, as well as on RUMs that satisfy single-peakedness over triples (Inada 1964).

# Shocks and Risk Preferences Revisited: New Evidence from Ethiopian Panel Data

Ferdinand Vieider and Salvatore di Falco

## Abstract

We present novel panel data from Ethiopia including incentivized measures of risk-tolerance paired with detailed data on rainfall. In cross-sectional analysis, we find a positive correlation between rainfall shocks and risk-tolerance. Using fixed-effects panel regressions, however, we find risk-tolerance to decrease following shocks. We use these contradictory findings to revisit the literature on shocks and preferences. That literature implicitly assumes that preferences are uniformly distributed across respondents ex ante. We show that this assumption is violated in our data. This has wide-reaching implications for the possibility of detecting the effect of shocks on preferences in cross-sections, which we discuss.

# Savage for Dummies and Experts

Peter Wakker and Mohammed Abdellaoui

## Abstract

The most famous theorem in our domain is Savage's (1954). He gave a behavioral foundation of classical subjective expected utility for homo economicus and for Bayesianism. Savage's axioms are exceptionally transparent and intuitive, and at the same time deep and strong in a mathematical sense. As appealing as his theorem is, so difficult and impenetrable is his proof. Therefore, people have treated his techniques as untouchable and as a black box that better be kept closed. Researchers rather use other more transparent frameworks (e.g., Anscombe-Aumann) to develop generalizations, tests, and applications, and to have the behavioral homo sapiens replace homo economicus as in modern ambiguity theories. We revisit Savage's analysis. We provide an updated analysis that is more general and way more accessible. Our derivations are self-contained. This helps to understand the depth and beauty of Savage's work and the foundations of Bayesianism better, to more easily teach it, and to more easily develop generalizations incorporating non-expected utility, ambiguity, and imprecise probabilities. Thus, we make the deepest theorem in the domain of FUR accessible to a wide audience and ready for use.

# A Generalization of Multiple Prior Models

Fan Wang

## Abstract

The purpose of this paper is to develop a generalization of maxmin expected utility (MMEU) in its original framework that is able to accommodate both non-EU behaviors and uncertainty-averse behaviors. To be specific, this goal is to be achieved by replacing the second-stage linear utility in MMEU with a RDU functional. The new decision rule, which I call maxmin rank dependent utility (MMRDU), is characterized in the main result. It is then extended to accommodate variational preferences (Maccheroni, Marinacci and Rustichini 2006) and multiplier preferences (Strzalecki 2011), still by replacing the second-stage linear utility in their original representations with a RDU functional. The key insight that makes this generalization possible is the following. The C-independence axiom of Gilboa and Schmeidler (1989) implies the von Neumann-Morgenstein independence axiom over risky lotteries and constant independence over uncertain acts. To accommodate non-EU behavior over risk, these two independence properties are reformulated and stated separately, with the first modified to allow for non-linear perception toward risk, and the second weakened to retain behavioral observability. Their uncertainty aversion axiom is similarly weakened with observability preserved. In these reformulations and, indeed, in the entire construction, I use extensively a notion of trade-offs between probability numbers, pioneered in a similar form by Abdellaoui (2002). In the domain of uncertainty, similar notions taking the form of trade-offs between events have appeared in Gilboa (1987) and Abdellaoui and Wakker (2005). The rich set of probability numbers is naturally present in a setting that involves risk, making any extra structural assumption unnecessary. Due to this parsimonious nature of our technique, the framework of Gilboa and Schmeidler (1989) can be fully preserved in this paper and the axioms are stated for easy comparison with theirs. In particular, arbitrary state space and arbitrary outcome space are allowed. In a related paper, Dean and Ortoleva (2017) axiomatize a decision rule that can accommodate both the Allais paradox and the Ellsberg paradox. However, this paper differs from theirs both conceptually and technically.

# Follow the Money: Bayesian Markets to Extract Crowd Wisdom

Tong V. Wang and Aurélien Baillon

## Abstract

Originally designed as an incentive mechanism to elicit private information (subjective judgments or unverifiable facts), Bayesian markets (Baillon 2017) also offer a solution to the single-question crowd wisdom problem. Here we propose an algorithm for extracting wisdom from the crowd: select the answer submitted by agents with a positive average ex post payoff in the Bayesian market. We show theoretically that this "follow the money" principle yields the correct answer under reasonable assumptions. A lab experiment with an artificial task demonstrates how to use this mechanism in practice. Another lab experiment involving natural tasks compares the performance of this mechanism with the "surprisingly popular" algorithm (Prelec et al. 2017).

# A Simple Discounting Model of Decreasing and Increasing Impatience

Craig Webb

**Abstract**

Recent evidence on intertemporal choice suggests that decision makers may exhibit both increasing and decreasing impatience, called inverse-S discounting. This paper studies inverse-S discounting behaviour. A formal connection between inverse-S discounting and inverse-S probability weighting is established. A tractable, yet flexible, model of inverse-S discounting is introduced. A preference foundation is provided, both in the context of timed outcomes and the context of consumption streams. The key axiom is a weakening of time consistency that allows both increasing and decreasing impatience.

# Pairwise Normalization

Ryan Webb and Peter Landry

## Abstract

We propose a theory of multi-attribute choice founded in the neuroscience of sensory perception. The theory explains a range of well-documented "context-dependent" choice phenomena using divisive normalization, a form of neural coding widely observed across many sensory modalities and species. We propose that the attributes of choice alternatives are normalized in a pairwise manner, drawing on experimental evidence of attribute-level comparisons between pairs of alternatives. Our resulting "pairwise normalization" model uniquely captures a broad range of observed context-dependent behaviours, including the dominance, compromise, and similarity effects, majority-rules intransitivity, and attribute comparability biases, while also providing a neurobiological basis for classic microeconomic preference representations.

**Decision Making under Risk in A Foreign Language – Replication Study and Cross-Country Comparison**

Anna Wielicka-Regulska, David Ascher and Jan Polowczyk

**Abstract**

People usually think that someone who uses a foreign language (FL) when making a decision should have the same results as he would use his native language (NL). People are convinced that they will make the same choices regardless of the language they are operating (Keysar et al, 2012), but a growing number of studies is showing opposite pattern. Damasio (1994) mentioned that an intuitive decision making is harder to activate in FL, so the use of FL can reduce cognitive biases in decision-making under risk (Caldwell-Harris, 2015). Research conducted by Keysar et al. (2012) described several well-known experiments to examine the Foreign Language Effect (FLe) in decision-making under risk. The scientific inquiry in this domain is important to multinational organizations and to people who make decisions under risk in a multilingual environment. This study investigated the effect of English as a foreign language on cognitive biases in decision-making under risk, adhering to the studies of Keysar, Hayakawa, and An (2012) and Costa et al. (2014) both originated from works of Kahnemann and Tversky (1979) and Tversky and Kahnemann (1981). The general research objective was to perform a comparative study to previous research on the effect of the foreign language in the development of cognitive biases in decision making under risk. Particularly the study was to evaluate the decision making patterns in framing, loss aversion, and mental accounting, in two conditions: in control groups that used the native language (Portuguese or Polish) and in experimental groups that operated in English but were formed of residents from Poland and Brazil. The additional inquiry was to observe differences between Brazilians and Poles in decision making in foreign languages. Finally, the study was to confirm or reject country's influence on decision making in FL. The study was based on controlled experiments and employed an interactive survey method. The experiments were run on Qualtrics platform. This research confirmed, at a certain level, the effect of the foreign language (FLe) on loss aversion under risk, and confirmed partially FLe on mental accounting, but it was not possible to confirm the FLe in the framing bias. In experiments, if there was a confirmation of the FLe, a decision-making pattern revealed two important aspects: (1) increased appetite for risk and (2) reduction of cognitive biases. It was not possible to verify the relationship between the country of origin and the change in decision-making pattern between monitored nations. This area still presents an interesting challenge taking into account the studies that report significant differences in decision-making in NL environment.

# Sequential Independence in Binary Choice Experiments: A Diagnosis

Nathaniel Wilcox

## Abstract

Many scholars conduct binary choice experiments involving a sequence of choice trials. Frequently these trials are analyzed by means of a structural maximum likelihood estimation of preference entities and, in the construction of likelihood functions, statistical independence of trials is a maintained assumption. Using new experimental data on binary choice under risk, I test this assumption. Surprisingly, I find that sequential independence of consecutive binary choice trials is not often rejected at the level of individual subjects.

# Top-Flop Betting: An Incentive Mechanism to Elicit Unverifiable Truths

Yan Xu and Aurélien Baillon

## Abstract

This paper introduces a simple mechanism to incentivize truth-telling even when the underlying truth is unverifiable. Most similar mechanisms in the literature rely on the existence of a common prior about the distribution of possible answers and on Bayesian arguments. In our mechanism, respondents to a question bet on the answers of others, relative to the answers given to other questions. For instance, people are asked to bet whether they think a given movie will get higher ratings than another, random movie. The bet reveals whether people themselves liked the movie. We call this method "top-flop betting" and show that it provides incentives to truthfully reveal private information, even in the presence of biases in the answers the bets are based on. Unlike existing methods, our method (i) relaxes assumptions on common prior; (ii) is robust to risk aversion and certainty effects, basically requiring first-order stochastic dominance only; (iii) leads to truth-telling as a dominant strategy (not needing a Nash equilibrium).

# Testing Hurwicz Expected Utility

Jingni Yang, Han Bleichrodt and Simon Grant

## Abstract

Gul and Pesendorfer (2015) propose a new theory of ambiguity, they dub Hurwicz expected utility (HEU). HEU is the first axiomatic theory that is consistent with most of the available empirical evidence on decision under uncertainty. We show that HEU is also tractable and a particular subclass can readily be estimated and tested. We do this by requiring the probability weighting functions in the HEU representation to come from a two-parameter family. We investigate two predictions of HEU. The first prediction is that ambiguity aversion is constant across different sources of ambiguity. We investigate this utilizing the data of Abdellaoui et al. (2011). We observe support for it in their most extensive data set, but not in the other data set. The second prediction is that ambiguity aversion and first-order risk aversion (Segal and Spivak 1990) are positively correlated. We tested this prediction in an experiment and indeed observed positive correlations. Although these correlations were only slight to fair, this might reasonably be expected given the heterogeneity in the perceived ambiguity by the individuals.

# Acceptable Losses: The Debatable Origins of Loss Aversion

Eldad Yechiam

**Abstract**

It is often claimed that negative events carry a larger weight than positive events. Loss aversion is the manifestation of this argument in monetary outcomes. In this review we examine early studies of the utility function of gains and losses, and in particular the original evidence for loss aversion reported by Kahneman and Tversky (1979). We suggest that loss aversion proponents have over-interpreted these findings. Specifically, early studies of utility functions have shown that while very large losses are overweighted, smaller losses are often not. Also, the findings of some of these studies have been systematically misrepresented to reflect loss aversion though they did not find it. These findings shed light both on the inability of modern studies to reproduce loss aversion as well as a second literature arguing strongly for it.

# A Useful Bias: the Role of Dominated Strategies in Coordination Games

Atiyeh Yeganloo

## Abstract

In games with multiple Nash equilibria, coordination failure can lead to off-equilibria and (Pareto) dominated outcomes. I use the dominance effect, a commonly observed bias in individual choices, to facilitate coordination among players in games. Dominance effect predicts that the addition of a dominated alternative increases the psychological attractiveness of the dominating alternative. Whereas, dominated alternatives are irrelevant under the rationality assumption. A dominated strategy in games can affect both players' strategy choices and facilitate coordination toward one of Nash equilibria of the games. Results from an experiment on the 2x2 Battle of Sexes games, with a dominated strategy for row players, is consistent with this prediction. Observed choices of row players differ depending on the presence of the dominated strategy. Column players anticipate row players' choices when the dominated strategy presents. Column players coordinate on their strategy choices to reach to the relevant equilibrium. Further, I study if the dominance effect carries over from risky choices to games. That is players biased by a dominated lottery in risky choices are more likely to show the bias in games. This bias is shown to be present in risky choices. There is no correlation at individual level between games and lotteries regarding the dominated alternative and its effect.

# The Optimal Amount of Attention to Capital Income Risk

Penghui Yin

## Abstract

This paper studies consumption-saving behavior of households who have CRRA preferences, face uninsured capital income risk, and suffer from an information-processing capacity constraint. For given attention devoted to capital income risk, we show that the expected savings demand is decreasing with capacity and expected welfare is increasing with capacity, assuming relative risk aversion degree larger than unity. Furthermore, we find that households with (i) lower cost of processing information, (ii) lower initial wealth endowment and (iii) higher prior volatility of capital return allocate more attention to capital income risk.

**Dynamic Consistency, Sample Selection and Attrition: Panel Experiment on Individual Discount Rates**

Hong Il Yoo, Glenn W Harrison and Morten I Lau

**Abstract**

Temporal stability in time preferences is a fundamental hypothesis that underlies the predictions of many economic models. We evaluate this hypothesis using data from a longitudinal field experiment in Denmark, with a representative sample of the adult population. Our experimental design allows us to identify a range of exponential and non-exponential discounting models, whilst controlling for the non-linear curvature of the utility function and the effects of sample selection and attrition. Detecting dynamic consistency or inconsistency in economic decisions requires the use of panel data, making the issue of endogenous selection and attrition inherently pertinent to the present analysis. We propose a structural econometric model that fully harnesses flexibility that our experimental design offers, in a framework that accounts for endogenous sampling and unobserved heterogeneity in preferences. The model captures within-individual correlation in preferences over study periods, and between risk and time domains. Our econometric strategy allows us to distinguish temporal stability in the population distribution of time preferences from within-individual correlation in time preferences. It also allows us to address a broad range of questions in a coherent manner, including whether risk averse individuals tend to me more patient; whether non-expected utility decision makers tend to be non-exponential discounters; and whether more patient individuals are more likely to participate in a field experiment.

# Attitudes towards Intertemporal Correlation

Xiao Yu and Kirsten Rohde

## Abstract

This paper studies preferences over intertemporal correlations. In an experiment, subjects are asked to report their present certainty equivalents of receiving a lottery twice, at two different points in time. These two lotteries are perfectly positively correlated, perfectly negatively correlated, or independent. Our results shed light on attitudes towards intertemporal correlations. We also test several models of decision making under risk and time. These models differ regarding their assumptions about separability of risk and time, and the order in which subjects aggregate over the risk and time dimensions.

# Modeling Attitudes towards Future Risks

Horst Zank and Mohammed Abdellaoui

## Abstract

We consider choices over streams of temporal prospects. The conventional model of discounted expected utility is relaxed in several ways in an attempt to account for descriptive features. First, we allow for general discounting functions to be able to accommodate empirical findings that are in conflict with constant/exponential discounting. Second, we allow preferences over risk to exhibit behavior that is revealed by the Allais examples of static choice, thus extending expected utility. This extra flexibility comes with the benefit of being able to deal with more recent experimental results that suggest increasing tolerance toward more distant risks. A further feature is, that we allow for a distinction between risky utility and riskless utility, which has the advantage of also separating risk attitude and time elasticity of substitution. Our general approach allows for specific models to be nested and this is demonstrated by the provision of a unified principle for preferences that is common to all our models. Applying this principle provides a natural separation of time discounting from attitudes towards outcomes. This way our models can be complemented to obtain specific discounting forms such as exponential or the popular quasi-hyperbolic family.

# When Knowing What Is Right Does Not Lead to Doing What Is Right

Sophie Van Der Zee, Robert Bouwman, Carlijn Broekman and Josine van de Ven

## Abstract

Many insights in human behaviour and behavioural change stem from questionnaires and controlled lab experiments. A relevant and timely example of behavioural change in organisations is the desire to train employees to become more cyber resilient. While the efficacy of these training programs is predominantly demonstrated in lab environments, it currently remains unclear whether these results extend to the real world. To address this question, we examined the predictive value of the Human Aspects of Information Security Questionnaire (HAIS-Q) on real world cyber secure behaviour. This scientifically developed and validated, state of the art questionnaire is used to measure cyber security knowledge, attitudes, and behaviour. In this field experiment, 133 participants from a large research institute completed the HAIS-Q questionnaire. A few weeks later, we tested whether their questionnaire results predicted real world behaviour. Specifically, we analysed their cyber resilience by sending a personalized phishing email to the participants' work email accounts, requesting them to change their passwords. We tracked who did and did not click on the provided link and connected this behavioural data to their HAIS-Q scores. Although previous research showed that people who score high on the HAIS-Q are more knowledgeable about cyber security and proved to be better at identifying mock phishing emails in the lab, we did not find such results in the field. In our study, knowing more about cyber security, did not actually safeguard people from falling for a phishing email. We demonstrated that "knowing what is right" does not necessarily lead to "doing what is right" when it comes to daily, real world behaviour. Especially in a security context, this discrepancy between knowledge and actual behaviour can be problematic and put people at risk. If this were an actual phishing email, participants could have lost access to their digital files due to ransomware, or lose large amounts of money when their online bank account was compromised. Importantly, this study also suggests that questionnaires developed to measure knowledge and awareness may not always be a good indicator of actual real world behaviour, and we should therefore be careful when using such instruments for risk assessments.

# A New Definition of Ambiguity Aversion

Jiankang Zhang

## Abstract

It is well known that the notion of attitude toward risk plays an important role in social science, in particular, in economics and finance. The notion has, at least, the following three desiderata: D1. Model free since it uses preference relation $\succcurlyeq$ only and nothing about particular utility function such as expected utility model; D2. Explicit and constructive since for any risky payoff x, agent $\succcurlyeq$ is risk averse at x if she prefers the expected value $E^{P}(x)$ with respect to the underlying probability P to the risk x itself; D3. Not involving attitude toward ambiguity since there is a probability measure P to represent her beliefs and her behavior is based on her beliefs. That is, she is probabilistically sophisticated, therefore there is no ambiguity here. Unfortunately, though the distinction between risk and ambiguity has been recognized by Frank Knight since 1921, "there is not unanimous agreement on what "ambiguity aversion", or even "ambiguity" itself", exactly is as Machina and Siniscalchi (2014) claimed in Handbook of the Economics of Risk and Uncertainty. Roughly, risk refers to situations where the likelihoods of relevant events could be represented by a probability measure, while ambiguity refers to situations where information available for the decision-maker is too insufficient to be represented by a probability measure. Ellsberg (1961) demonstrates that such a distinction is empirically meaningful. To define attitude toward ambiguity properly, similar to the notion of risk aversion, some obvious desiderata should be proposed at the outset. In this paper, we also propose three desiderata for the notion of ambiguity aversion as follows: D1. Model free: It should be not tied to any particular model such as Choquet expected utility model or Multiple prior expected utility model; D2. Explicit and constructive: For any ambiguous act f, it would be ideal if there exists another reference act or lottery such that agent $\succcurlyeq$ is ambiguity averse at f if she prefers the reference act or lottery to the ambiguous act of itself; D3. Not involving attitude toward risk (as much as possible): It also would be ideal if the reference act or lottery does not involve any attitude toward risk. For example, an ambiguity neutral agent should be indifferent between any ambiguous act and its reference act or lottery regardless of her attitude toward risk. Unfortunately, all the existing notions of attitude toward ambiguity are either not model free or involving risk attitude too much. To overcome those problems, this paper suggests a new notion of ambiguity aversion that tries to perform fairly well in terms of these criteria.

# Goal Setting in Tournament with Sabotage: Theory and Experimental Evidence

Le Zhang and Cheng-Tao Tang

## Abstract

This paper investigates the effects of goal setting in the tournament-like reward scheme where agents have two-dimension activities: productive effort and sabotage activities. Our theoretical model predicts that goal setting (within an appropriate range) in the tournament can play a positive role: both increase productive effort and decrease sabotage activities. Consistent with the theory, the results from our laboratory experiment confirm the positive effects of goal setting in the tournament. However, contrary to the theory, we find the effect of goal setting diminishes as the financial incentives increases. Financial incentives become dysfunctional when high goals are implemented. Overall, high goals increase performances more than high financial incentives.

# Temporal Stability of Risk Preferences: MSL Estimation of Cumulative Prospect Theory

Hongming Zhao, Morten Lau and Hong Il Yoo

## Abstract

Individual risk attitudes are typically assumed to be temporally stable in decision models, but only a handful of empirical studies have formally tested this assumption in the context of Cumulative Prospect Theory. We evaluate the hypothesis of temporal stability using data from an incentivized choice experiment and a structural econometric model that captures unobserved heterogeneity in all components of a general preference functional under CPT: namely, sign-dependent utility functions, sign-dependent probability weighting functions and loss aversion. A unique feature of our model is that it specifies each preference parameter as a subject- and session-specific random coefficient, and allows for an unrestricted pattern of correlations across the random coefficients, both between experimental sessions and between different components of CPT. This allows us to develop rich insight into temporal stability, by formally testing stability in the population joint distribution of preference parameters, as well as a within-subject autocorrelation of each preference parameter. Our results suggest that assuming away between-session and between-component correlations as in the existing literature could have substantive effects on conclusions that one draws regarding temporal stability.

# Willingness to Pay and Accept for Morbidity and Mortality Risks under Anticipated Regret

Jiakun Zheng

## Abstract

In this paper, we study the willingness to pay (WTP) and accept (WTA) for morbidity and mortality risks within a framework of anticipated regret (Bell 1982; Loomes and Sugden 1982). As results, we find that a regret averse decision maker (DM) has a higher WTP and WTA for morbidity risks than when he is regret neutral, but a lower WTP and WTA for mortality risks as the baseline risk is less than one half. These opposite results between the two types of risks are due to the asymmetry in state-dependent regret sensitivities. More specifically, a regret averse DM is sensitive to regret and rejoicing emotions only when he is still alive. We further discuss how differential regret intensities in case of having and not having a direct feedback over the forgone alternative affect a regret averse DM's WTP and WTA, and how the attribution effect in belief formation may bias our results.

# Putting Preference for Randomization to Work

Songfa Zhong

## Abstract

A sense of conflict is commonly experienced when people have the freedom to choose, ranging from the insignificant decisions such as daily dress choice to the important ones such as family planning. Such conflict often leads to the behavioral biases of indecisiveness, inertia, and procrastination. Here we examine the usage of coin flipping to help resolve the conflict in the setting of donation. In a randomized field experiment, we find that coin flipping increases donation when choice is under conflict due to choosing between two similar charities, but not when matching fund is provided to one of the two charities. A laboratory experiment replicates the observed patterns and further sheds light on the underlying psychological mechanism. More generally, our results point to the power of randomization for conflict resolution when facing difficult decisions.

# How to Choose among Multiple Mutually Exclusive Decisions: An Alternative Normative Decision Theory

Pengyu Zhu

## Abstract

Mutually exclusive decisions have been studied for decades. Many well-known decision theories have been defined to help people either to make rational decisions or to interpret people's behaviors, such as expected utility theory, regret theory, prospect theory, and so on. The paper argues that none of these decision theories are designed to provide practical, normative and simple approaches for multiple mutually exclusive decisions. Different decision-makers should naturally make different choices for the same decision question, as they have different understandings and feelings on the same possible outcomes. The author tries to capture the different understandings and feelings from different decision-makers, and model them into a normative decision-making process, which everyone could benefit from. The basic elements in classic expected utility theory are kept in the new decision theory, but the influences from mutually exclusive decisions will also be modeled into the evaluation process. This may sound like regret theory, but the new approach could be used in multiple mutually exclusive decisions, and it does not require a definition of probability weighting function. The new theory is designed to be simple and straightforward to use, and the results are expected to be rational for each decision-maker.

# Information Defaults in Repeated Public Good Provision

Daniel John Zizzo, Jia Liu and Axel Sonntag

## Abstract

We present an experiment on information defaults and information seeking in a repeated public good provision setting. In our experiment the default is one either with or without information about others' contributions, and having information comes with a positive, zero or negative financial incentive. When information comes without a financial incentive or even is financially beneficial, subject choose to have the information, but around a third have the information even when this is costly. Moreover, a default of not having information about the others' contributions leads to a slower unraveling of cooperation, independent of the financial incentives of having information. This slower unraveling is explained by the beliefs about others' contributions in these treatments. A secondary informational default effect appears to take place. When the default is no information, subjects do not seek information more often but, conditional on considering financial incentives, they tend to believe that more other subjects seek information.

# Does Exposure to Violence Affect Reciprocity? Experimental Evidence from the West Bank

Daniel John Zizzo, Elisa Cavatorta and Yousef Daoud

## Abstract

Violent conflict is often a dynamic situation where the onset of conflict depends crucially on the response to the first attack. If the tendency of a victim of violence is to respond to aggression with aggression, it is possible that conflict begets more conflict. On the other hand, exposure to violence may detract other people from engaging into violence. The extent to which people affected by violence reciprocate other people's actions is a matter of great interest for peace and conflict resolution, but underappreciated. This paper is concerned with how positive and negative reciprocity is affected by exposure to violence in early age. Using an experimental methodology and lab-in-the-field experiments, we study how conditional cooperation (positive reciprocity) and vindictive behavior (negative reciprocity) in adolescents vary as a result of exposure to violence. We focus on young Palestinians in the West Bank region of the Palestinian Territories. To elicit conditional cooperation, we implement a "public good game" eliciting unconditional and conditional contributions (Fischbacher et al. 2001). To elicit negative reciprocity, we implement a decision task in which retaliatory behavior can, but need not, occur. This is a simplified form of the vendetta game developed by Bolle et al. (2014). One challenge in the analysis of the effect of violence on these attitudes is that violence may be more likely to occur in places where people are less cooperative already. To solve this issue, we employ an IV strategy based on the location of Israeli settlements pre-dating the first episode of widespread violence against Palestinians (the First Intifada). This strategy allows us to create exogenous variation in the exposure to violence. Our main sample includes 1,000 students in 20 pairs of schools, one in each pair located in an area of high exposure to violence (treatment) and one in an area with low exposure to violence (control). Our preliminary analysis shows that, on average, there are significantly more attackers in the retaliation game in treatment areas than control areas. We have some initial evidence that in areas with high violence there is significant correlation between reciprocity in the public good game and "negative" reciprocity in the retaliation game. One of the mechanisms through which violence may impact the degree of reciprocity is through an effect on beliefs about what other people would do in general. To test the importance of this mechanism, we introduce an additional treatment: we elicited the subject's expectations about other participants' behavior before their decisions in the games. As expected, we observe that behavior is positively associated with the expectations on the same behavior by others. The initial results support the existence of this channel of impact.

**PG Experiments in Ukraine: Typical Pattern and Biased Behaviour under the Influence of Conflict**

Vitalina Zubova and Tamara Merkulova

**Abstract**

We present the outcomes of PG experiments conducted in Ukraine with the goals: to verify the findings concerning behavioural propensity for cooperation and free-rider behaviour using Ukrainian experiments outcomes; to study the impact of the conflict in the east of Ukraine on participants' behaviour. We have used the design of the game with three anonymous fixed participants in a group, with repeats and with/without paid punishment. Motivation of participants (students of Ukrainian universities) during the game was ensured by nonmonetary reward. In our experiments the participants got an exogenous endowment of 20 points. The points participants gained during the game were taken into account in their total assessment by certain academic subjects and therefore their gains influenced their ranking and possibilities to get allowance. That is why this reward can be considered as a kind of an implicit monetary incentive. We have carried out more than a dozen experiments (about 200 participants) in different universities of Ukraine. The most impressed result is the reproducibility of some outcomes, first of all, the average value of initial participants' contributions that is about 50% of the initial income with a very slight deviation. Conducting the experiments we expected to obtain some quantitative characteristics of what is called as "post-soviet mentality" and usually used as an explanatory factor, when there are no other arguments. Such quantitative assessments were mined and as it is turned out they are similar to foreign experiments outcomes. The latest experiment was devoted to studying how conflicts influence behavioural features and willingness of people to cooperate. We involved students who had been living in the armed conflict area in the east of Ukraine. These students have moved from Donbass (a conflict zone) to Kharkiv and entered the V.N. Karazin university. All of them have relatives in the region uncontrolled by Ukraine or in the so called "grey zone" (near to the conflict area). We expected that they would behave with caution, their willingness to cooperate would be poor and as the result their contributions would be smaller, then contributions of other students. The experimental outcomes show the following. The average value of initial contributions is about 50% in the groups of students from the conflict zone. This is the same as in other groups. However, the participants from this area react much more rapidly to selfish behaviour of their partners. This is an effect of the so called "broken efforts of kindness". The outcomes of this experiment can be considered as an argument in favour of the hypothesis that living in the conflict area does not have a significant impact on willingness to cooperate but reinforces reciprocal feature of human behaviour.