Yale School of Management
Yale University

MGT 595: Quantitative Investing

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Class hours	Tue. 5:10-8:10pm in Classroom TBD and Zoom (Evans Hall, Yale SOM)
Office hours	By appointment only by Zoom.

Course Description

This course develops, examines, and applies models for portfolio decisions by investors and the pricing of securities in capital markets. While developing portfolio theory, we will study the extensive empirical work that characterizes movements in security prices, evaluates alternative investment and asset pricing models, and attempts to test those models and interpret the implications of those tests. This is a research oriented course with practical implementation of quantitative methods in finance, aimed at highly motivated and technically proficient MBA and undergraduate students.

This course is designed for students who want a more detailed and up-to-date treatment of academic asset pricing theory and empirical work and its application to the practice of quantitative finance. The course is especially appropriate for students contemplating analytical finance and quantitative money management, and provides many tools and concepts that are essential for a career in quantitative investments. The material is covered in a rigorous analytical manner, and students must be comfortable with some technical methodologies (i.e., calculus, linear and matrix algebra, and statistical theory). The course is meant to be challenging, but accessible. The expectation is that the average student spends 10-20 hours per week on the course, outside of class.

A good fundamental background in economics and especially statistics is required. The course is highly quantitative because the field is, and so relies heavily on analytical tools and economic theory developed throughout the course. Students should be comfortable with probability, statistics, and regression analysis. Students should also feel comfortable with the concepts of risk aversion, utility functions, and budget constraints. Use of a statistical package or programming language will be vital for the course, saving time and aiding in understanding the material. Many of the applications will move beyond simple spreadsheet packages such as Excel. You will need a good statistical programming language – we will

support both Matlab and Python, which are standard programming languages used in quantitative finance – but you are also welcome to use any other programming language you are comfortable with. We will supplement the course with programming help in Matlab and Python and the data assignments will be done in groups (more below).

Course Requirements and Grading

The requirements for the course are 10 problem sets (which include data analysis) and a final exam. The problem sets are to be done in groups of 1-3 people. Class participation is also used to determine grades.

Your course grade will be determined as follows:

Class Participation	5%
Referee Report	10%
11 Problem Sets	50%
Final Exam	35%

This course should not be taken pass/fail – to get anything out of it you need to do the work, and if you're going to do that much work you might as well get a grade for it!

Class participation will be weighted heavily, as it is key to understanding the material in the course. Many topics and economic questions will not have a specific answer. Therefore, dialogue and debate are an important part of this course. Thus, students need to be prepared *before* class. I want classroom discussion to be open; this will help immensely.

Problem sets will be due most weeks and are to be done in groups of 1-3 people*. The problem sets will consist mostly of data analysis and replication of studies with some extensions of the data analysis in those studies and some conceptual questions concerning the interpretation of the analysis. The goal is to generate a set of quantitative tools and programs throughout the course that are applied in practice. The problem sets cumulatively develop these tools by adding on to previous analysis so that extensive models are developed by the end of the course and similar routines are applied to multiple contexts.

*You may choose to do the problem sets and/or group project individually if you wish . . . but it's a hell of a lot of work!

The referee report should be written clearly and concisely, with any tables and figures labeled clearly and any analysis clearly described. Points will be deducted for lack of clarity and poor organization and sloppiness. (Think of this as a research report that gets circulated internally and perhaps externally at a quantitative investment shop.) The report is evaluated on quality, not quantity. The written text should be a maximum of 5 pages, double spaced, 1 inch margins everywhere, 12 point Times New Roman font, including references, but excluding any tables and figures (though none are necessary). More details to come on what a "referee report" entails and what is expected of you.

TA and Review Sessions

- The TA for the course is **Leland Bybee**, a Ph.D. student in Finance.
- The TA will hold a Matlab tutorial session the first week of class – students are STRONGLY encouraged to attend (you'll thank me later).
- The TA will hold weekly office hours. The TA's objective is to help you with data and statistics questions primarily for the upcoming problem set each week, but also to go over any lingering questions from the previous problem set if time permits.
- You should feel free to contact the TA with any and all questions. You can reach the TA by e-mail at the following address:

leland.bybee@yale.edu

Readings for the Course

- **Texts**

  Required texts:

  1. NONE.

- **Other Readings**
  Almost all of the readings for the course will be posted on the course webpage with links to the articles. Some of the articles are challenging. However, I will assign certain portions of these articles that I feel are relevant to the topics discussed in class, and will not hold you responsible for the most difficult and advanced material. In addition, I have included some optional readings, which will be discussed briefly in class. For anything that I'm not allowed to post online (due to copyright issues) I will print out and bring to class. You are responsible for *any and everything* covered in class and maybe even some stuff not covered in class.

- **Class Notes and Handouts**
  Lecture notes are posted on the course website. You should either take notes electronically in class or print out the lecture notes ahead of time and take notes during class on the hard copies, so that you can follow the lecture as we discuss the various topics. However, much of the material will be presented in discussion format in class.

Feedback, Questions, and Concerns

This course is conceptually and analytically challenging, and will require a large time commitment from students (10-20 hours per week). If you have any concerns about the course, please let me know. The best way to catch me is to e-mail me to set up an appointment.

Schedule of Classes

Date	Topic	Due
Sept 1	Modern Portfolio Theory in Practice	
Sept 8	Evaluating Assets: Cross-Section	PS#1
Sept 15	Evaluating Assets: Time-Series	PS#2
Sept 22	Market Efficiency and Limits to Arbitrage	PS#3
Sept 29	Value Investing	PS#4
Oct 6	Momentum Investing	PS#5
Oct 13	Quality and Defensive Investing	PS#6
Oct 20	NO CLASS - mid-semester break	
Oct 27	How Reliable is a Backtest?	PS#7
Nov 3	Other Asset Markets	PS#8
Nov 10	Carry Strategies	PS#9
Nov 17	Implementation Costs and Illiquidity	
Nov 24	NO CLASS - Thanksgiving break	
Dec 1	Building Models and Portfolios	PS#10
Dec 8	Factor Timing	PS#11, Referee report

Course Outline

* indicates required reading.

† indicates lecture note obtained from website or hard copy in class.

Bold indicates article to be discussed in class.

Before the course begins: (Students should know this material before entering the class)

0 **Preliminaries: Background and Statistics (not to be covered in class, but you NEED TO KNOW)**

† Lecture 0: Stock returns, portfolio mathematics, return distributions, and the Market Model

Fama, Eugene, *Foundations of Finance*, chs. 1-4.

Lecture Topics covered in class:

1. **Modern Portfolio Theory in Practice** (8/29)

† Course Outline and Introduction.

† Lecture 1: Portfolio Theory, the CAPM, and Practice

* Roll, Richard, "A Critique of the Asset Pricing Theory's Tests," 1977, *Journal of Financial Economics*, 4 129-176.

* **Jorion, Phillipe, "Portfolio Optimization in Practice."**

2. **Evaluating Assets: Cross-Section** (9/5)

   - **Problem Set#1 DUE.**

   † Lecture 2: Cross-Sectional and Time-Series Asset Pricing Tests

   Fama, Eugene, and James MacBeth, "Risk, Return, and Equilibrium: Empirical Tests," 1973, *Journal of Political Economy*, 81, 607-636.

3. **Evaluating Assets: Time-Series** (9/12)

   - **Problem Set#2 DUE.**

   † (continue) Lecture 2: Cross-Sectional and Time-Series Asset Pricing Tests

   Gibbons, Michael, Steve Ross, and Jay Shanken, "A Test of the Efficiency of a Given Portfolio," 1989, *Econometrica*, 57, 1121-1152.

   * **Fama, Eugene and Kenneth French, "The Cross-Section of Expected Stock Returns," 1992,** *Journal of Finance***, 47, 427-466.**

4. **Market Efficiency and Limits to Arbitrage** (9/19)

   - **Problem Set#3 DUE.**

   † Lecture 3: Market Efficiency/Inefficiency

   * Bodie, Kane, and Marcus ch. 12 (good review of the issues).

   * Shleifer, Andre, *Inefficient Markets*, ch.1

   Fama, Eugene, "Efficient Capital Markets II," 1991, *Journal of Finance*, 1575 - 1617.

   * **Fama, Eugene and Kenneth French, "Common Risk Factors in the Returns on Stocks and Bonds," 1993,** *Journal of Financial Economics***, 33, 3-56.**

   * **Lamont, Owen and Richard Thaler, "Can the Market Add and Subtract? Mispricing in Tech Stock Carve-Outs," 2002,** *Journal of Political Economy***.**

   Kaplan, Steven, Tobias Moskowitz, and Berk Sensoy, "The Effects of Stock Lending on Security Prices: An Experiment," 2013, *Journal of Finance*.

5. **Value Investing** (9/26)

   - **Problem Set#4 DUE.**

   † Lecture 4: Value

* **Lakonishok, Josef, Andre Shleifer, and Robert Vishny, "Contrarian Investment, Extrapolation, and Risk," 1994,** *Journal of Finance*, **49, 1541-1578.**

* **Fama, Eugene and Kenneth French, "Multifactor Explanations of Asset Pricing Anomalies," 1996,** *Journal of Finance*, **51, 55-84.**

* **Daniel, Kent and Sheridan Titman, "Evidence on the Characteristics of Cross-Sectional Variation in Stock Returns," 1997,** *Journal of Finance*, **52, 1-33.**

Davis, James L., Eugene Fama, and Kenneth French, "Characteristics, Covariances, and Average Returns: 1929-1997," 2000, *Journal of Finance*, 389-406.

Berk, Jonathan, "Sorting Out Sorts," 2000, *Journal of Finance*.

Asness, Cliff and Andrea Frazzini, "The Devil in HML's Details," 2013, *Journal of Portfolio Management*.

* Israel, Ronen, Kris Larsen, and Scott Richardson, 2020, "Is (Systematic) Value Investing Dead? ", AQR Capital working paper.

* Maloney, Thomas and Tobias J. Moskowitz, 2020, "Value and Interest Rates: Are rates to blame for values torments?" AQR Capital working paper.

6. **Momentum Investing** (10/3)

- **Problem Set#5 DUE.**

† Lecture 5: Momentum

* **Jegadeesh, Narasimhan and Sheridan Titman, "Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency," 1993,** *Journal of Finance*, **48, 65-91.**

* **Moskowitz, Tobias and Mark Grinblatt, "Do Industries Explain Momentum?", 1999,** *Journal of Finance*, **54, 1249-1290.**

Grinblatt, Mark and Tobias Moskowitz, "Predicting Stock Price Movements from Past Returns: The Role of Consistency and Tax-Loss Selling", 2003, *Journal of Financial Economics*, 71(3), 541-579.

Grundy, Bruce D. and J. Spencer Martin, "Understanding the nature of the risks and the source of the rewards to momentum investing," 2001, *Review of Financial Studies*.

Hong, Harrison, Terence Lim, and Jeremy Stein, "Bad News Travels Slowly: Size, Analyst Coverage, and the Profitability of Momentum Strategies," 2000, *Journal of Finance*, 55, 265-295.

Hvidkjaer, Soeren, "A Trade-Based Analysis of Momentum," 2006, *Review of Financial Studies*.

* **Daniel, Kent and Tobias Moskowitz, "Momentum Crashes," 2016,** *Journal of Financial Economics*, **122(2), 221-247.**

Kelly, Bryan, Tobias J. Moskowitz, and Seth Pruitt, "Understanding Momentum and Reversals," 2020, *forthcoming Journal of Financial Economics*.

7. **Quality and Defensive Investing** (10/10)

   - **Problem Set#6 DUE.**

   † Lecture 6: Quality and Defensive

   * **Novy-Marx, Robert, "The Other Side of Value: The Gross Profitability Premium,"** *Journal of Financial Economics*, **2013.**

   Novy-Marx, Robert, "The Quality Dimension of Value Investing," Working paper, 2013.

   * **Asness, Cliff, Andrea Frazzini, and Lasse Pedersen, "Quality Minus Junk," 2019,** *Review of Accounting Studies*, **24(1), 34-112.**

   * **Frazzini, Andrea, and Lasse H. Pedersen, "Betting against Beta," 2013,** *Journal of Financial Economics*, **111, 1-25.**

   Frazzini, Andrea, and Lasse H. Pedersen, "Embedded Leverage," 2013, Working paper.

   Moskowitz, Tobias J. and Kaushik Vasudevan, "What Can Betting Markets Tell Us About Investor Preferences and Beliefs?" 2020, Yale University working paper.

8. **How Reliable is a Backtest?** (10/24)

   - **Problem Set#7 DUE.**

   † Lecture 7: Robustness of Anomalies, Data Mining and Backtest Reliability

   * **Harvey, Campbell, Yan Liu and Heqing Zhu, " . . . and the Cross-Section of Expected Returns",** *Review of Financial Studies*, **2016, 29, 5-68.**

   * **Israel, Ronen and Tobias Moskowitz "The Role of Shorting, Size, and Time on Market Anomalies," 2013,** *Journal of Financial Economics*, **108, 275-301.**

   * **McLean, David and Jeff Pontiff, "Does Academic Publication Destroy Stock Return Predictability?" 2016,** *Journal of Finance.*, **71, 5-32.**

   Hou, Kewei, Chen Xue, and Lu Zhang, "Replicating Anomalies" 2017, Working paper, Ohio State University.

   * Asness, Cliff, Andrea Frazzini, Ronen Israel, and Tobias J. Moskowitz "Fact Fiction and Momentum Investing," 2015, *Journal of Portfolio Management*, 40th Anniversay edition, Vol 40, Issue 5, 75-92.

   * Asness, Cliff, Andrea Frazzini, Ronen Israel, and Tobias J. Moskowitz "Fact Fiction and Value Investing," 2015, *Journal of Portfolio Management*, 42(1), 34-52.

   Alquist, Ron, Ronen Israel, and Tobias J. Moskowitz "Fact Fiction and the Size Effect," 2018, *Journal of Portfolio Management*, 45(1), 3-30.

Fama, Eugene and Kenneth French, "Dissecting Anomalies," *Journal of Finance*, 2008, Volume 63, 4, 1653-1678.

9. **Other Asset Markets** (10/31)

   - **Problem Set#8 DUE.**

   † Lecture 8: Other Asset Classes

   * Fama, Eugene and Kenneth French, "Size, value, and momentum in international stock returns," *Journal of Financial Economics*, 2012, Volume 105, Issue 3, 457-472.

   * **Asness, Cliff, Tobias Moskowitz, and Lasse Pedersen, "Value and Momentum Everywhere," 2013,** *Journal of Finance*, **68(3), 929-985.**

   * **Moskowitz, Tobias, Yao Hua Ooi, and Lasse Pedersen, "Time Series Momentum,"** *Journal of Financial Economics*, **2012, 104(2), pp. 228-50.**

   * **Moskowitz, Tobias, "Asset Pricing and Sports Betting," working paper Yale University.**

10. **Carry Strategies** (11/7)

    - **Problem Set#9 DUE.**

    † Lecture 9: Carry Strategies

    * **Brunnermeier, Markus, Stefan Nagel, and Lasse H. Pedersen, "Carry Trades and Currency Crashes," 2008, NBER Macroeconomics Annual, 23, 313-348.**

    * **Koijen, Ralph, Tobias Moskowitz, Lasse H. Pedersen, and Evert Vrugt, "Carry," 2018,** *Journal of Financial Economics*, **127(2) 197-225.**

    * Lustig, H., N. Roussanov, and A. Verdhelan, "Common Risk Factors in Currency Markets," 2012, *Review of Financial Studies.*

11. **Implementation Costs and Illiquidity** (11/14)

    † Lecture 10: Trading Costs, Liquidity, and Liquidity Risk

    * **Korajczyk, Robert and Ronnie Sadka, "Are Momentum Profits Robust to Trading Costs?," 2004,** *Journal of Finance*, **Vol. 59 No. 3, 1030-1082.**

    * **Frazzini, Andrea, Ronen Israel, and Tobias Moskowitz, "Trading Costs," 2017, Working paper Yale University.**

    * **Frazzini, Andrea, Ronen Israel, and Tobias Moskowitz, "Trading Costs of Asset Pricing Anomalies," 2015, Working paper Yale University.**

    Korajczyck, Robert and Ronnie Sadka, "Pricing the commonality across alternative measures of liquidity", *Journal of Finance*, 2007.

    * Amihud, Y., H. Mendelson, and L. Pedersen, "Liquidity and Asset Prices," 2005.

Nagel, Stefan, "Evaporating Liquidity," *Review of Financial Studies*, 2012, 25, 2005-2039.

* Khandani, Amir and Andrew W. Lo, "What Happened to the Quants in August 2007?"

* Acharya, V. V. and Pedersen, L. H., "Asset pricing with liquidity risk.," *Journal of Financial Economics*, 2005.

* Pastor, L. and Stambaugh, R. F., "Liquidity risk and expected stock returns," *Journal of Political Economy*, 2003.

Novy-Marx, Robert and Mihail Velikov, "A Taxonomy of Anomalies and Their Trading Costs," *Review of Financial Studies*, 2017.

12. **Building Models and Portfolios** (11/21)

- **Problem Set#10 DUE.**

† Lecture 11: Building Models and Portfolios

* **Fama, Eugene and Kenneth French, "A Five-Factor Asset Pricing Model," 2015,** *Journal of Financial Economics***.**

* **Asness, Cliff, "Our Model Goes to Six and Saves Value from Redundancy Along the Way",** *Cliff's Perspectives***, Dec. 17, 2014.**

* **Asness, Cliff, Andrea Frazzini, Ronen Israel, Tobias Moskowitz, and Lasse Pedersen, "Size Matters, If You Control Your Junk", 2018,** *Journal of Financial Economics***, 129(3), 479-509.**

* Asness, Cliff, Antti Ilmanen, Ronen Israel, and Tobias Moskowitz, "Investing with Style", 2014 Journal of Investment Management.

Lewellen, Jonathan, "The Cross-Section of Expected Stock Returns" 2014, *Critical Finance Review*.

13. **Factor Timing** (12/5)

- **Problem Set#11 and "Referee Report" DUE.**

† Lecture 12: Factor Variation and Timing

* **Ilmanen, Antti, Ronen Israel, Rachel Lee, Tobias Moskowitz, and Ashwin Thapar, "How Do Factor Premia Vary Over Time? A Century of Evidence," Working paper Yale University.**

* Alquist, Ron, Sarah Jiang, and Tobias Moskowitz, "Crowding" Working paper Yale University.

* **Cohen, R. B., C. Polk, and T. Vuolteenaho (2003). The value spread. The Journal of Finance 58 (2), 609-641.**

* **Moreira, A. and T. Muir (2017). Volatility-managed portfolios. The Journal of Finance 72 (4), 1611-1644.**

* Haddad, Valentin, Serhiy Kozak, and Shrihari Santosh, 2018, Economic Factor Timing, Working paper UCLA.

* Asness, C. S., J. A. Friedman, R. J. Krail, and J. M. Liew (2000). Style timing: Value versus growth. Journal of Portfolio Management 26 (3), 5060.

* Gupta, T. and B. Kelly (2018), Factor Momentum Everywhere, forthcoming Journal of Portfolio Management.

* Arnott, R. D., M. Clements, V. Kalesnik, and J. Linnainmaa, (2018), Factor momentum. Working paper, Research Affiliates.

  Asness, C., A. Ilmanen, and T. Maloney (2017), Market timing: Sin a little, Journal of Investment Management, 15 (3), 23-40.

  Asness, C. S. (2016). The siren song of factor timing aka smart beta timing" aka "style timing". The Journal of Portfolio Management 42 (5), 16.

  Asness, C., S. Chandra, A. Ilmanen, and R. Israel (2017). Contrarian factor timing is deceptively difficult. The Journal of Portfolio Management 43 (5), 7287.

14. **Final exam** (12/12)