Asset Pricing I: Theory and Evidence

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1 Course objectives

This course provides an overview of the field of asset pricing. The emphasis of this course is on the theoretical underpinnings of the field and the evaluation of models built to address the empirical regularities observed in the US (and to some extent international) securities data. The emphasis will largely be on discrete-time models, though we will deal with continuous-time methods in some places. The topics covered include: the law of one price and the stochastic discount factor, consumption asset pricing, recursive preferences, habit formation, measuring cash flow and discount rate news, market frictions and transaction costs, disaster risk models, empirical evidence on stock returns, and issues in fixed income and currency pricing.

This is not an econometrics course, nor an empirical asset pricing course. We will cover empirical results to the extent that they provide context for the theory. We will also work with data (a little bit) when it helps to elucidate theoretical concepts. Finally, we will do numerical analysis of some of the models we cover, which will require some programming. Numerical analysis of models is so standard in the field, that you might as well get used to these tools at an early stage.[1]

The course is designed for second year doctoral students in finance. Economics doctoral students and other finance doctoral students are also welcome. Other students may take this course if they have previously taken at least one PhD-level finance course on asset pricing and one PhD-level course on statistics or econometrics.

[1] I recommend either R or Python. Matlab is a good choice also, but it isn't an open source package, which is probably a disadvantage in the long-term. We will do our in-class examples in R.

2 Logistics

Class schedule

Classes are held Fridays from 2:15-5:30pm in TBD, with a 15 minute break in the middle. What better way to kick off the weekend than with 3 hours spent pondering asset pricing? Table 1 shows the class dates, the anticipated class topics, and the assignment due dates.

Office hours and TA

Office hours are by appointment. Please email me first (`hm2646@columbia.edu`). Our TA will be Cristina Tessari (`CTessari21@gsb.columbia.edu`). He will have office hours on TBD in TBD.

Grading

There will be 6 homeworks (the last homework may be replaced with an in-class presentation) which will represent 40% of the grade and an in-class final with is worth 60% of the grade. Homeworks will go out roughly every two weeks. Tentative homework topics are in Table 2.

Student presentations

We will devote most of the final three classes to students presentations of recent (or some classic) research papers that build on concepts we will have covered in class. Presentations will be done in groups of three people. Those presenting will not have to hand in homework 6, but will still be responsible for understanding the material homework 6 covers.

Final exam

We will have an in-class three hour final. There will be a handout with many questions (and solutions) that I will give out at the end of the semester. This will be good practice for the final exam. In the past, we have been able to allow more time for the final for students who did not finish in three hours. Though the exam is intended to take less than three hours, I don't want people to get stressed because of time pressure. The final exam will be during exam week, on [During exam week] at TBD in TBD.

3 Materials

The course is self-contained and not based on any one book. The one that comes closest:

* John Campbell's (fantastic) new book called *Financial Decisions and Markets* (henceforth FDM).

If you buy only one book for the course, buy FDM. The following books are directly relevant in parts. Cochrane's book is very close to the early part of the course flow.

- John Cochrane's book *Asset Pricing* deals with many of the theoretical underpinnings of the course – SDF's, Hansen-Jagannathan bounds, Euler equations – but spends less time on the newer extensions of the standard model, like habits, recursive preferences, and so on. If you get only two books, get this one and Campbell's.

- Ljungqvist and Sargent, *Recursive Macroeconomic Theory* for coverage of dynamic programming, as well as two excellent chapters on asset pricing.

The following books are useful references:

- Back, *Asset Pricing and Portfolio Choice Theory* as a backup reference for the Cochrane book (with slightly more technical details).

- Campbell, Lo, MacKinlay, *The Econometrics of Financial Markets* for empirical topics.

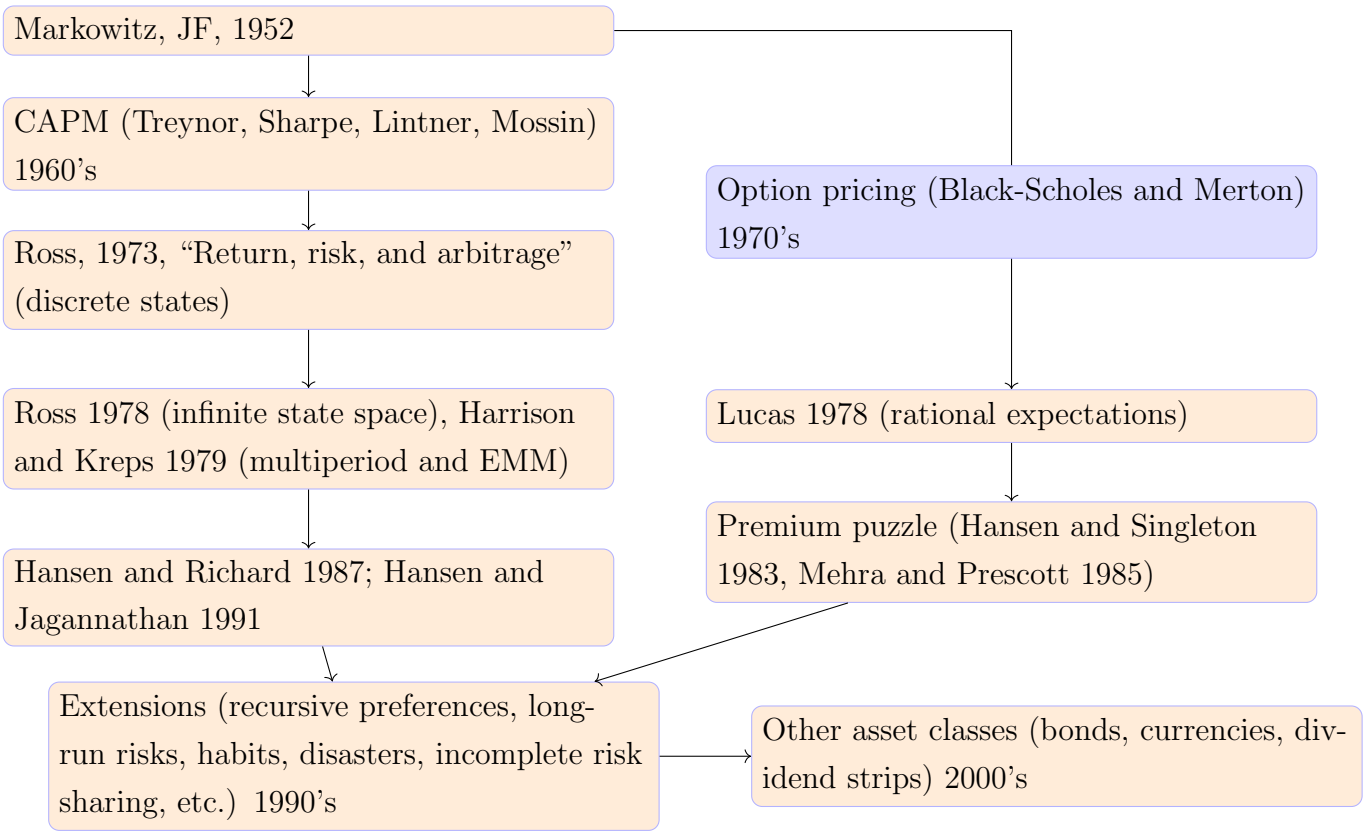
- Duffie, *Dynamic Asset Pricing* for continuous time methods.

- Harrison, *Brownian Motion and Stochastic Flow Systems* for an excellent introduction to stochastic calculus.

- LeRoy and Werner, *Principles of Financial Economics* for coverage of the CAPM and aspects of the stochastic discount factor.

- Stokey and Lucas with Prescott, *Recursive Methods in Economic Dynamics* is the classic book on dynamic programming in economics. The presentation in Ljungqvist and Sargent is much more readable, but L&S simply refer the reader here for most of the techincal details.

4 Logical evolution



5 Topics

1. Introduction

   - Overview of course topics
   - Arrow-Debreu state prices with finite states
   - Development of Euler equation and kernel representation
   - Connection to CAPM
   - Empirical review

   References

   Breeden, D., R. Litzenberger, and T. Jia, 2015, "Consumption-based asset pricing, Part 1: Classic theory and tests, measurement issues, and limited participation," *Annual Review of Financial Economics*, 7, 35–83.

Breeden, D., R. Litzenberger, and T. Jia, 2015, "Consumption-based asset pricing, Part 2: Habit formation, conditional risks, long-run risks, and rare disasters," *Annual Review of Financial Economics*, 7, 85–131.

*Campbell, J., 1999, "Asset prices, consumption, and the business cycle," *Handbook of Macroeconomics*, volume 1, 1231–1303.

*Cochrane, J., 2017, "Macro-finance," *Review of Finance*, 945–985. (I recommend you read this fantastic paper *at the end of the semester*. It will provide great context for many of the models we will have worked on over the next few months.)

*Dybvig, P. and S. Ross, 2003, "Arbitrage, state prices and portfolio theory," *Handbook of the Economics of Finance*.

2. Law of one price and principle of no-arbitrage

- Kernel representation: $P(X) = E[MX]$
- Hansen-Jagannathan bounds
- SDF and the mean-variance frontier

<u>*References*</u>

*Hansen, L. and R. Jagannathan, 1991, "Implications of security market data for models of dynamic economies," *Journal of Political Economy*, 99 (2), 225–262.

Hansen, L. and R. Jagannathan, 1997, "Assessing specification errors in stochastic discount factor models," *Journal of Finance*, 52 (2), 557–590.

Hansen, L. and S. Richard, 1987, "The role of conditioning information in deducing testable restrictions implied by dynamic asset pricing models," *Econometrica*, 55, 587–614.

Harrison, J.M. and D. Kreps, 1979, "Martingales and arbitrage in multiperiod securities markets," *Journal of Economic Theory*, 20, 381–408. (Among many other contributions, they show that with infinite state space, no-arbitrage implies the existence of an equivalent martingale measure (EMM), which through the Radon-Nikodym theorem implies the existence of a non-negative stochastic discount factor.)

Hodrick, R. and X. Zhang, 2001, "Evaluating the specification errors of asset pricing models," *Journal of Financial Economics*, 2001, 62, 327–376.

3. Consumption asset pricing

   - Dynamic programming
   - $M \sim U'(C)$
   - The consumption Euler equation
   - The equity premium puzzle
   - Bond pricing introduction
   - Empirical failure of the standard model

   <u>*References*</u>

   Hansen, L. and K. Singleton, 1983, "Stochatic consumption, risk aversion, and the temporal behavior of asset returns," *Journal of Political Economy*, 91 (2), 249–265.

   Ljungqvist and Sargent, 2012, *Recursive Macroeconomic Theory*, chapters 3-4.

   Kocherlakota, N., 1996, "The equity premium: It's still a puzzle," *Journal of Economic Literature*, 42–71.

   Kydland, F. and E. Prescott, 1977, "Rules rather than discretion: The inconsistency of optimal plans," *Journal of Political Economy*, 85 (3), 473–492.

   *Lucas, R., 1978, "Asset prices in an exchange economy," *Econometrica*, 46, 1429–1446.

   Mehra, R. and E. Prescott, 1985, "The equity premium: A puzzle," *Journal of Monetary Economics*, 15 (2), 145–161.

4. Recursive preferences

   - Separating risk aversion and intertermporal substitution
   - Epstein-Zin preferences
   - Campbell's version of the ICAPM

   <u>*References*</u>

   *Campbell, J., 1993, "Intertemporal asset pricing without consumption data," *American Economic Review*, 83 (3), 487–512.

   Hall, R., 1988, "Intertemporal substitution in consumption," *Journal of Political Economy*, 96 (2), 339–357.

This and the Yogo (2004) paper argue the IES is close to zero (or 0.2) in the US. The value of the IES plays a large role in the Bansal-Yaron long run risks model.

Epstein, L. and S. Zin, 1989, "Substitution, risk aversion, and the temporal behavior of consumption and asset returns: A theoretical framework," *Econometrica*, 57 (4), 937–969.

*Epstein, L. and S. Zin, 1991, "Substitution, risk aversion, and the temporal behavior of consumption and asset returns: An empirical analysis," *Journal of Political Economy*, 99 (2), 263–286.

Yogo, M., 2004, "Estimating the elasticity of intertemporal substitution when instruments are weak," *The Review of Economics and Statistics*, 86 (3), 797–810.

5. Long-run risks

- Bansal-Yaron paper
- Log-linear approximation of the pricing kernel
- Empirical evidence and applications
- Validity of approximation

References

*Bansal, R. and A. Yaron, 2004, "Risks for the long run: A potential resolution of asset pricing puzzles," *The Journal of Finance*, 59 (4), 1481–1509.

Bansal, R., D. Kiku, and A. Yaron, 2012, "An empirical evaluation of the long-run risks model for asset prices," *Critical Finance Review*, 1, 183–221.

Beeler, J. and J. Campbell, 2012, "The long-run risks model and aggregate asset prices: An empirical assessment," *Critical Finance Review*, 1, 141–182.

Pohl, W., K. Schmedders, and O. Wilms, 2018, "Higher order effects in asset pricing models with long-run risks," *Journal of Finance*, 73 (3), 1061–1111.

Restoy, F. and P. Weil, 2011, "Approximate equilibrium asset prices," *Review of Finance*, 15, 1–28.

6. Habit formation

- External habit model of Campbell and Cochrane
- Introduction to continuous time methods (the Kerry Back book is a good reference for the finance stuff, and the Harrison book for the math stuff)
- External habit model of Menzly, Santos and Veronesi

References

Abel, A., 1990, "Asset prices under habit formation and catching up with the Joneses," *American Economic Review*, 38–42.

Bekaert, G., E. Engstrom, and Y. Zing, 2009, "Risk, uncertainty, and asset prices," *Journal of Financial Economics*, 91, 59–82. (add a shock to the surplus process so it's not mechanically driven by consumption shocks)

*Campbell, J. and J. Cohrane, 1999, "By force of habit: A consumption-based explanation of aggregate stock market behavior," *Journal of Political Economy*, 107 (2), 205–251.

Harrison, J.M. and S. Pliska, 1981, "Martingales and stochastic calculus in the theory of continuous trading," *Stochastic Processes and their Applications*, 11, 215–260.

Menzly, L., T. Santos, and P. Veronesi, 2004, "Understanding predictability," *Journal of Political Economy*, 112 (1), 1–47.

Wachter, 2005, "Solving models with external habit," *Finance Research Letters*, 2, 210–226.

Guiso, L., P. Sapienza, and L. Zingales, 2018, "Time varying risk aversion," *Journal of Financial Economics*, 128, 403–421.

7. Discount rate and cash flow innovations

- Log-linearization of the returns R_{t+1} equation
- Value and growth firms: a reduced form SDF approach
- Dividend strips
- Euler equation errors

References

Bansal, R., S. Miller, D. Song, and A. Yaron, "The term structure of equity risk premia," *NBER Working Paper No. 25690*. (This is a counterpoint to the dividend-strip anomaly literature.)

*Campbell, J., 1991, "A variance decomposition for stock returns," *The Economic Journal*, 101 (405), 157–179.

Lettau, M. and S. Ludvigson, 2009, "Euler equation errors," *Review of Economic Dynamics*, 12, 255–283.

*Lettau, M. and J. Wachter, 2007, "Why is long-horizon equity less risky? A duration-based explanation of the value premium," *Journal of Finance*, 62 (1), 55–92.

*van Binsbergen, J., M. Brandt, and R. Koijen, 2012, "On the timing and pricing of dividends," *American Economic Review*, 102 (4), 1596–1618.

van Binsbergen, J. amd R. Koijen, 2017, "The term structure of returns: Facts and theory," *Journal of Financial Economics*, 124, 1–21.

8. Market frictions

- Incomplete markets, uninsurable income heterogeneity, and empirical evidence

  <u>*References*</u>

*Brav, A., G. Constantinides, and C. Geczy, 2002, "Asset pricing with heterogeneous consumers and limited participation: Empirical evidence," *Journal of Political Economy*, 110 (4), 793–824.

*Constantinides, G. and D. Duffie, 1996, "Asset pricing with heterogeneous consumers," *Journal of Political Economy*, 104 (2), 219–240.

Luttmer, E.G.J., 1999, "What level of fixed costs can reconcile consumption and stock returns?" *Journal of Political Economy*, 7 (5), 969–1033. (This is a classic paper about the effect of transaction costs in asset pricing. We will not get to it this semester.)

Scheinkman, J., 1989, "Market incompleteness and the equilibrium valuation of assets," in S. Bhattacharya and G. Constantinides (Eds.) *Theory of Valuation*, 45–51.

- Disaster risk (and dynamic models of disaster risk?)

  <u>*References*</u>

*Barro, R., 2006, "Rare disasters and asset markets in the twentieth century," *Quarterly Journal of Economics*, 121 (3), 823–866.

*Barro, R., 2009, "Rare disasters, asset prices, and welfare costs," 99 (1), 243–264.

Gabaix, X., 2012, "Variable rare disasters: An exactly solved framework for ten puzzles in macro-finance," *Quarterly Journal of Economics*, 127, 645–700.

Martin, I., 2013, "Consumption-based asset pricing with higher cumulants," *Review of Economic Studies*, 80, 745–773.

Nakamura, E., J. Steinsson, R. Barro, and J. Ursua, 2013, "Crises and recoveries in an empirical model of consumption disasters," *American Economic Journal: Macroeconomics*, 5 (3), 35–74.

Rietz, T., 1988, "The equity risk premium: A solution," *Journal of Monetary Economics*, 22 (1988), 117–131.

Tsai, J. and J. Wachter, 2015, "Disaster risk and its implications for asset pricing," *Annual Review of Financial Economics*, 7, 219–252.

Wachter, J., 2013, "Can time-varying risk of rare disasters explain aggregate stock market volatility?" *Journal of Finance*, 68 (3), 987–1035.

9. Properties of the pricing kernel [slightly tentative]

   - Alvarez, F. and U. Jermann, 2005, "Using asset prices to measure the persistence of the marginal utility of wealth," *Econometrica*, 73 (6), 1977–2016.
   - Campbell, *FDM*, Chaper 8.
   - Hansen, L. and J. Scheinkman, 2009, "Long-term risk: An operational approach," *Econometrica*, 77 (1), 177-234.
   - Jensen, C., D. Lando and L. Pedersen, 2019, "Generalized recovery," *Journal of Financial Economics*, 133 (1), 154–174.
   - Ross, S., 2015, "The Recovery Theorem," *Journal of Finance*, 70 (2), 615–648.
   - Schneider, P. and F. Trojani, 2019, "(Almost) model-free recovery," *Journal of Finance*, 74 (1), 323–370.

10. Fixed income and currencies

- Fixed income models

  <u>*References*</u>

  Ang, A. and M. Piazzesi, 2003, "A no-arbitrage vector autoregression of term structure dynamics with macroeconomic and latent variables," *Journal of Monetary Economics*, 50, 745–787.

  *Cochrane, J. and M. Piazzesi, 2005, "Bond risk premia," *The American Economic Review*, 95 (1), 138–160.

  Cochrane, J. and M. Piazzesi, 2008, "Decomposing the yield curve," *working paper*.

  Fama, E. and Bliss, R., 1987, "The information in long-maturity forward rates," *American Economic Review*, 77 (4), 680–692.

  Lettau, M. and Wachter, J., 2011, "The term structures of equity and interest rates," *Journal of Financial Economics*, 101, 90–113.

  Piazzesi, M. and M. Schneider, 2007, "Equilibrium exchance rates," *NBER Macroeconomics Annual 2006*, Volume 21.

  Thornton, D. and G. Valente, 2012, "Out-of-sample predictions of bond excess returns and forward rates: An asset allocation perspective," *Review of Financial Studies*, 25 (10), 3141–3168.

- Currencies

  <u>*References*</u>

  *Backus, D., S. Foresi, and C. Telmer, 2001, "Affine term structure models and the forward premium anomaly," *Journal of Finance*, 56 (1), 279–304.

  Brandt, M., J. Cochrane and P. Santa-Clara, 2006, "International risk sharing is better than you think, or exchange rates are too smooth," *Journal of Monetary Economics*, 53, 671–698.

  Dornbusch, R., 1985, "Purchasing power parity," *NBER working paper no. 1591*.

  Fama, E., 1984, "Forward and spot exchange rates," *Journal of Monetary Economics*, 14, 319–338.

  Farhi, E. and X. Gabaix, 2016, "Rare disasters and exchange rates," *The Quarterly Journal of Economics*, 131 (1), 1–52.

Hanson, L. and R. Hodrick, 1980, "Forward exchange rates as optimal predictors of future spot rates: An econometric analysis," *Journal of Political Economy*, 88 (5), 829–853.

11. Student presentations

- Students will form groups and submit a ranked list of 3 papers that they would like to present. I will assign papers to groups from their lists.
- In the presentation, you should focus on the paper's modeling contribution and any empirical tests related to this. Make sure to go over the important derivations in the paper (try not to skip steps so your classmates will understand the material). Some papers have sections dealing with continuous time models – you can skip over these (or discuss them if you feel comfortable). Each group will have 1 hour to present. People are strongly encouraged to ask questions during the presentations.

Consumption-based pricing models

Adam, K., A. Marcet, and J. Nicolini, 2016, "Stock market volatility and learning," *Journal of Finance*, 71 (1), 33–81.

Albuquerque, R., M. Eichenbaum, V. Luo, and S. Rebelo, 2016, "Valuation risk and asset pricing," *Journal of Finance*, 71 (6), 2861–2903.

Bekaert, G., E. Engstrom, and Y. Zing, 2009, "Risk, uncertainty, and asset prices," *Journal of Financial Economics*, 91, 59–82.

> A habit model with exogenous shocks, i.e., variation in habit unrelated to consumption growth.

Constantinides, G. and A. Ghosh, 2016, "Asset pricing with countercyclical household consumption risk," *Journal of Finance*, 72 (1), 415–460.

> Combines Constantinides and Duffie (1996) with recursive preferences.

Gabaix, X., 2012, "Variable rare disasters: An exactly solved framework for ten puzzles in macro-finance," *Quarterly Journal of Economics*, 127, 645–700.

> If you present the Gabaix paper, you can focus on the part that deals with power utility. The part on Epstein-Zin preferences (in Section V) can be skipped.

Jorda, O., A. Schularick, and A. Taylor, 2019, "The total risk premium puzzle," *NBER working paper No. 25653*.

*Kaltenbrunner, G. and L. Lochstoer, 2010, "Long-run risk through consumption smoothing," *Review of Financial Studies*, 23 (8), 3190–3224.

Characteristics of SDF

Cochrane, J. and J. Saa-Requejo, 2000, "Beyond arbitrage: Good-deal asset price bounds in incomplete markets," *Journal of Policitical Economy*, 108 (1), 79–119.

Kozak, S., S. Nagel, and S. Santosh, 2018, "Interpreting factor models," *Journal of Finance*, 73 (3), 1183–1223.

Martin, I., 2013, "Consumption-based asset pricing with higher cumulants," *Review of Economic Studies*, 80, 745–773.

Applications to non-equity or to international asset classes

*Bansal, R. and I. Shaliastovich, 2013, "A long-run risks explanation of predictability puzzles in bond and currency markets," *The Review of Financial Studies*, 26 (1), 1–33.

Backus, D., N. Boyarchenko and M. Chernov, 2018, "Term structure of asset prices and returns," *Journal of Financial Economics*, 129, 1–23.

Brusa, Ramadorai, and Verdelhan, 2017, "International CAPM redux," working paper.

Lettau, M. and J. Wachter, 2011, "The term structure of equity and interest rates," *Journal of Financial Economics*, 101 (1), 90–113.

*Verdelhan, A., 2010, "A habit-based explanation of the exchange rate premium," *The Journal of Finance*, 65 (1), 123–146.

*Wachter, J., 2006, "A consumption-based model of the term structure of interest rates," *Journal of Financial Economics*, 79, 365–399.

van Binsbergen, J. amd R. Koijen, 2017, "The term structure of returns: Facts and theory," *Journal of Financial Economics*, 124, 1–21.

Insights from log-linearization

Ang, A. and G. Bekaert, 2006, "Stock return predictability: Is it there?" *Review of Financial Studies*, 20 (3), 651–707.

Lettau, M. and S. Ludvigson, 2001, "Consumption, aggregate wealth, and expected stock returns," *Journal of Finance*, 56 (3), 815–849.

Lettau, M. and S. Ludvigson, 2001, "Resurrecting the (C)CAPM: A cross-sectional test when risk premia are time-varying," *Journal of Political Economy*, 109 (6), 1238–1287.

Cross-sectional and other empirical tests

*Campbell, J. and T. Vuolteenaho, 2004, "Bad beta, good beta," *American Economic Review*, 94 (5), 1249–1275.

*Campbell, J., S. Giglio, C. Polk, and R. Turley, 2018, "An intertemporal CAPM with stochastic volatility," *Journal of Financial Economics*, 128, 207–233.

Nakamura, E., J. Steinsson, R. Barro, and J. Ursua, 2013, "Crises and recoveries in an empirical model of consumption disasters," *American Economic Journal: Macroeconomics*, 5 (3), 35–74.

Consumption-based cross-sectional tests

Jagannathan, R. and Y. Wang, 2007, "Lazy investors, discretionary consumption, and the cross-section of stock returns," *Journal of Finance*, 62 (4), 1623–1661. (measure consumption changes based on Q4 consumption)

Malloy, C., T. Moskowitz, and A. Vissing-Jorgensen, 2009, "Long-run stockholder consumption risk and asset returns," *Journal of Finance*, 64 (6), 2427–2479. (look at consumption covariance of stock holders vs non-holders)

Parker, J., and C. Julliard, 2005, "Consumption risk and the cross-section of expected returns", *Journal of Political Economy*, 113, 185–222. (measure consumption changes over 11 quarters)

Table 1: **Schedule.**

Class	Fall 2019	Topic	Assign	Due Date
01	Fri Sep 06	Introduction: CAPM, SDF, empirical evidence, writing good code	1	Fri Sep 20
02	Fri Sep 13	Law of one price and the stochastic discount factor		
03	Fri Sep 20	Consumption asset pricing	2	Fri Oct 04
04	Fri Sep 27	Empirical shortcomings of the standard model; recursive preferences and ICAPM		
05	Fri Oct 04	Recursive preferences and long-run risks	3	Fri Oct 25
06	Fri Oct 11	Habit formation and continuous time basics		
07	Fri Oct 25	Continuous time basics and disaster risk	4	Fri Nov 08
08	Fri Nov 01	Incomplete markets, discount rates and cash flows, application to other markets		
09	Fri Nov 08	Fixed income and currencies	5	Fri Nov 29
10	Fri Nov 15	Currencies and student presentations	6†	Fri Dec 06
11	Fri Nov 22	Student presentations		
12	Fri Dec 06	Student presentations		
	[During exam week]	Final exam held in TBD at TBD		

†HW6 to be handed in only by those not doing in-class presentations.

Table 2: **Homework topics.**

1. Stochastic discount factor
2. Dynamic programming
3. Bonds and generalized preferences
4. Habits and long-run risks
5. Disaster risk and log-linearization
6. Fixed income and currencies