EC 718: DECISION THEORY

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This course is co-taught with Jawwad Noor. I will teach the first half and will focus on *choice under uncertainty*. Topics to be covered include the theory of subjective probability (both the Savage and Anscombe-Aumann models), ambiguity, demand for flexibility, dynamic choice, updating and learning.

You should purchase:

L. J. Savage, *The Foundations of Statistics,* Dover, 1954.

D. Kreps, *Notes on the Theory of Choice*, Westview, 1988.

A particularly useful reference for the material in this half of the course is:

I. Gilboa, *Theory of Decision under Uncertainty*, Cambridge, forthcoming.

Though we will not discuss these explicitly, the following papers may offer useful perspective on decision theory and on its connections to "behavioral economics":

F. Gul and W. Pesendorfer, The case for mindless economics, 2005.
W. Pesendorfer, Behavioral economics comes of age, *JEL* 44 (2006), 712-21.
D. Fudenberg, Advancing beyond advances in behavioral economics, *JEL* 44 (2006), 694-711.
Rubinstein, Discussion of "behavioral economics", 2005.

Grades for this part of the course will be based on class participation (you should read papers in advance), assignments, and a take-home test.

#1. THE ANSCOMBE-AUMANN MODEL

Kreps, Chs. 4 (domains of choice), 5 (the mixture-space theorem)
Kreps, Ch. 7
F. Anscombe and R. Aumann, A definition of subjective probability, *Ann. Math. Stat.* 34 (1963), 199-205.

#2. THE SAVAGE MODEL

Savage: Chs. 1-6; Kreps: Chs. 8, 9 and 4; Gilboa: Part II.
P. Fishburn, *Utility Theory for Decision Making*, Wiley, 1970, Ch. 14.
M. Machina & D. Schmeidler, A more robust definition of subjective probability, *Econometrica* 60 (1992), 745-780.

Extensions:

F. Gul, Savage's theorem with a finite number of states, *JET* 57 (1992), 99-110; and erratum in *JET* 61 (1993), p. 184.
E. Karni, Schmeidler and Vind, On state-dependent preferences and subjective probabilities, *Econometrica* 51 (1983), 1021-1032.
B. Hill, When is there state independence? *JET*, forthcoming.

Subjective Probability on 'Small' Domains:

D. Ellsberg, Risk, ambiguity and the Savage axioms, *QJE* 75 (1961), 643-669.
L. Epstein and J. Zhang, Subjective probabilities on subjectively unambiguous events, *Econometrica* 69 (2001), 265-306.
I. Kopylov, Subjective probability on 'small' domains, *JET* 133 (2007), 236-265.
I. Kopylov, Savage meets Kolmogorov, 2008. (See also his expository piece "Subjective probability" available on his web site.)

Models without a state space:

Gilboa and Schmeidler, *A Theory of Case-Based Decisions*, Cambridge U. Press, 2001; there are also a number of related articles, e.g., *QJE* 110 (1995), 605-39 and *ET* 9 (1997), 47-62.

#3. AMBIGUITY

I. Gilboa and D. Schmeidler, Maxmin expected utility with non-unique prior, *JME* 18 (1989), 141-153.
Gilboa, Postlewaite, and Schmeidler, Probabilities in economic modeling, *J. Econ. Perspectives*, 22 (2008), 173-188. (A reader-friendly expository paper.)
Gilboa, Part III.

Other models:
T. Bewley, Knightian decision theory: Part I, Cowles, 1986.
D. Schmeidler, Subjective probability and expected utility without additivity, *Econometrica* 57 (1989), 571-587.
F. Maccheroni, M. Marinacci and A. Rustichini, Ambiguity aversion, robustness and the variational representation of preferences, *Econometrica* 74 (2006), 1447- 1498.
P. Klibanoff, M. Marinacci and S. Mukerji, A smooth model of decision making under ambiguity, *Econometrica* 73 (2005), 1849-1892.
K. Seo, Ambiguity and second-order belief, *Econometrica*, forthcoming.
F. Gul and W. Pesendorfer, Measurable ambiguity, 2008.

Extensions and critiques:
S. Mukerji, Understanding the nonadditive probability model, *ET* 9 (1997), 23-46.
P. Ghirardato, Coping with ignorance, unforeseen contingencies and nonadditive uncertainty, *ET* 17 (2001), 247-276.
M. Siniscalchi, Vector expected utility and attitudes toward variation, *Econometrica*, forthcoming.
I. Kopylov, Choice deferral and ambiguity aversion, 2008.
T. Hayashi, T. Gajdos, J.M. Tallon and J.C. Vergnaud, Attitude toward imprecise information, *JET*, 140 (2008), 27-65.
M. Machina, Risk, ambiguity and the rank-dependence axioms, *AER*, forthcoming.
N. Al-Najjar and J. Weinstein, The subjective approach to ambiguity: a critical assessment, Kellogg 2008.
D. Ahn and H. Ergin, Framing contingencies, 2007.

De Finetti and ambiguity:

Kreps: Ch. 11; Savage pp. 46-55
L.G. Epstein and K. Seo, Symmetry of evidence without evidence of symmetry, 2008.

Some applications (static settings):

J. Dow and S. Werlang, Uncertainty aversion, risk aversion and the optimal choice of portfolio, *Econometrica* 60 (1992), 197-204.
L. Epstein, Sharing ambiguity, *AER* (2001), 45-50.
A. Billot, A. Chateauneuf, I. Gilboa and J.M. Tallon, Sharing beliefs; between agreeing and disagreeing, *Econometrica* 68 (2000), 685-94.
L. Rigotti and C. Shannon, Uncertainty and risk in financial markets, *Econometrica* 73 (2005), 203-243.
S. Mukerji, Ambiguity aversion and incompleteness of contractual form, *AER* 88 (1998), 1207-31.
S. Mukerji and J.M. Tallon, Ambiguity aversion and incompleteness of financial markets, *RES* 68 (2001), 883-904.
S. Mukerji and J.M. Tallon, An overview of economic applications of David Schmeidler's models of decision making under uncertainty, in *Uncertainty in economic theory: a collection of essays in honor of D. Schmeidler's 65th birthday*, I. Gilboa ed., Routledge 2004.
P. Lopomo, L. Rigotti and C. Shannon, Uncertainty in mechanism design, 2006.
K.C. Lo, Extensive form games with uncertainty averse players, *GEB* (1999) 28, 256-270; and Equilibrium in beliefs under uncertainty. *JET* (1996) 71, 443-484.
S. Bose, E. Ozdenoren and A. Pape, Optimal auctions with ambiguity, *TE* (2006) 1, 411-438.
Yaron Azrieli and Roee Teper, Uncertainty aversion and equilibrium existence in games with incomplete information, 2008.
J. Sutton, Flexibility, profitability and survival in an (*objective*) model of Knightian uncertainty, Walras-Bowley Lecture, 2004.
L. Garlappi, R. Uppal and T. Wang, Portfolio selection with parameter and model uncertainty: a multi-prior approach, *Rev. Finan. Stud.* 20 (2007), 41-81.
D. Easley and M. O'Hara, Ambiguity and non-participation: the role of regulation, *RFS*, forthcoming.
D. Easley and M. O'Hara, Microstructure and ambiguity, 2006.
R. J. Caballero and A. Krishnamurthy, Financial system risk and flight to quality, 2005.
J.A. Caskey, Information in equity markets with ambiguity-averse investors, *RFS,* 2008.
D. Chapman and V. Polkovnichenko, First-order risk aversion, heterogeneity and asset market outcomes, *J. Finance*, forthcoming.
K. Nehring and C. Puppe, A theory of diversity, *Econometrica* 70 (2002), 1155-98.

#4. INTERTEMPORAL MODELS - RECURSIVE UTILITY

RISK:

Kreps Chs. 10 and 12
Machina, Dynamic consistency and non-expected utility models of choice under uncertainty, *J. Ec. Lit.* 27 (1989), 1622-1668.
Kreps and Porteus, Temporal resolution of uncertainty and dynamic choice theory, *Econometrica* 46 (1978), 185-200.
Epstein & Zin, Substitution, risk aversion and the temporal behavior of consumption and asset returns: a theoretical framework, *Econometrica* 57 (1989), 937-969.

UNCERTAINTY:

Epstein and Schneider, Recursive multiple-priors, *JET* 113 (2003), 1-31.
Epstein & LeBreton, Dynamically consistent beliefs must be Bayesian, *JET* 61 (1993), 1-22.
P. Ghirardato, Revisiting Savage in a conditional world, *ET* 20 (2002), 83-92.
M. Siniscalchi, Dynamic choice under ambiguity, 2006.

UPDATING & LEARNING:

Bayesian models:

Kreps Chs. 11: de Finetti again
D. Blackwell and L. Dubins, Merging of opinions with increasing information, *Ann. Math. Stats.* 38 (1962), 882-886.
M. Feldman, On the generic nonconvergence of Bayesian actions and beliefs, *ET* 1 (1991), 301-321.
Acemoglu, Chernozhukov and Yildiz, Fragility of asymptotic aggreement under Bayesian learning, 2008.

Non-Bayesian models of learning:

P. Walley, *Statistical Reasoning with Imprecise Probabilities*, pp. 454-476.
Epstein and Schneider, Learning under ambiguity, *Rev. Econ. Stud.* 2007.
N. Al Najjar, Decision makers as statisticians: diversity, ambiguity and robustness, 2008.
I. Gilboa and D. Schmeidler, Inductive inference: an axiomatic approach, *Econometrica* 71 (2003), 1-26.
A. Billot, I. Gilboa, D. Samet and D. Schmeidler, Probabilities as similarity-weighted frequencies, *Econometrica* 73 (2005), 1125-1136; and Gilboa, Part IV.
Gilboa, Lieberman and Schmeidler, A similarity-based approach to prediction, *J. Econometrics*, forthcoming.
Gilboa and L. Samuelson, Preferring simplicity, 2008.

Applications of ambiguity in a dynamic setting:

Epstein & T. Wang, Intertemporal asset pricing under Knightian uncertainty, *Econometrica* 62 (1994), 283-322.
H. Cao, T. Wang and H. Zhang, Model uncertainty, limited market participation and asset prices, *Rev. Finan. Stud.*18 (2005), 219-1251.
I. Alonso, Ambiguity in a two-country world, 2007.
L. Hansen, Beliefs, doubts and learning: valuing macroeconomic risk, *AER*, May 2007.
Epstein and Schneider, Ambiguity, information quality and asset prices, *J. Finance*, 2008.
Gagliardini, Porchia and Fabio Trojani, Ambiguity aversion and the term structure of interest rates, *RFS*, forthcoming.
M. Leippold, Fabio Trojani and P. Vanini, Learning and asset prices under ambiguous information, RFS 21 (2008), 2565-97.
N. Ju and J. Miao, Ambiguity, learning and asset returns, 2007.
H. Chen, N. Ju and J. Miao, Dynamic asset allocation with ambiguous return predictability, 2008.
F. Reidel, Optimal stopping with multiple priors, *Econometrica*, forthcoming.
P. Illeditsch, Ambiguous information, risk aversion, and asset pricing, Wharton, 2008.
Maxim Ulrich, Inflation ambiguity and the term structure of arbitrage-free U.S. government bonds, Columbia, 2008.
C.I. Ilut, Ambiguity aversion: implications for the uncovered interest rate parity puzzle, 2008.

#5. SUBJECTIVE STATES

Kreps: A representation theorem for preference for flexibility, *Econometrica* 47, 1979, 565-578; Static choice in the presence of unforeseen contingencies, in *Essays in Honour of F. Hahn*, P. Dasgupta et al eds., MIT Press, 1992. See also Kreps, Ch. 13.

Dekel, Lipman and Rustichini, A unique subjective state space for unforeseen contingencies, *Econometrica* 69 (2001), 891-934. Corrigendum with T. Sarver (2006).

Epstein, Marinacci and Seo, Coarse contingencies and ambiguity, *TE*, 2007.
K. Hyogo, A subjective model of experimentation, *JET*, 2007.
H. Ergin and T. Sarver, A unique costly contemplation representation, 2008.
P. Ortoleva, The price of flexibility: towards a theory of thinking aversion, NYU, 2008.