RISLαβ workshop JUNE 2023: "Cognitive Economics"

Dates: Workshop: June 14 and 15
RISLαβ discussions June 16
Location: Workshop: *Het Pand*, Priorzaal, Onderbergen 1, Ghent, Belgium
RISLαβ discussions: Faculty Council Room, 2nd floor Tweekerkenstraat 2, Ghent

Mobile Ferdinand (also Whatsapp): +32-456-185010

Programme:

Wednesday, June 14th	
9:00 – 9:30	Arrival and registration; coffee
9:30 – 11:00	Cary Frydman ***On the Source and Instability of Probability Weighting*** Ranoua Bouchouicha ***Choice lists and 'standard patterns' of risk-taking***
11:00 – 11:30	Coffee break
11:30 – 13:00	Christian Ruff ***Individual risk attitudes can arise from noise in neurocognitive magnitude representations*** Ferdinand Vieider ***Closing the GAP***
13:00 – 14:30	Lunch break
14:30 – 16:00	Rafael Polania ***Rational Sensing: from insects to rodents to humans to machines*** Jack Stecher ***Noisy wealth maximization in bargaining***
16:00 – 16:30	Coffee break
16:30 – 18:00	Salvatore Nunnari ***Coordination with Cognitive Noise*** Larbi Alaoui ***Coordination and Sophistication***
19:00 –	Dinner @ Brasserie Ha, Kouter 29, Ghent

Thursday, June 15th	
9:30 – 11:00	Thomas Graeber ***Complexity and Time*** Taisuke Imai ***Measuring Deviations from Theories of Choice Under Risk and Uncertainty***
11:00 – 11:30	Coffee break
11:30 – 13:00	Yoram Halevy ***Difficult Decisions*** Loïc Berger ***Ambiguousness of compound lotteries***
13:00 – 14:30	Lunch break
14:30 – 16:45	Paulo Natenzon ***Random Choice and Differentiation*** Carlos Alòs-Ferrer ***tbd*** Emmanuel Kemel ***Econometric Estimation of Prospect Theory for Natural Uncertainty***
19:00 –	Dinner @ Per Bacco, Sint-Jacobsnieuwsstraat 56, Ghent

Friday, June 16th (For RISL$\alpha\beta$ members only) Faculty council room; 2nd floor, Tweekerkenstraat 2, Ghent	
10:00 – 12:00	RISL$\alpha\beta$ discussions
12:00 – 13:00	Lunch break—end of meetings

Confirmed Speakers	
Carlos Alòs-Ferrer, University of Zurich	Paulo Natenzon, Washington University SL
Cary Frydman, USC	Rafael Polania, ETH Zurich
Christian Ruff, University of Zurich	Ranoua Bouchouicha, Ghent University
Emmanuel Kemel, CNRS & HEC Paris	Salvatore Nunnari, Bocconi University
Ferdinand Vieider, Ghent University	Taisuke Imai, LMU Munich
Jack Stecher, University of Alberta	Thomas Graeber, Harvard Business School
Larbi Alaoui, University Pompeu Fabra	Yoram Halevy, University of Toronto
Loïc Berger, CNRS & IÈSEG Lille	

Confirmed Attendees	
Alice Soldà	Levent Gumus
Cedric Gutierrez	Michele Garagnani
Christian Walter	Mohamed El Guide
Emmanuel Kemel	Mohammed Abdellaoui
Enrico Diecidue	Olivier L'Haridon
Hayat Zouiten	Thibault Richard
Helen Grapow	Uyanga Turmunkh
Ilke Aydogan	Yassine Kaouane
Jilong Wu	Yuchi Li

ABSTRACTS

Larbi Alaoui

Coordination and Sophistication

How coordination can be achieved in isolated, one-shot interactions without communication and in the absence of focal points is a long-standing question in game theory. We show that a cost-benefit approach to reasoning in strategic settings delivers sharp theoretical predictions that address this central question. In particular, our model predicts that, for a large class of individual reasoning processes, coordination in some canonical games is more likely to arise when players perceive heterogeneity in their cognitive abilities, rather than homogeneity. In addition, and perhaps contrary to common perception, it is not necessarily the case that being of higher cognitive sophistication is beneficial to the agent: in some coordination games, the opposite is true. We show that subjects' behavior in a laboratory experiment is consistent with the predictions of this model, and reject alternative coordination mechanisms. Overall, the empirical results strongly support our model.

Carlos Alòs-Ferrer

Loïc Berger

Ambiguousness of compound lotteries **(with Mohammed Abdellaoui and Ilke Aydogan)**

Representation of uncertainty in terms of compound (multi-stage) lotteries underlies some modern theories of ambiguity (Segal 1989). The correlation between ambiguous and compound lotteries has been documented in the literature (Halevy 2007, Chew et al. 2018). Yet there exists almost no direct empirical test of ambiguity attitudes towards compound lotteries. In this study, we measure ambiguity functions for compound lotteries that entail objective and subjective probabilities, by using the rigorous matching probability method of Dimmock et al. (2016). Our investigation sheds light on the preferences over compound lotteries in three important ways. We provide (1) measurements scanning the entire probability domain, examining events with small, medium and large likelihoods, (2) a comprehensive analysis of attitudes, including aversion and likelihood insensitivity, the latter of which is also interpreted as the perceived ambiguity in sources, and (3) a comparison of the preferences of a convenience sample of students with those a unique pool of risk professionals to understand the potential role of sophistication.

Ranoua Bouchouicha

Choice lists and 'standard patterns' of risk-taking **(with Jilong Wu and Ferdinand Vieider)**

The fourfold pattern of risk attitudes has been called 'the most distinctive impli- cation of prospect theory'. It constitutes the central mechanism by which prospect theory (PT) explains the coexistence of gambling and insurance. Here, we com- pare risk-taking patterns obtained from certainty equivalents (CEs) to risk-taking patterns observed when presenting all single choices contained in the CE lists one- by-one in a binary choice setup. Choices obtained from CEs indicate a clear fourfold pattern. Binary choices, on the other hand, indicate uniform risk aversion for gains, and uniform risk seeking for losses. The use of CEs to measure PT parameters is often justified based on the fact that they avoid endogenous reference points, which have been documented by comparing CEs to probability equivalents (PEs). We show that loss aversion in a PT model can actually not account for this discrep- ancy, since the gap between CEs and PEs requires different loss aversion coefficients for each PE task. Our results thus challenge the predictive ability of PT beyond the restrictive realm of CEs, which are arguably a poor proxy for most real-world decisions.

Cary Frydman

On the Source and Instability of Probability Weighting

We propose and experimentally test a new theory of probability distortions in risky choice. The theory is based on a core principle from neuroscience called efficient coding, which states that perception is more accurate for those stimuli that the agent expects to encounter more frequently. We show that when the agent holds a prior that attaches greater likelihood to extreme probabilities compared to intermediate probabilities, efficient coding generates the inverse S-shaped probability weighting function from prospect theory. More important, as the agent's prior varies, the model predicts that probability distortions change systematically. Across two experiments, we provide novel support for the efficient coding hypothesis. In the first experiment, we show that perception of probability is more precise for those values near the boundaries of 0 and 1. These data validate the key model assumption about the shape of the prior, which generates the steeper slope of the weighting function for low and high probabilities compared to intermediate probabilities. In the second experiment, we provide evidence that the shape of the weighting function can be modulated through changes in the prior. Our theory generates additional novel predictions regarding heterogeneity and time variation in probability distortions.

Thomas Graeber

Complexity and Time **(with Benjamin Enke and Ryan Oprea)**

We provide experimental evidence that core intertemporal choice anomalies – including extreme short-run impatience, structural estimates of present bias, hyperbolicity and transitivity violations – are driven by complexity rather than time or risk preferences. First, all anomalies also arise in structurally similar atemporal decision problems involving valuation of iteratively discounted (but immediately paid) rewards. These computational errors are strongly predictive of intertemporal decisions. Second, intertemporal choice anomalies are highly correlated with indices of complexity responses including cognitive uncertainty and choice inconsistency. We show that model misspecification resulting from ignoring behavioral responses to complexity severely inflates structural estimates of present bias.

Yoram Halevy

Difficult Decisions

We investigate the problem of identifying incomplete preferences in the domain of uncertainty by proposing an incentive-compatible mechanism that bounds the behavior that can be rationalized by very general classes of complete preferences. Hence, choices that do not abide by the bounds indicate that the decision maker cannot rank the alternatives. Data collected from an experiment that implements the proposed mechanism indicates that when choices cannot be rationalized by Subjective Expected Utility, they are usually incompatible with general models of complete preferences. Moreover, behavior that is indicative of incomplete preferences is empirically associated with deliberate randomization.

Taisuke Imai

Measuring Deviations from Theories of Choice Under Risk and Uncertainty **(with Federico Echenique and Kota Saito)**

Revealed preference methodology provides a powerful tool to analyze data from experimental studies of risk, time, or social preferences in which participants make a series of choices from budget sets. In this study, we apply a measure of deviations from expected utility theory introduced by Echenique et al. (2023) to data from a large-scale online experiment on decision making under risk and uncertainty. Unlike many existing experiments following Choi et al. (2007, 2014), which ask participants to allocate

a budget between two equiprobable Arrow securities, our design manipulates the objective probabilities and the degree of uncertainty both within and across subjects. We investigate the degree to which participants are consistent with utility maximization and expected utility, and explore the effects of decision environment.

Emmanuel Kemel

Econometric Estimation of Prospect Theory for Natural Uncertainty

Prospect Theory (PT) has been one of the most experimentally studied models for describing behavior under risk. This model also applies to natural sources of uncertainty where probabilities are unknown, the context that concerns the large majority of real-life decisions. Surprisingly however, the literature does not propose any elicitation of PT in such setting. The paper reports a laboratory experiment that allows to estimate all PT parameters in decisions involving a natural source of uncertainty: the participation rate in the 2019 European Parliament elections in the UK. This source is a genuine example of uncertainty inasmuch as it has no objective probability distribution, nor past frequencies related to similar (Brexit) context. We analyzed the data using structural econometric modeling that allows to estimate subjective probabilities, jointly with PT components. We also elicited PT parameters for risk, considered as a benchmark, in a within-subject fashion. The main features of PT apply under natural uncertainty: attitudes follow the fourfold pattern, and evidence for loss aversion is captured. Additionally, the estimated subjective probabilities give plausible results.

Paulo Natenzon

Random Choice and Differentiation (with Junnan He)

Measuring product differentiation and substitutability is a key concern in the analysis of consumer demand. We develop and analyze a general yet tractable model of random choice with product differentiation in a multi-attribute setting. We show the analyst can separately identify vertical and horizontal product differentiation from binary comparison data alone. We characterize the binary choice rules that arise from our model using four easily understood axioms. In multinomial choice, we show the intersection of our model with the classic random utility framework yields random coefficients with an elliptical distribution. We provide applications to consumer demand and choice under risk.

Salvatore Nunnari

Coordination with Cognitive Noise **(with Cary Frydman)**

We experimentally study how cognitive noise affects behavior in coordination games. When players face small computational errors in valuation, equilibrium play becomes more predictable owing to the disappearance of multiple equilibria. Our experimental data provide novel evidence for this prediction: the frequency of coordination depends systematically on (i) public information and (ii) the distribution from which public information is drawn. We estimate that cognitive noise constitutes roughly half of the observed noise in strategic behavior. The errors that we model are distinct from those in previous behavioral game theory models and give rise to novel predictions that our data support.

Rafael Polania

Rational Sensing: from insects to rodents to humans to machines

Is the role of our sensory systems to represent the physical world as accurately as possible? If so, are our preferences and actions—which are often labeled as irrational—decoupled from these “ground-

truth" sensory experiences? We argue that the answer to both questions is no. Perhaps counterintuitively, we propose that accurate representations of sensory signals do not necessarily maximize the organism's chances of survival. To test this hypothesis, we developed a unified normative framework for fitness-maximizing encoding by combining theoretical insights from neuroscience, computer science, and economics. Initially, we applied predictions of this model to neural responses from large monopolar cells (LMCs) in the blowfly retina. We found that neural codes that maximize reward expectation—and not accurate sensory representations—account for retinal LMC activity. Behavioral experiments in humans revealed that sensory encoding strategies are flexibly adapted to promote fitness maximization. Moreover, human fMRI data confirmed that novel behavioral goals that rely on object perception induce efficient stimulus representations in early sensory structures. Interestingly, this result was confirmed by deep neural networks with information capacity constraints trained to solve the same task in humans. Furthermore, experiments in which rodents were trained to solve the same task in humans revealed that mice also adaptively allocate their sensory resources in a way that maximizes reward consumption in novel stimulus-reward association environments. These experiments allowed us to discover that arousal systems carry reward distribution information of sensory signals and that distributional reinforcement learning mechanisms—a fundamental mechanism in state-of-the-art machine learning algorithms—regulate sensory precision via top-down normalization. These findings reveal how agents can efficiently perceive and adapt to environmental contexts within the constraints imposed by neurobiology. Thus, the often- observed irrationalities and biases attributed to downstream processing might unavoidably originate from the way early sensory systems should adapt to and process information in insects, rodents, humans, and machines.

Christian Ruff

Individual risk attitudes can arise from noise in neurocognitive magnitude representations

Humans are generally risk averse, preferring smaller certain over larger uncertain outcomes. Economic theories usually explain this by assuming concave utility functions. Here, we provide evidence that risk aversion may also arise from underestimation of monetary payoffs, a purely perceptual bias rooted in the noisy logarithmic coding of numerical magnitudes. We confirmed this with psychophysics and fMRI, by measuring behavioural and neural acuity of magnitude representations during a magnitude perception task and relating these measures to risk attitudes during separate risky financial decisions. Computational modelling suggested that participants based both choice types on similar mental magnitude representations, with correlated precision across perceptual and risky choices. Participants with more precise magnitude representations in parietal cortex showed less variable behaviour and less risk-aversion. In a second experiment, we show that even within-subject changes in risk attitudes across time and experimental treatments relate systematically to moment-to-moment fluctuations in the precision of model-captured mental and neural magnitude representations. Our results highlight that at least some individual characteristics of economic behaviour may reflect fluctuating capacity limitations in perceptual processing rather than processes that assign subjective values to monetary outcomes.

Jack Stecher

Noisy wealth maximization in bargaining

Experimental studies of bargaining situations, known as ultimatum games, consistently show that proposers of offers do not appear to exploit all of their bargaining power. Furthermore, even if a proposer does give away some surplus, the responder to the offer commonly rejects it, even though doing so leaves the responder with nothing. These findings appear to conflict with the joint assumptions of subgame perfection and individual wealth maximization. To give away more than necessary or to reject surplus is to leave something on the table. Prior work has suggested many possible directions for extending standard assumptions to better fit the data, such as social

preferences, experimenter demands, desires to honor property rights, and focal points. We argue, however, that the simplest explanation -- noisy wealth maximization -- fully explains the systematic patterns in ultimatum bargaining.

Ferdinand Vieider
Closing the GAP **(with Ryan Oprea)**
Different measurement paradigms of preferences have revealed a systematic GAP, whereby decision makers take less risk for small probability gains and large probability losses when they need to explore the choice options by sampling compared to when the options are fully described. Large probability gains and small probability losses produce an opposite GAP. Here, we propose an efficient coding model that can explain the GAP based on informational differences, and based on different opportunities to efficiently adapt coding noise to a given choice task. In particular, we depart from the literature by treating decisions from experience and decisions from description symmetrically—both are subject to uncertain belief distributions over outcomes. This insight suggests that restoring symmetry by allowing for efficient coding adaptation in both experience-based and description-based ought to close the GAP. A reduced form experiment shows that such adaptation does indeed take place not only when options need to be experienced, but also when options are fully described. This contrasts with standard approaches in economics, and showcases the role of coding noise in driving deviations from optimality in both experience- and description-based choice.