



Allievi Program, Master in Economics, and Ph.D. in Economics

# ADVANCED DECISION THEORY

## Spring 2022

Instructor: Paolo Ghirardato

### Contact Information

Collegio Carlo Alberto

First Floor, Office #109

[paolo.ghirardato@carloalberto.org](mailto:paolo.ghirardato@carloalberto.org)

<http://sites.carloalberto.org/ghirardato>

Office Hours: Drop by, or send me an email and we set up an appointment

### Introduction

This is an advanced course in decision theory, focusing specifically on models of ambiguity and their consequences for economic behavior. Knowledge of basic decision models, at the level of Chapters 1-9 of David Kreps's *Notes on the Theory of Choice* (Westview Press, 1988), as for instance in my Master's course "Decisions and Uncertainty," is taken for granted. The course will devote all of the time to *one* of the many areas of great development in decision theory in the last two decades, which is the models of ambiguity-sensitive preferences, as well as some of the implications of such preferences for Economics and Finance.

The plan is that I will teach (for about 18-20 hours) Part I of the course, presenting the earlier contributions as well as the more recent modelling efforts. In Part II, each student will do one class presentation of one (or a set of) paper(s) on the applications (particularly masochistic students are also allowed to present additional theoretical papers, if they so wish). Students will be graded based on their presentation, as well as on their class participation in lectures and, more importantly, in the fellow students' presentations.

I have collected all the papers that are mentioned and used during the course in a Drop-box directory. Please contact me to receive a link. The papers indicated in parentheses below are *not* required reading; rather, they are suggestions for further reading. (I may mention them in class, but only briefly.)

As to Part II, what we will cover there will be mostly dictated by the students' interest, as it will be based on student presentations. The list given for that part is a collection of possible topics and papers for student presentations. Please contact me to arrange yours.

## Prerequisites

This class builds on prior exposure to mathematical reasoning and to the fundamental models used in Decision Theory. As a guide, traditional mathematics sequences in multivariable calculus and some real analysis should suffice (but some exposure to Measure Theory and Functional Analysis is also helpful). An understanding of Decision Theory at the level of an introductory course (such as the Decision and Uncertainty course that I teach for the Master's in Quantitative Finance and Insurance) is, instead, a necessary background.

## Detailed Syllabus

### Part I: Theory

1. Ellsberg's "paradoxes" and the empirical evidence. Here we "define" ambiguity attitudes (starting from Ellsberg's classical paper), and discuss its normative and descriptive relevance. (I try to convince you that it is normatively relevant.)

#### Reading:

- D. Ellsberg, "Risk, ambiguity and the Savage axioms," *QJE*, 1961. (JSTOR)
  - C. Camerer and M. Weber, "Recent developments in modeling preferences: Uncertainty and ambiguity," *J. Risk and Uncertainty*, 1992.
  - C. Fox and A. Tversky, "Ambiguity aversion and comparative ignorance," *QJE*, 1995. (JSTOR)
2. Two basic preference models with ambiguity. The Choquet expected utility (CEU) model and the maxmin expected utility with multiple priors (MEU) model are introduced. Their intersection: convex capacities and their cores. A special case of CEU: The rank-dependent EU model.

#### Reading:

- I. Gilboa and M. Marinacci, "Ambiguity and the Bayesian Paradigm," ICER WP n. 379, April 2011.

- D. Schmeidler, "Subjective probability and expected utility without additivity," *Econometrica*, 1989.
  - D. Schmeidler and I. Gilboa, "Maxmin expected utility with non-unique prior," *Journal of Mathematical Economics*, 1989.
3. A more general preference approach. We start by looking at Bewley's model, and show how it can provide the background to unify all the theories seen so far, to obtain invariant biseparable preferences (and the  $\alpha$ -MEU model).

**Reading:**

- T. Bewley, "Knightian decision theory: Part I," *Decisions in Economics and Finance*, 2002.
  - PG, F. Maccheroni and M. Marinacci, "Differentiating ambiguity and ambiguity attitude," *JET*, 118(2), 2004.
4. Some recent popular models. We look at some more recent models, which violate the Certainty Independence axiom. The "smooth ambiguity" model of Klibanoff-Marinacci-Mukerji and the "Variational Preferences" model of Maccheroni-Marinacci-Rustichini.

**Reading:**

- I. Gilboa and M. Marinacci, "Ambiguity and the Bayesian Paradigm," ICER WP n. 379, April 2011.
  - P. Klibanoff, M. Marinacci and S. Mukerji, "A smooth model of decision making under ambiguity," *Econometrica*, 2005.
  - F. Maccheroni, M. Marinacci and A. Rustichini, "Ambiguity aversion, robustness, and the variational representation of preferences," *Econometrica*, 2006.
5. Dynamic extensions. Updating rules. The dynamic inconsistency "problem." Recursive Multiple Priors and other approaches.

**Reading:**

- I. Gilboa and D. Schmeidler, "Updating ambiguous beliefs," *JET*, 1993.
- (L. Epstein and M. Le Breton, "Dynamically consistent beliefs must be Bayesian," *JET*, 1993.)
- P. Ghirardato, F. Maccheroni and M. Marinacci, "Revealed ambiguity and its consequences: Updating," in *Advances in Decision Making under Risk and Uncertainty. Selected Papers from the FUR 2006 conference* (M. Abdellaoui and J. Hey, Eds.), Berlin: Springer-Verlag, 2008.

- L. Epstein and M. Schneider, "Recursive Multiple Priors," *JET*, 113(1), 2003.

## Part II: Applications

1. Games with ambiguity averse players. Equilibrium in beliefs. Definitions of equilibrium in games with ambiguity averse players, in both the CEU and MEU world. The support problem.

### Reading:

- J. Dow and S. Werlang, "Nash equilibrium under Knightian uncertainty: Breaking down backward induction," *JET*, 1994.
  - P. Klibanoff, "Uncertainty, decision and normal form games," mimeo, 1996.
  - M. Marinacci, "Ambiguous games," *Games and Ec. Behavior*, 31(2), 2000.
  - M. Ryan, "What do uncertainty averse decision makers believe?" *Economic Theory*, 2002.
2. General equilibrium with ambiguity-sensitive agents. Betting between MEU, CEU and agents with convex preferences. Optimal risk-sharing and equilibrium. Relations to incompleteness of financial markets.

### Reading:

- A. Billot, A. Chateauneuf, I. Gilboa, and J.M. Tallon, "Sharing beliefs: Between agreeing and disagreeing," *Econometrica*, 2000.
  - A. Billot, A. Chateauneuf, I. Gilboa, and J.M. Tallon, "Sharing beliefs and the absence of betting in the Choquet expected utility model," *Statistical Papers*, 2002.
  - L. Rigotti, T. Strzalecki and C. Shannon, "Subjective beliefs and ex-ante trade," *Econometrica*, 2008.
  - A. Chateauneuf, R.A. Dana and J.M. Tallon, "Optimal risk-sharing rules and equilibria with Choquet expected utility," *J. Math. Econ.*, 34(2), 2000.
  - R.A. Dana, "Ambiguity, uncertainty aversion and equilibrium welfare," *Economic Theory*, 23, 2004.
3. Finance. Portfolio inertia: Bid-ask spreads and Arrow's local risk neutrality theorem. Intertemporal asset pricing, in discrete time. Two-fund separation. Incomplete markets. Corporate Finance. Some experimental evidence.

### Reading:

- J. Dow and S. Werlang, "Uncertainty aversion, risk aversion, and the optimal choice of portfolio," *Econometrica*, 1992.
  - L. Epstein and T. Wang, "Intertemporal asset pricing under Knightian uncertainty," *Econometrica*, 1994.
  - K. Wakai, "Aggregation under homogeneous ambiguity: A two-fund separation result," mimeo, 2005.
  - (Z. Chen and L. Epstein, "Ambiguity, risk and asset returns in continuous time," *Econometrica*, 2002.)
  - S. Mukerji and J.M. Tallon, "Ambiguity aversion and incompleteness of financial markets," *Review of Economic Studies*, 2001.
  - L. Rigotti and C. Shannon, "Uncertainty and risk in financial markets," *Econometrica*, 2005.
  - L. Garlappi, R. Giammarino and A. Lazrak, "Ambiguity in corporate finance," mimeo, 2012.
  - P. Bossaerts, P. Ghirardato, S. Guarnaschelli and B. Zame, "Ambiguity and Asset Prices: Theory and Experiment," *Review of Financial Studies*, 2010.
4. Job search and other dynamic applications. The job search problem. Irreversible investments.

**Reading.**

- K. Nishimura and H. Ozaki, "Search and Knightian uncertainty," *JET*, 2004.
  - K. Nishimura and H. Ozaki, "Irreversible investment and Knightian uncertainty," *JET*, 2007.
5. Contracts, mechanism design and other economic applications. Incomplete contracts. Auctions and other optimal mechanisms with ambiguity averse agents. Entrepreneurial innovation. Agency problems with ambiguity averse agents. Insurance.

**Reading:**

- S. Mukerji, "Ambiguity aversion and incompleteness of contractual form," *AER*, 1998.
- S. Bose, E. Ozdenoren and A. Pape, "Optimal auctions with ambiguity," *Theoretical Economics*, 2006.
- A. Di Tillio, N. Kos and M. Messner, "The design of ambiguous mechanisms," mimeo, 2012.

- L. de Castro and N. Yannelis, "Uncertainty, efficiency and incentive compatibility," *JET*, 2018.
  - G. Lo Pomo, L. Rigotti and C. Shannon, "Knightian uncertainty and moral hazard," mimeo, 2011.
  - PG, "Agency theory with non-additive uncertainty," mimeo, 1994.
  - L. Rigotti, M. Ryan and R. Vaithianathan, "Optimism and firm formation," *Economic Theory*, 2009.
  - M. Ryan, R. Vaithianathan and L. Rigotti, "Throwing good money after bad," mimeo, 2014.
  - G. Bryan, "Ambiguity and insurance," mimeo, 2010.
6. Applications to politics. Selective abstention in multiple elections.

**Reading:**

- PG and J. Katz, "Indecision theory: Weight of evidence and voting behavior", *Journal of Public Economic Theory*, 2006.