

**Economics 8010**  
*Spring, 2023*

Econ 109  
Department of Economics  
Everything will be remote: <https://cuboulder.zoom.us/j/2920046632>

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This course develops the mathematical tools necessary to analyze optimal decision-making by individual households and firms over time and in the face of risk. Such decisions are building blocks for general equilibrium models, for statistical models of behavior and for theoretical analyses of policy.

Thinking about optimization over time and in the face of risk can seem overwhelming. This course will give you a way to orient yourself when thinking about behavior in a dynamic, stochastic context. In particular, several powerful methods that I have been involved in developing within economics provide a unified approach to the economics of risk and time: the diffidence theorem, polars, the symmetry theorem, conjugate functions and more.

The rapid decline in the price of computing power has led to increased use of the computer as a way of looking at economic models. This raises the value of the complementary activity of understanding results theoretically and intuitively. Understanding is needed both to cross-check computer results and to give them meaning. Theoretical results for a model or class of models can save a lot of time one might otherwise spend looking for the impossible and suggest fruitful directions to look for important effects. General theoretical results are also often publishable in their own right.

Evaluation is by problem sets and two take-home exams: a take-home midterm and a take-home final. You may collaborate on the problem sets, but you must do the take-home exams without communicating with anyone about them but me, the professor until the time each is due. (That should be by email, so I can reply to the question for everyone taking the class). The take-home exams are open book.

This is difficult material, but I'll go through it slowly, so you can do it! For the first time, I am able to flip the class: I'll ask you to watch a video or two of the Spring 2021 Zoom version of the class before each of our classes and then use the class time when we are together to have you practice on the spot on often simpler problems than what I lectured on in 2021 or you to go to the board and work a problem with my guidance. Some of this will be individual, some of it you'll be trying to crack a problem as a group. So you'll get practice during class time on the types of problems you'll get in homework and on the take-home exams. The cost of this is that you need to commit to watch the videos in advance.

No books are required, but there are two recommended books, both of which you can find on Amazon:

Christian Gollier *The Economics of Risk and Time*

R. Tyrrell Rockafellar *Convex Analysis*

They are optional because I'll give you the key content in class. As we go along, I'll tell you which things are most important to read. Here are some additional readings. Assume they are all optional, unless explicitly say a paper is required reading.

## **I. The Economics of Uncertainty in One- and Two-Period Models**

Gollier, Christian. *The Economics of Risk and Time*.

A. *Using Extremal Functions: The Diffidence Theorem*

\* Gollier Part III: Technical Tools

Kimball, M., 1992: "Precautionary Motives for Holding Assets," *The New Palgrave Dictionary of Money and Finance*, Peter Newman, Murray Milgate and John Eatwell (eds.), Stockton Press, New York, 158–161.

\* Gollier Part V: Consumption and Saving

\* Kimball, M., 1990: "Precautionary Saving in the Small and in the Large," *Econometrica* (January), 53–73.

\* Kimball, M., and Philippe Weil, 2003: "Precautionary Saving and Consumption Smoothing over Time and Possibilities," mimeo.

Kimball, M., 1989: "The Effect of Demand Uncertainty on a Precommitted Monopoly Price," *Economics Letters*, **30** (September), 1–5.

Kimball, M., 1994: "Discussion of 'The Importance of Precautionary Motives for Explaining Individual and Aggregate Saving,' by R. Glenn Hubbard, Jonathan Skinner, and Stephen P. Zeldes," Carnegie-Rochester Conference Volume, *Journal of Monetary Economics*.

\* Gollier Part IV: Multiple Risks

Kimball, M., 1993: "Standard Risk Aversion," *Econometrica* (May), 589–611.

Elmendorf, E. and Kimball, M., 2000: "Taxation of Labor Income and the Demand for Risky Assets," *International Economic Review*, 41 (August), 801–832.

### *B. Polars*

Rockafellar, R. Tyrrell, 1970. *Convex Analysis*.

## **II. Recursive Characterization of the Value Function**

Fama (1970): "Multiperiod Decision Problems," *American Economic Review* **60**, 163–174.

### *A. The Preser-Max Principle*

### *B. The Symmetry Theorem*

Boyd, John H. III (1990): "Symmetries, Dynamic Equilibria, and the Value Function," in *Conservations Laws and Symmetry*, Ryuzo Sato and Rama V. Ramachandran Eds., Kluwer.

Merton, Robert C., "Optimum Consumption and Portfolio Rules in a Continuous Time Model," JET 3 (1971): 373–413.

Kimball, M. and Mankiw, N. G., 1989: "Precautionary Saving and the Timing of Taxes," *Journal of Political Economy*, **97** (August), 863–879.

\* Kimball, Miles: "Consumption Technology Neutrality"

### *C. The Method of Conjugate Functions: Horizontal and Vertical Addition of the Marginal Value Function*

\* Carroll, C. and Kimball, M., 1996: "On the Concavity of the Consumption Function," *Econometrica*, 64 (July), 981–992.

\* Carroll, Chris, and Kimball, M., (2001): "Liquidity Constraints and Precautionary Saving." NBER Working Paper # 8496.

\* Kimball, Miles S., "Precautionary Saving and the Marginal Propensity to Consume," NBER Working Paper #3403.

## **III. Perturbation Methods**

Kimball, Miles "The Effect of Uncertainty on Optimal Control Models in the Neighborhood of a Steady State."