UNCERTAIN DECISIONS

Bridging Theory and Experiments

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Contents

List of Figures	xi
List of Tables	xiii
Contributors	xiv
Introduction	xix
Part I Non-expected Utility Theory	1
1	
Risk and Uncertainty Aversion with Reference to the Theories of Expected Utility, Rank Dependent Expected Utility, and Choquet Expected Utility	3
<i>Aldo Montesano</i>	
1.1 Introduction	3
1.2 Definitions of Risk Aversion, Comparative Risk Aversion, Aversion to Increasing Risk, and Comparative Aversion to Increasing Risk	5
1.3 Risk Aversion in the Case of the von Neumann-Morgenstern Expected Utility Theory (EUT)	7
1.4 Risk Aversion in the Case of the Rank Dependent Expected Utility Theory (RDEUT)	12
1.5 Definitions of Uncertainty Aversion, Comparative Uncertainty Aversion, Aversion to Increasing Uncertainty, and Comparative Aversion to Increasing Uncertainty	24
1.6 Uncertainty and Risk Aversion in the Case of the Savage Expected Utility Theory (EUT)	27
1.7 Uncertainty and Risk Aversion in the Case of the Choquet Expected Utility Theory (CEUT)	27
References	37

2		
	Dynamic Consistency and Non-Expected Utility	
	<i>Uzi Segal</i>	
2.1	Introduction	39
2.2	Definitions	41
2.3	Expected Utility as the Limit of Updated Preferences	42
2.4	The Reduction Axiom	47
2.5	Concluding Remarks	49
	References	51
3		
	Ambiguity-Aversion and Non-Additive Probability: Experimental Evidence, Models and Applications	53
	<i>Colin Camerer</i>	
3.1	Introduction	53
3.2	Subjective Expected Utility and the Ellsberg Paradox	54
3.3	Conceptions of Ambiguity as Missing Information	56
3.4	Experimental Tests	56
3.5	Formal Models of Ambiguity	60
3.6	Applications and Speculations	68
3.7	Conclusion	72
	References	75
	Part II Non-expected Utility Applications	81
4		
	Consumption, Savings and Asset Returns with Non-Expected Utility	83
	<i>Larry G. Epstein</i>	
4.1	Introduction	83
4.2	Intertemporal Utility	85
4.3	Risk	93
4.4	Knightian Uncertainty	100
	References	105
5		
	Estimating (Risk) Preference Functionals Using Experimental Methods	109
	<i>John D. Hey</i>	
5.1	Introduction	109
5.2	Experimental Methods	110
5.3	Estimatable Preference Functionals	114
5.4	Assumptions about the Data Generating Process	119
5.5	Estimation Procedures	121
5.6	Previous Results	122
5.7	Exploring the Adequacy	124
5.8	Conclusions	125
	References	127
6		
	Randomisation, Mixed Strategies and the Reduction Axiom	129
	<i>Michele Bernasconi</i>	
6.1	Introduction	129
6.2	Individual Decision Making with Non-linear Preferences	130

6.3	Mixed Strategies with Non-linear Preferences	135
6.4	A Concluding Discussion on the General Perceptual Problems when Reduction Fails	142
References		145
7		
	Experimental Studies of Signaling Games	147
	<i>Frans van Winden</i>	
7.1	Introduction	147
7.2	Game Theory and Experimental Issues	148
7.3	Equilibria and Refinements	151
7.4	Comparative Statics	157
7.5	Subjects Pool Effects	161
7.6	Adaptive Behavior and Learning	163
7.7	Concluding Discussion	165
References		171
8		
	Independence between Events with Non-additive Probability	175
	<i>Nicola Dimitri</i>	
8.1	Introduction	175
8.2	Definitions of Independence and their Implications	176
8.3	An Alternative Characterization of Independence	178
8.4	Discussion and Conclusions	180
References		181
Part III	New departures from classical decision theory	183
9		
	Fuzzy Decision Theory	185
	<i>Antoine Billot</i>	
9.1	Introduction	185
9.2	Basics	186
9.3	The Fuzzy Preference and its Properties	187
9.4	Fuzzy Utility Function on a Convex Set	190
9.5	Another Proof for Fuzzy Utility	194
9.6	Aggregation of Fuzzy Preferences	197
9.7	Arrovian Dictator and Fuzzy Preferences	198
9.8	Proof of the Dictator Theorem with Fuzzy Preferences	201
9.9	Fuzzy Coalitions and Democracy	201
9.10	Generalized Theorem: Arrow vs May	206
References		211
10		
	An Overview of Case-Based Decision Theory	215
	<i>Itzhak Gilboa and David Schmeidler</i>	
10.1	Introduction	215
10.2	Behavioral Theories and Cognitive Plausibility	216
10.3	Decision under Uncertainty	218
10.4	Epistemological Foundations	222
10.5	Repeated Choice	224
10.6	Aspiration Level Adjustment and Optimality	225
10.7	Planning	228
10.8	Consumer Theory	229
10.9	Process-dependent preferences	231

References	233
11	
The Recent Advances in Decision Theory under Uncertainty: a Non-Technical Introduction	237
<i>Alessandro Vercelli</i>	
11.1 Introduction	237
11.2 First-order and Second-order Measures of Uncertainty	238
11.3 A Taxonomy of Decision Theories	242
11.4 Decision Theories and Decision Criteria	247
11.5 The Scope of Hard Uncertainty Decision Theory	248
11.6 The Puzzle of Awareness	249
11.7 Time and rationality	251
11.8 Learning	252
11.9 Concluding Remarks	253
References	254
Part IV Value to Real World: the Experimental Contribution	261
12	
Decision Theory and Real Decisions: a Research Agenda	263
<i>Kenneth R. MacCrimmon</i>	
12.1 Introduction	263
12.2 Goals as the Primitive Value Concept	266
12.3 Specification of Constraints and Resources	269
12.4 Linking Beliefs back to Facts	271
12.5 Dealing with Ambiguous, Multiple-event Scenarios	273
12.6 Risk Modification as a Strategy	275
12.7 Formulating Decision Problems	276
12.8 Generating Alternatives	278
12.9 Bounded Rationality of Decision Makers	280
12.10 Personality, Emotion and Culture	283
12.11 Dynamics of Decisions: Learning, Adaptation and Evolution	284
12.12 Conclusions	285
References	287
13	
Policy and the Use of Laboratory Experimental Methodology in Economics	293
<i>Charles R. Plott</i>	
13.1 Introduction	293
13.2 The concept of an institution	294
13.3 The creation of simple laboratory auction processes	296
13.4 Some competing theories	299
13.5 Results and data	301
13.6 Philosophy and application of experimental methods: an overview	302
13.7 A map to the method: the fundamental equation	307
13.8 Reflections on the issues	308
References	317

14		
Buyer and Seller Effect Disentangled.		
An Experiment on the Microstructure of Demand		319
<i>Claudio Borelli, Alessandro Innocenti and Luigi Luini</i>		
14.1	Introduction	319
14.2	A microstructural approach	321
14.3	Laboratory procedures	322
14.4	Descriptive data analysis	324
14.5	Final remarks	331
References		339
Index		

List of Figures

2.1	Why updated preferences almost obey the independence axiom	45
2.2	The full form of the decision trees T^1 and T^2	48
5.1	Different display styles	126
6.1	Examples of single-stage and two-stage lotteries	132
6.2	Indifference curves in the Marshak-Machina triangle	133
6.3	A game with no Nash equilibrium when preferences are quasiconvex	136
6.4	Games in the Marshak-Machina triangle	139
6.5	The zero-sum game from player R's perspective	140
6.6	Two ways of perceiving the three bags problem	143
11.1	Standard Terminology	238
11.2	Suggested Terminology	243
11.3	Decision criteria	248
11.4	Uncertainty, Ignorance, Unawareness	250
13.1	EPA price discovery process	311
13.2	EPA auction: observed behavior	311
13.3a	Uniform price auction, periods 1-8	312
13.3b	Uniform price auction, periods 9-16	312
13.3c	Uniform price auction, periods 17-24	313
13.4a	EPA auction, periods 1-8	313
13.4b	EPA auction, periods 9-16	314
13.4c	EPA auction, periods 17-24	314
13.5	Fundamental equation	315
14.1	Parameters for Phase A	332
14.2	Parameters for Phase B	332
14.3	Parameters for Phase C	333
14.4	Phase A first period: plot of bids, asks and transactions prices	333
14.5	Phase A second period: plot of bids, asks and transactions prices	333
14.6	Phase B first period: plot of bids, asks and transactions prices	334

14.7	Phase B second period: plot of bids, asks and transactions prices	334
14.8	Phase C Market 1: plot of bids, asks and transactions prices	334
14.9	Phase C Market 2: plot of bids, asks and transactions prices	335
14.10	Phase B Plot of price change against lagged price change	335
14.11	Timing of transactions: average values	335
14.12	Timing of transactions	336
14.13	Phase A: ask-bid spread	336
14.14	Phase B: ask-bid spread	336
14.15	Phase C Market 1: ask-bid spread	337
14.16	Phase C Market 2: ask-bid spread	337

List of Tables

3.1	The three-color Ellsberg problem	55
3.2	Stylized empirical facts about ambiguity effects	57
3.3	The row player bets on column's rationality	71
7.1	Game 2 of BCP (1994): Sequential vs Nash	152
7.2	Game 3 of BCP(1994): Intuitive vs Sequential	152
7.3	Game 1 of BH (1993)	154
7.4	Game 2 of BH (1993): changed payoffs, same equilibria	154
8.1	Independence relations: duality	179
11.1	Theories of decision under uncertainty	246
12.1	Decision theory focus: Is vs Ought; real vs ideal	265
13.1	EPA auction: redemption values and costs	315
14.1	Summary of implications to be tested	321
14.2	Price distribution and transaction price changes	325
14.3	Transaction partners	326
14.4	Successive improvements on bids (asks) by the same seller (buyer) as percentage of all bids and asks	328
14.5	The effect of outrageous errors	330

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Introduction*

This volume contains fourteen papers from the International Summer School of Economic Research, held at the University of Siena, Italy, in July 1995. They examine the relationship between theory and experiments in economic decisions.

Decision theory is of central importance in economics and, arguably, to the whole of social science. It has undergone substantial changes in recent years, as conventional wisdom has broken down, yet many practicing economists are not well-informed about these changes. The economics profession largely relies on foundations which would be perceived as shaky, to say the least, by many specialist decision theorists. Moreover, as the old consensus has crumbled, decision theory has itself become more specialized and fragmented, so that it is now hard even for specialists to keep track of the whole of decision theory. In view of the many new directions, it is not surprising that there is a lack of agreement even among decision theorists on the most promising new avenues. As a result, decision theory has not yet sufficiently engaged decision-making.

In the last few years, experimental economists have reported results of individual choice that are in conflict with economic theory and in particular with expected utility theory (EUT): the famous Allais and Ellsberg paradoxes are perhaps the best known examples. Because EUT is the main paradigm for the "representative agent" in macroeconomic models, laboratory experiments with human subjects and animals¹ can provide common ground for discovering if the new avenues opened by experimental economics are a firm foundation for macroeconomic models and real decision-making.

The papers in this book are a tentative step in this direction.

* Many thanks to Claudio Borelli for organizing ISER 95 and for a first draft of this introduction, and to Alessandro Vercelli for supervision

¹ According to Kagel, Battalio and Green (1995) experiments with human volunteers do not adequately represent real economic conditions in which there are large differences in income or extremely low levels of income. For these cases (i.e. 'cycle of poverty' or 'welfare trap') and some other related arguments (Giffen goods, minimum wage) these authors proved the utility of experiments with animals.

The volume is divided into four parts. Part I is devoted to non-expected utility theories, Part II presents some applications of non-expected utility, Part III deals with new departures from classical decision theory Part IV contains experimental papers of value to real world.

Part I: Non-expected utility theory

These theories are related to individual behavior “which represent the preference preordering on the set of lotteries by means of the utility which is non linear in the probabilities of consequences” (Montesano, here, p. 3). They seek a distinction between risk aversion and aversion to increasing risk. These definitions are based on Ellsberg’s definition of aversion to uncertainty and on Schmeidler’s definition of aversion to increasing uncertainty, respectively.

Montesano provides a systematic set of definitions for von Neumann-Morgenstern Expected Utility Theory (EUT) (§ 1.3), Rank Dependent UT (RDUT) (§1.4), Savage Expected Utility Theory (§ 1.6) and Choquet UT (CUT) (§ 1.7). Different measures are distinguished for EU (propositions 15), RDEU (propositions 6-17), CEU (propositions 18-27).

Although non-expected utility theories have “initial” common ground, Montesano considers each theory and derives important corollaries for possible fields of application: corollary 14 for RDEUT, corollary 59 for CUT. Each theory is considered in isolation because of the difficulty of formulating a general unified statement for all theories: one of the most fascinating argument for future research will probably be the comparison of EU, RDEU and CEU to determine whether or not they have a “final” common field of application. This sort of comparison could be useful for redirecting the individual “representative agent” concept discussed above.

Segal explores dynamic consistency under expected utility theory (EUT) and non-expected utility theory (NEUT) focusing on the limit of preference updating. Consistency, to be intended as a reduction of compounded lottery, is satisfied if:

$$\text{for every } T, T \approx L(T) \quad (1)$$

for every set of preferences, where L is the set of lotteries and T the set of decision trees.

In EUT, intertemporal dynamic consistency works but it is no longer possible to distinguish between (intertemporal) preference change and (intertemporal) risk attitude change. The same result is not true for most NEUT, and Segal studies how and when the compound lotteries axiom is satisfied for NEUT. He presents a theorem (theorem 1, p. 46) according to which dynamic consistency and the compound lotteries axiom oblige the decision-maker’s preferences to converge in time to EUT.

As a conclusion Segal states that if general NEUT is to be maintained, we must renounce either dynamic consistency or the compound lotteries axiom: but in this case a Dutch book problem arises.

Camerer investigates ambiguity-aversion under non-additive probability, reviewing experimental evidence models and showing possible applications. Most ambiguity theories are inspired by the Ellsberg/Newcombe’s paradox, but none of them embodies the concept of ambiguity as missing information. Ambiguity is a

general term to dispute the SEU approach based on “the principle that the confidence one has in a probability judgement about a state should play no direct role in determining willingness to bet on that state” (Camerer, here, p. 53): this dispute is based on descriptive (mainly experimental) works. The author defines ambiguity-aversion as aversion to betting on ambiguous events and makes the conjecture that “attitudes toward ambiguity are roughly uncorrelated with the size of bet payoff” (fact 10, p. 58). Because “missing information” is an excessively too restrictive concept, a broader concept, for which the author suggests “competence-gap”, must be considered for economic decisions: empirical proof is provided by the fact that people prefer betting on events they know well (holding beliefs constant). This individual aspect is even more accentuated in social and organizational situations than in individual situations, because of (possible) imitation.

While presenting the formal models on ambiguity, Camerer explicitly reveals that his “favourite models are those which use non-additive probabilities” (p.65). The author presents a wealth of possible applications: 1) health economics, that are a “little discouraging, because they show less ambiguity-aversion, and less reliable measurement of ambiguity, than is observed or assumed in laboratory experiments” (p. 68); 2) financial markets, for which more careful studies are needed (the assets market is an important future field of experimentation) (see: Sunder, 1995, Duxbury, 1995); 3) entrepreneurship prize (in a Knightian sense) for which, at the present state of the art, no clear predictions can be derived; 4) the insurance market, particularly when underwriters have little experience.

The common element that can be obtained from ambiguity models is a genuine demand for ambiguity-reducing (or competence-increasing) information: the poor correlation between risk-attitude and ambiguity-aversion is a clear sign of the need for a second generation of theories which go beyond Ellberg’s paradox and incorporate something more than missing information and (in)competence.

According to Camerer, real advancement is possible if future studies are directed towards the importance of the learning/dis-learning process under incomplete or imperfect information².

Part II: Non-expected utility applications

Epstein suggests how to reformulate saving and asset returns for NEUT consumption, separating risk and Knightian uncertainty. He describes NEUT successes in intertemporal modeling of consumption-savings decisions and asset return determination, underlining the dual role played by the felicity function u in the general function $U(c)$

$$U(c) = E[\varepsilon_0^T \beta \mu(c_t)] \quad (2)$$

as a determinant of the degree of risk aversion and the agent’s willingness to substitute across time.

The standard model of intertemporal utility (e.g.: Additive EUT (AEUT)) (see eq. (2.1) p.85) is very inflexible because risk aversion and willingness to substitute across time are dually represented in the felicity function $u(\cdot)$. In this model, only

² There is a clear relation between Camerer individual ambiguity and the Heiner (1988) and Heath Tversky (1991) competence-difficulty problem.

the pairs: a) high risk aversion, low substitution; b) low risk aversion, high substitution; can be derived. This function cannot model variations in consumption across time and across states. An intertemporal change in the concavity of the utility function has an ambiguous interpretation because of the impossibility of distinguishing risk aversion change from willingness to substitute across time in cases not included under a) and b).

Epstein defines the common ground of NEUT as any deviation from:

$$U(c) = Eu(c_0, \dots, c_t, \dots) \quad (3)$$

a review of NEU that “has made a difference in the area of intertemporal modeling of consumption-savings decisions and asset return determination” (here, p. 83).

The model favoured by the author is Recursive Utility (RU), that can be defined as a minimal generalization of AEU “upon which all applications in the paper are based” (here, p.87). RU is appealing because of the possibility of extending intertemporal NEUT formulated and analyzed for a one-shot (static) setting to an infinite horizon. In this framework, the relevant intertemporal choice data involves choices by a single agent from several opportunity sets. RU is dynamically consistent (without requiring dependence on unrealized alternatives, that is, without consequentialism) and permits comparative risk (or uncertainty) aversion analysis conducted in (partial) separation from intertemporal substitution.

A fascinating example of application is presented by Epstein for financial market analysis. In the C-CAPM covariance, the discount factor (or intertemporal marginal rate of substitution $IMRS_{(t,t+1)}$), determines the systematic risk of an asset. In this case the expectation ($t, t+1$) is computed with respect to a conditional probability measure that conditionally defines null events: under this condition consumption always has a positive rate of growth. In the market-portfolio-based CAPM, the covariance is based on the return of the market portfolio; and Roll’s critique (wealth is not observable, which is the same as trading all the assets contributing to consumption) of the market-portfolio-based CAPM.³

Recursive utility with certainty equivalent is usually known as Kreps-Porteus Utility: but that is not completely true, because in REU separation is valid for some, though not all, consumption gambles: both theory and experiments have shown its limits. The independence axiom is only satisfied in the domain of timeless wealth lotteries, but this domain is precisely the source of experimental violations of the independence axiom.

In discussing Implicit EU, sometimes referred to as “betweenness utility”, Epstein presents “timeless wealth gambles” in which a lottery in current wealth is resolved before any consumption/savings decision: under this condition any decision becomes independent of current wealth and future asset returns. Of the many possible specifications, the author chooses the single-parameter extension of Gul (1991): “disappointment aversion” occurs when the return is smaller than the certainty equivalent and therefore “worse than expected”. Epstein emphasizes the necessity to study connections between: a) the patterns of behaviour and preference in the probability simplex as revealed by experiments; b) the properties of risk preferences suggested by market data on consumption and assets return.

³ See: Restoy and Weil, "Approximate Equilibrium Asset Prices" mimeo, 1994.

Epstein then turns to the analysis of habit formation (Campbell and Cochrane, 1994), as expressed by Weil's (1990) certainty equivalent of the exponential form combined with a CES aggregator, presenting an important result for the determinants of precautionary saving, under non-diversifiable labour income uncertainty.

After introducing the problem of the functional form of the certainty equivalent, Epstein examines the restrictions on risk preferences that can be expressed (experimentally) in terms of Knightian uncertainty (when probabilities are not available to guide choices). Reconsidering Recursive Utility (REUT) with multiple-priors (instead of a single prior), he demonstrates volatility in asset prices that leaves room for "sunspot" and/or "animal spirit" interpretations. These cases occur: a) when the predicted degree of indeterminacy varies across assets; b) when there is discontinuity and a small change in fundamentals may be associated with abrupt changes in the security price (e.g. booms and crashes).

Hey describes experiments with risk preference functionals, raising the problem of error evaluation in estimation procedures. The main question is how to interpret individual mistakes in experiments on decision-making. In particular, given a relation between incentive mechanisms and indifference revelation, the author emphasizes the importance of different procedures. If the attention is focused on preference ranking, "one cannot infer anything about the strength of preference" (here, p.113). Another procedure is indifference revelation via a certainty equivalent, using a Becker-DeGroot-Marschak (BDM) mechanism: if revelation is intended in terms of forms of expression, they "may give rise to different expressions of preference" (here, p.114).

Hey quotes Smith and Walker (1993), who make the general statement that "the magnitude of such mistakes is inversely proportional to the magnitudes of the payments on offer" (here, p.120), and Harless and Camerer (1994), who assume that "the probability of making mistake is the same." Because preference revelation may be connected to individual mistakes during the process of revelation, Hey, introduces the following different statement: "the probability of making a mistake declines as the magnitude of $V(C) - V(D)$ increases" (here, p.121) where C is truly preferred to D . The mistake estimation method used by the author is that of maximum likelihood, which has the difficulty of pairwise choice.⁴

Bernasconi focuses on the different interpretations of "randomization" for NEUT. These different interpretations (which depend on acceptance or rejection of Reduction of Compound Lotteries Axiom), are such that a local approximation of betweenness is attained if the validity of reduction axiom is assumed.

Introducing a game in which two-stage action with mixed strategies is assumed, the author obtains a "reduced betweenness" property that is weaker than "reduced independence": for the former only linear properties (but not parallelism properties) of the utility function are satisfied.

Several experiments have proved that individuals do not obey betweenness: a way of representing this state of affairs is Rank Dependent Utility Theory (RDUT) for which a class of mixtures of symmetric utility functionals can vary from strictly

⁴ Balliger & Wilcox (1997) identify a variety of restrictions for "choice errors" by subjects in the laboratory. They "encourage the development and testing of alternative stochastic restrictions" (p.1104).

quasi-concave preferences to strictly quasi-convex preferences (and viceversa). This variability depends on the decision maker's moving choice in the direction of stochastic dominance; if the reduction axiom is satisfied, compound independence is the same as reduced independence.

Laboratory experiments by Kahneman & Tversky (1984) proved that subjects obey compound independence but violate reduced independence (and the same for betweenness): moreover if the Certainty Equivalent Mechanism (CEM) is valid, subjects always satisfy compound betweenness but do not satisfy reduced betweenness.

With regard to individual decision-making with mixed strategies when preferences are non-linear, the author emphasizes the importance of general perceptual problems when reduction fails. In the case of non-validity of the reduction axiom, the importance of perception is noteworthy because of the implications of non-linear preferences on game theory.

For a two-player game, the author emphasizes that if the reduction axiom is accepted in order to define an "equilibrium in beliefs" in games without Nash equilibrium (Crawford 1990), a player with quasi-concave preferences succeeds in optimal randomization. On the other hand, if the reduction axiom is rejected (Dekel, Safra & Segal, 1991) in a non-sequential zero-sum game, a hypothesis on the players' perception of compound lotteries must be introduced (every player is assumed to play as a first mover in a sequential game). The centrality of perception becomes evident in relation to the opponent's supposed behaviour: whether or not the opponent randomizes in the one-shot game, modifies the results and may influence the decision related to randomization.

Bernasconi concludes that if reduction fails, more than agents' preference and agents' choice of reduction mechanism is required: the question of how decision makers perceive a choice becomes extremely important and the Certainty Equivalent Mechanism (CEM) is no longer sufficient to leave out the role of perception in a normative approach.

Part III: New departures from classical decision theory

The importance of studying the relation between individual decision and interactive decision were introduced in previous papers (especially by Camerer and Bernasconi): most of the new departure from classical decision theory presented in this section, is related to the process of interaction between two (or more) decision makers.

Van Winden reports some experimental results in sender-receiver sequential equilibrium games (Kreps & Wilson, 1982) and discusses the ambiguity reduction criteria used in the laboratory by the subjects. The role of information - in the case of a sender, who send a signal (with some private information), and a receiver, who after observing the signal chooses an action - and the presence (or otherwise) of a conflictual situation are the two variables investigated by the author.

After reviewing previous experiments to establish the extent to which game theory is helpful in predicting and explaining the behaviour of senders and receivers in a laboratory environment, and after discussing the relevance of subject pool effects and adaptive behaviour and learning, the author summarizes his main findings. In the absence of conflict of interests, signaling enables coordination even if there are no conceivable focal points for subjects to rely on: in general trembling hands equilibria are a sufficient condition for coordination. In the case of partial conflict of interests,

the theoretical predictions of game theory are realized experimentally only under conditions of costly messages which have an impact on the behaviour of receivers. In the case of strong conflict of interests with multiple Nash equilibria solutions, neither equilibrium selection theory nor equilibrium refinements can be reproduced in the laboratory, and if they are, this may be for the “wrong reasons”, that is, not implied by game theory.

Van Winden concludes the paper asking for a new generation of experiments with more attention to “stylized facts” in order to investigate how different environments and institutions can be helpful in determining the conditions under which specific game theoretical models and learning models can be predictors of behaviour.

Dimitri studies the independence between events, and their implications under non-additive probability, presenting an alternative characterization of independence. He provides an extension of Gilboa & Schmeidler (1993), who axiomatized some aspects of Bayes and Dempster-Shafer updating rules, such as conditional probability.

Because commutativity is a more robust property than additivity, the author focuses on non-additive probability. While additive probability updating via Bayes’ rule simultaneously satisfies the properties of complementarity and symmetry, the independence relation is not satisfied under non-additive probabilities. In such a context a pairwise independence relation between events is observed (A is independent of B , but A^c is not independent of B^c).

An alternative characterization of independence is provided by Dimitri in terms of product factorization of beliefs and plausibility functions for joint events. The author suggests that the definition of stochastic independence should depend on the uncertainty attitude of the agent.

Billot introduces Fuzzy Decision Theory (FDT), distinguishing two schools of thought, one according to which fuzzy preferences are based on additive measures of satisfaction, which exclude any possibility of intra/interpersonal comparison of preferences because the axiom of Independence of Irrelevant Alternatives (IIA) is not satisfied, and a second, based on purely ordinal preferences, that satisfy IIA and permit intra/interpersonal comparison of preferences.

After extending Ponsard’s (1987) result on fuzzy utility for a countable set of objects, to a convex set of objects by giving conditions under which a fuzzy (complete) preorder can be represented by a numerical function, Billot considers the problem of aggregation when agents’ preferences are fuzzy (in an ordinal and non-cardinal way), emphasizing the main role of certain agents, called leximin (the least satisfied agent) and leximax (the most satisfied agent) in the fuzzy process of aggregation of preferences.

He links fuzzy preferences with collective choice, assuming ordinal utility: the requirement of the planner (who solves and decides) depends on the nature of preorders of preference. Arrow’s theorem determines the minimal group of axioms under which the only feasible collective choice rule corresponds to the identity between the collective relation of preference and any individual preorder. May’s theorem determines the minimum group of axioms under which the majority (quantitative comparison of individual choice) is a feasible collective choice rule. Billot links these approaches in a single approach, in which they are extreme cases.

After explaining the role of coalitions in May's electoral model, and how different agents can be compared ordinally in terms of membership of the same coalition, Billot explains how, the leximin and leximax principles can be used to show that the planner's action consists in excluding agents whose membership is ordinally compared to a given exogenous step (weak membership means weak involvement in choice). In this sense, according to Billot, Arrow's and May's approaches can be regarded as limit-cases of his more general approach.

Gilboa and Schmeidler present their Humean (empirical) approach to case-based problems: if people tend to choose acts which performed well in a similar case in the past, Case-Based Decision Theory (CBDT) can be used for decision problems in which the states of the world are neither naturally given, nor easily constructed. Each case can be viewed as depending on the decision problem, the act chosen and the result obtained. At any given time, the decision-maker has a memory of a finite subset of cases. The authors postulate a similarity function on which a present case is compared to past cases. This function can be evaluated in terms of the similarity-weighted sum of the utility yielded in the past $U(.)$ or in terms of similarity-based average utility $V(.)$.

EUT requires that an agent imagine the outcome of each act at each state of the world. CBDT requires no hypothetical reasoning because the agent merely has to judge the desirability of the outcomes previously obtained.

If process-dependent preferences and repeated choice are considered in relation to adjustment of aspiration level by the subjects, both production planning and consumer theory are compatible with this "new" decision theory.

Vercelli gives an original presentation of recent advances in decision theory based on the separation between soft uncertainty (Ponsard 1986) and hard uncertainty, defining the latter as a non-additive probability distribution or a plurality of (possibly additive) probability distributions. He maintains that objective and subjective EUT (representable by a unique, fully reliable, additive probability distribution function) can only be applied to a "familiar world", that is unlikely to be exhaustive. For the "unfamiliar world" of hard uncertainty, he suggests a distinction between theories based on non-additive priors and theories based upon multiple-priors. The approach favoured by the author is CEUT.

Faced with the puzzle of awareness of structural ignorance, Vercelli maintains that awareness encompasses the case of certainty and uncertainty and offers a solution for the case in which time and learning (which imply a complex process) are introduced as the key variable.

Part IV Value to real world: the experimental contribution

MacCrimmon compares the elegant core of individual decision theory to real decisions, which deal with ambiguous, multiple-event scenarios. With ten examples, he shows how an interdisciplinary approach can be used for a radical reorientation of current research. In considering both the "is" and the "ought" aspects of decision theory, and the "real" and "idealized" decision-maker, MacCrimmon reports success in the application to behavioral and social science models and a lack of success in applications to real decisions.

Theory focuses on preference function as the value primitive and beliefs are based on well specified states of events but constraints and resources are not well defined,

whereas real decisions are driven by goals and motives and are sensitive to external constraints, and beliefs are based on facts.

MacCrimmon describes the opposition between reality and theory. Although facts are actually in search of a theory, this theory must be focused more on the objects of decision than on the deciding subjects. Moreover, because multiple events/goals are so common in real decision-making, they must be introduced into the theory. As a final point, the author suggests reorienting research towards a new generation of theoretical models that consider cognitive processes in relation to information.

Plott starts with an experimental design to solve the actual policy problem of regulating air pollution, and discusses the conditions for a broader application of experimental methodology in economics. He explains the relations between simple cases (that be created in a laboratory) and complex cases (such as those that involve policy). Plott uses the simple case of an auction process designed and implemented by the Environmental Protection Agency (EPA) for the sale of the right to emit sulphur dioxide, to discuss how theory can be based on experience acquired and used in policy decisions.

The EPA auction can be considered at the same time a choice of a process and a choice of an institution, in this way different "price discovery" processes can be converted into comparative institutional analysis. After recalling the importance of controlled preferences in a simple setting like a laboratory, Plott emphasizes the importance of distinguishing between theories that work quite well in these simple settings, and theories that work badly even in simple settings.

Plott reviews two experiments, the first using the EPA auction and the second using the uniform price auction, comparing their competing performance. In a uniform price auction, buyers tend to reveal their limit values and sellers reveal their costs: bids and asks have no influence at all in the price that is determined. The EPA auction provides a strong incentive to bid something other than their true value: buyers pay what they bid, so if they are to make profits they must bid below value (under-revelation). Similarly, sellers have an incentive to ask less than their cost. The experimental result is a striking difference between the uniform price auction and the EPA auction: prices are higher and efficiencies are higher in the former. This clearly shows that the hypothesis that the form of the auction has no influence is wrong and that the issue of the form of auction must be studied. In fact, the EPA auction does not meet the (institutional) goal for which it was designed and its performance is inferior to that of the uniform price auction. As a final reflection, Plott emphasizes the importance of experiments for institutional design problems.

Borelli, Innocenti and Luini present a market microstructure experiment on buyer and seller behaviour, where these two agents are distinguished in terms of starting prices and initial budgets. In a three-phase experiment with only one market open in the first two phases and two markets open simultaneously in the third phase, the average price was nearer to buyer price than to seller price in phases A and B. During these phases two different processes of learning seemed to be acting: learning the whole experimental design (in phase B transaction prices approach equilibrium prices faster than in phase A), and learning the correct value of buyer price in any single phase. In phase C transaction were not uniformly distributed between the two markets (subjects tended to specialize in one of the two), but in both markets the deadline effect showed that prices converged towards a competitive price. Borelli et

al. demonstrate that buyer behaviour is more influential than seller behaviour in the price formation process.

* * *

Today, decision theory is usually presented as an equivalent for economic rationality. Unfortunately, even at first sight, the relation between the old (instantaneous) utility theory on which many standard economic propositions have been built, and expected (intertemporal) utility theory (EUT) is not simple. Not all the propositions and models belonging to the old theory can be converted at zero price to EUT. (Menger, 1979). As quoted by Plott (1994) "the word rational has no single meaning in economics". Economics is full of assumptions of irrationality, e.g.: 1) agents assumed to be price takers in the competitive model, 2) the reaction function in the Cournot model, 3) the monopolist, or any imperfect competitor, who never works through the income effect in the general equilibrium framework, are but a few clear examples of irrational behavior.

EUT demands that agent have a huge amount of knowledge and information. This may be why the role played by approximate reasoning and bounded rationality emerged in decision theory (and NEUT is a tentative answer in this direction) and in decision theorists interested in real decision making. From a terminological point of view, limited knowledge and information are better terms because they enable distinction between different situations usually labeled as "bounded rationality".

Experimental economists progressively became aware of this fact: Selten (1997) suggests the separation of the decision processes based on the different complexities of decision rules into casuistic processes and unified processes. A casuistic process is "a system of case distinctions based on simple criteria determines which simple decision rules are employed". "The system of case distinctions may be simple or quite complex. However the application of such strategies always remains simple". This process appeals from the point of view of a restricted concept of bounded rationality: an example given in this volume is Case-Based Decision Theory (CBDT) by Gilboa & Schmeidler. A unified process is based on "a complex formula, which computes the decision as a function of past observation uniformly for all situations, which may arise". This approach is appealing from the point of view of a different and broader concept of "bounded rationality" and the possibility of revisions (local adjustments) to past experience. The whole body of NEUT and ambiguity models based on non-additive probability presented in this volume are examples of this approach.

Selten (1978) presents another case of bounded rationality, in which individuals have limited control over behavior; he calls it: decision emergence view. Selten proposes a three-level theory of decision making: 1) the routine level, based on a quick decision which does not leave any time for conscious deliberation; 2) the level of imagination, where the decision maker tries to visualize how initial actions may influence future events; 3) the level of reasoning, where the model is completely analyzed. Since a pre-decision can be based on 1), on 1) and 2), and on 1) ,2) and 3),

according to Selten more must be done to understand our incomplete understanding of the motivational limits of rationality.⁵

Moreover, in the case of complexity there are severe limits for a single objective function (like EUT and NEUT). If multi-objective optimization is used instead of a single objective function, however the multi-objective approach can be easily criticized for non-compliance with the Pareto (efficiency) optimality principle (see in particular Goal Programming methodology literature). An interesting approach, starting from the reference point modeled in the Goal Programming method, comply with the efficiency principle only if some traditional assumptions are relaxed (Ogryczak, 1994). In this case it is possible to tackle the difference between the goal programme satisfying approach, that does not meet the efficiency Pareto criterion and the quasi-satisfying approach redefined in terms of the reference point⁶ (Wierzbicki, 1982) that does comply with the Pareto efficiency criterion.

The papers in this volume are only a tentative step to bridging decision theory, experimental economics and real decision making.

LUIGI LUINI

⁵ For the argument under investigation finite automata research agenda is promising for its philosophical (abstract) insight, whereas actual individual research (e.g. experimental economics) can be a descriptive theory, a test of the theory and, in some cases, a theory generating approach.

⁶ In this approach, the so-called “scalarizing achievement function” is introduced: in the case of (sub) optimization, this function generates efficient decisions related to the specified reference levels.

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