

Investment Management
MIT Sloan Course 15.439, Spring 2019

Class schedule: Monday, 4:00 – 7:00 pm

Instructor: Prof. Matthew Rothman

Email: rothmanm@mit.edu

Office hours: By appointment, before or after class

TA: TBA

Course Overview:

This is a course in the implementation of successful investment strategies from the perspective of quantitative institutional money management. This is not a course in managing your own personal finances. Rather, it is a course that blends academic finance with the practice of investment management as actually carried out by many of the most sophisticated (quantitative) investors in the world. Students considering a career in any aspect of the financial services industry would be well served to take this course. By its very nature, this course is quantitative and requires an understanding of basic statistical and financial concepts. Most of all, it requires a willingness to learn, to be challenged, and a desire to actively engage with the material.

The course is divided into four parts. First, we will focus on why inefficiencies in the market may arise and persist – this topic is known as behavioral finance and was the subject of last year's Nobel Prize in Economics. We will read some of the classic texts in this field including the seminal work on the failure of the CAPM to explain returns. Second, we will discuss a number of investment strategies that have and are being used by investors and how one constructs investment strategies and an actual model. Third, we will discuss the issue of portfolio construction and trading. Topics in this section will include the consideration of transaction costs, risk management and the efficient execution of trading given the current market microstructure. Fourth and finally, we will discuss the dynamics of institutional investment management today, including the shift to more passive investment and low-fee vehicles as well as the impact of MIFID II. We will discuss the topics of machine learning and big data from time-to-time but this is not a course on these topics directly.

Our primary tools in this course will be a mixture of textbooks, lectures and cases. We will also be joined by several luminary industry speakers.

I have some clear biases that will be apparent from my bio. I am a quant – that is, a quantitative asset manager/researcher. That means, I am skeptical about the value of fundamental analysis and as such we will spend little time on this topic. It does not mean that one can ascertain capital "T" Truth through model building. Models are just that: models, an abstraction of reality. But what they allow you to do is, hopefully, avoid the flaws of behavioral biases and heuristics (and in fact profit from others use of them) as well as demand a level of precision and clarity from you in your thinking. There will also be a clear tilt to equity markets as opposed to fixed income, commodity or currencies as almost all my career has been spent thinking about equities.

Grading Policy:

In-class discussion/participation/attendance/punctuality: 15%

Cases/Assignments: 45%

In-class Final exam: 40%

Assignments will be graded on a "check plus", "check", "check minus" system. A clear solid and sincere effort will earn you a "check". To earn a "check-plus", you must do something exemplary. You must really "nail" the issues or do something exemplary, you will earn a "check plus". "Check minuses" are reserved for those showing minimal to no effort. Of course, not handing in a case at all is a more serious issue.

Please do not ask for regrades. They will only be granted when there are clear mathematical errors in adding up the scores. In the exceedingly rare case where a regrade is given, it will also result in the entire exam (assignment) being regarded, which may end up with a new net lower score.

General Course Requirements and Expectations:

Class attendance is required. It is essential that you come to every class, come on time and stay for the entire time. Attendance and punctuality will be a key determinant of class participation grade.

Please note that in accordance with MIT Sloan Classroom policy, MIT Sloan requires that students schedule campus interviews outside of scheduled class times and to make every attempt to schedule second round interviews and site visits outside of class times. Classes missed for such activities are not excused absences and may count against your participation grade.

In-class discussion participation is highly encouraged and thoughtful participation (quality (but not exclusively) more than quantity) will determine the remainder of the participation grade. Please be sensitive to allowing others to participate, talk when you truly have something important to say, and do not dominate the conversation. I am happy to have more detailed conversations after class or in office-hours.

In years past, there have been clear gender and ethnic biases among those students participation levels. This bothers me greatly. ALL students are encouraged to speak up. I do not want to be in the position where I need to start cold-calling on students but I will do so if the class conversation starts to become dominated by a few voices. Know also to be successful in industry, you need to be comfortable speaking and articulating your thoughts. So consider this good training for the workplace. *In short, please participate.*

There will be 2 cases. For the cases, student groups of up to three members per group may turn in assignments jointly. In keeping with MIT Policies on Group Work, you should consider these to be "Type 3 collaboration" – in other words, each team member is expected to make a substantial contribution to each assignment.

There will be 3 homework assignments. These assignments will be traditional homework assignments to make sure you are absorbing the material taught in the class. These

assignments will be individual work that must be completed on your own, with no consultation with anyone else either within the class or any other individual. Referring to the in-class materials is fine. These assignments will be a very good gauge of whether you are mastering the material.

The final exam will be in the exam period and will be closed-book. Obviously, this is individual work with all the associated expectations.

It is your responsibility to familiarize with the MIT Sloan Classroom Policies and Norms and please abide by them (as will I). Please note that laptops and e-readers are not to be open in the classroom. Please note that cell-phones and PDAs are not to be used or permitted to ring in the classroom; texting or other social messaging apps are absolutely not to be used during class.

Please use your plastic nameplates at all times. I am absolutely horrible at remembering names – it is admittedly a bad characteristic of mine that I wish I could change and so please do not be personally offended if out class I do not remember your name.

It is always critically important (and even more so in these emotionally charged times) to recognize others' contributions to the discussion and when disagreeing, to do so respectfully. Few of the complex issues we will be discussing have an absolutely "right" answer so it is important to acknowledge that multiple perspectives on these problems may likely be valid. It is especially important to remember that many of the people will likely come from different personal, cultural and/or professional backgrounds from your own. Please be sensitive and respectful of these views. It is often very helpful to actively acknowledge multiple perspectives on complex issues can be valid.

That said, unwelcome or derogatory remarks based on sex, gender, national origin, race, sexual orientation, or any other class of people will not be tolerated. We should all be vigilant to address the situation immediately if it happens. We should all feel comfortable and empowered to address these situations – whether it is by me, a fellow student, or a visitor to our class.

Furthermore, I feel strongly that the language one uses is important. Even in what may seem trivial, such as the gender of the pronouns one uses or the gender or ethnicity of the participants in examples, language imparts values in subtle ways. I will do my best to be sensitive on this issue – feel free to call me out when I slip. We should all strive to be aware of the language we use.

Please refrain from sidebar conversations. If you have a question or something is truly unclear to you, it is likely unclear to others in the class. Ask it! On the other hand, if it is just a peripheral conversation with a friend, please wait until after class.

I take the issue of academic integrity and plagiarism with the utmost of seriousness. I will have no hesitancy or leniency in enforcing MIT standards in these regards. It is your responsibility to familiarize yourself the document "Academic Integrity at the Massachusetts Institute of Technology: A Handbook for Students" as those articulated by the MIT Sloan School. If you have any questions or are unsure whether some course

of action is proper, it is your responsibility to reach out to me and ask for assistance and/or clarification.

Final Exam:

The final exam will be a closed book exam during the exam period. At the end of each set of lecture notes, there will be a series of "Thought Questions" that are designed to make you think through the issues presented in class. It is my strong advice to you that you read these questions and with your study group you discuss the related issues in-depth. Do not wait until the end of the semester to start this process. The exam questions will closely mirror these questions. Hence, if you are able to clearly articulate the well-reasoned thought-out answers to these questions -- showing your mastery of the debate -- and have done the readings for the class then you should be very well prepared for the final exam.

Final Grades and Final Exams Scheduling:

If you require to take the exam for any reason outside of the regularly scheduled time, it is your responsibility to be aware of this and make arrangements with me by April 15th.

This includes: (i) if you need an early grade for any reason -- for example, a provisional or final grade to graduate -- or because your program is on a different academic calendar from MIT; (ii) if you have some other commitment on the exam day; (iii) if you require extra time on the exam; or (iv) any other reason.

Requests after April 15th will most likely not be honored unless they are due to exceptional circumstances that truly could not have been anticipated.

Required Books:

"Inside the Black Box" by Rishi Narang

"Asset Management: A Systematic Approach to Factor Investing", by Andrew Ang

"Efficiently Inefficient: How Smart Money Invests & Market Prices are Determined", by Lasse Heje Pedersen

"Inefficient Markets", by Andrei Shleifer, Oxford University Press

Supplemental Books:

"Investments" by Z. Bodie, A. Kane and A. Marcus

"Expected Returns" by Antti Ilmanen

Each topic in and of itself could have a supplemental reading list. If you are interested in reading more on a specific topic, please let me know. There are also numerous references in Ang and Pedersen and Ilmanen.

Lecture Packet:

There is a lecture packet for this course with additional readings and case materials.

Detailed class schedule:

(Please note: changes to this schedule are likely! Changes will be announced in class and posted on the class website)

15.439 Schedule and Class List

Module 1 – Capital Markets and Basics of Quant Investing

Monday, February 11 – Intro., Players in the Capital Markets & Intro to Quant Investing

This class features an introduction to the course, followed by an introduction to the major players in the capital markets from both the buy-side and sell-side and exchanges, along with a detailed introduction to quantitative investing.

Assignment: Read Chapter 1 of Ang; Chapter 1 of Pedersen; Chapter 1-2 of Narang

Monday, February 18 – The Rise and Fall of CAPM

In this class, we will review CAPM and the empirical evidence supporting (?) it. In this class, we will review the seminal article in Finance in the last 25+ years: Fama-French (1992) "The Cross-Section of Expected Stock Returns". Read this quite closely and carefully and then we will begin to discuss alternative models to explain equity returns.

Assignment: Eugene Fama and Ken French "The Cross-Section of Expected Returns", *Journal of Finance*, June 1992; and Chapter 6 of Ang (read Chapters 2 and 3 if you need refreshing); "Are Markets Efficient?", Chicago Booth Review (on-line article). Michael Mauboussin "Revisiting Market Efficiency: The Stock Market as a Complex Adaptive System", *Journal of Applied Corporate Finance*, Winter 2002;

Module 2 – Patterns in Asset Returns and Quantitative Investing

Thursday, February 21 (NOTE: The change in date) – Where Do Market Anomalies Come From And How Do You Evaluate Success?

Investors are not utility maximizers or computers. They are subject to a number of biases, use rules of thumbs and a number of heuristics. These create patterns in returns. We will seek to understand how investors make systemic mistakes and the impact this can have on markets and decisions by investors across their economic life. Understanding human behavior in this degree can help to understand the type of strategies we should begin to look for and why they might persist.

Assignment: Chapter 7 of Ang; Chapter 1 of Andrei Shleifer "Inefficient Markets"; Amos Tversky and Daniel Kahneman "Judgement under Uncertainty: Heuristics and Biases", *Science*, September 1974; Optional but suggested: Matthew Rabin Article, "Psychology and Economics", *Journal of Economic Literature*, March 1998.

Monday March 4 - Factors

There are a multitude of factors that have been advanced and a multitude of styles. How does one begin to judge whether a factor is a “real”? What are the possible factors out there? How does one begin to back-test and approach “factor investing”?

Assignment: Read Chapters 2 & 3 of *Efficiently Inefficient*; Read Chapter 3 and Chapter 9 of *Narang*; Read Rothman, “Lehman Brothers Launch Piece”.

Homework Assignment #1 Please turn in via Stellar before start of the class

Monday March 11– More on Factors; Quant Investing and Momentum Case.

In this class, we will continue and conclude our conversation on traditional equity factors.

Case: The "momentum effect" is the tendency of stocks that performed well over the prior year to outperform those that didn't. It's difficult to believe that such a simple strategy could work, yet the historical returns were remarkable in early 2009 when AQR decided to launch a momentum-based mutual fund. The case looks at the pros and cons of such a fund from both the money manager and investor perspectives.

AQR Momentum Case (graded); Please turn in via Stellar before start of the class

Monday, April 1 – Correlation vs. Causation; New Factors, and Big Data and Quant Crisis Case Discussion

In this class, we tackle a number of interrelated topics. The first is a discussion of the Quant Crash of August 2007. Second, we will want to clearly distinguish between causation and correlation. We will begin our examination, we will examine several popular “new factors” and the techniques used to construct them such as Natural Language Processing (NLP). We will also consider several other types of so-called “Big Data” factors. We will not discuss specific machine learning algorithms in this section, as this is a course in and of itself.

Readings: Chapter 9 of *Efficiently Inefficient*; Rothman, “Turbulent Times in Quant Land”, Lehman Brothers; Additional Readings TBD

Case: August 2007 (graded) Please turn in via Stellar before start of the class

Monday, April 8 – Continuing on New Factors, Big Data and *outside speaker, Stephen Cash, Co-Founder, CIO, Seven Eight Capital*

In this class, we will continue our discussion of New Factors, ML, Webscraping and NLP. Finally, we will discuss some of issues of fairness and legality surrounding “Big Data” data-sources, including issues of material non-public information (MNLP). We will not discuss specific machine learning algorithms in this section, as this is a course in and of itself.

Readings: Read Chapter 8 *Narang*; Other readings to TBA

Module 3 – Execution and Portfolio Construction

Thursday, April 11, (NOTE: The change in date) – Short Selling and Portfolio Construction

In order to take advantage of overpriced, as well as underpriced, securities, it is necessary to master the mechanics of selling short. Selling short is not nearly as neat and simple as buying a security (e.g. going long). Moreover, there is no centralized market for shorting (or borrowing) securities. Yet, efficient markets require that overpriced stocks be driven down to their fundamental values. In this class, we will go through and explore the issues associated with shorting.

We will also start our conversation on portfolio construction. In many ways, portfolio construction is one of the principal ways that distinguishes quantitative investors from fundamental investors. We will begin our conversation on the construction

Assignment: Chapter 8 *Efficiently Inefficient*; Article by Owen Lamont, "Short Sale Constraints and Overpricing", working paper (on class website). Chapter 4 of *Efficiently Inefficient*; Chapter 6 of *Narang*.

Monday, April 22 - Portfolio Construction, Risk Models and Portfolio Analytics with outside speaker, Peter Zangari, Global Head of Research and Product Development at MSCI

Portfolio theory is the basic framework for measuring risk and weighing it against expected returns. It is near-universally used by professional investors -- even those who criticize it need to understand it so as to understand the bogey they wish to improve upon. In this class, we will discuss some of the operational issues of portfolio construction, including the construction of risk models, the realities of portfolio optimization, issues of position sizing, questions regarding model overrides and then understanding the actual drivers of one's portfolio ex-post.

Assignment: Chapter 4 of *Efficiently Inefficient*; Chapter 10 of *Narang*; Additional material on optimization to be provided.

Homework Assignment #2: Please turn in via Stellar before start of the class

Monday, April 29 – Trading

Trading costs have been the death of many well-designed investment strategies. On the other hand, skilled trading can be a source of profit rather than cost. This is one of the more technically complex parts of the course and will require a class and a half to discuss fully.

Assignment: Chapter 5 of *Efficiently Inefficient*. Read Lindsey et al "History of Market Microstructure Regulation and 1997 Order Handling Rule"; Read from Credit Suisse "We are all High Frequency Traders Now"; Read from Goldman Sachs, "Presentation on Market MicroStructure"; From Larry Harris book on "Trading and Exchanges" read, Chapter 4, Chapter 19, Chapter 21, Chapter 26, & Chapter 27.

Monday May 6 – Trading continued *with outside speaker Raj Mahajan, Partner, Co-Head of Strats and Engineering, Securities Division, Goldman Sachs and Co-Founder of Allston Trading*

We will conclude the topic on trading and have an outside speaker in to help illuminate the real-world issues of trading as they are being faced today by investors and the sell-side alike.

Readings: Chapters 13, 14, 15, and 16 of *Narang*.

Homework Assignment #3: Please turn in via Stellar before start of the class

Module 5 – Future of Asset Management and Quantitative Investing

Monday, May 13 – Active vs. Passive debate, ETFs and Smart Beta The Future of Asset Management, Scott H

Come to class ready to actively debate these issues. The readings are easy! But the issues are provocative. You should be inspired to participate and speak up!

We will be joined by a very special outside speaker: **David Kabiller, Co-Founding Partner of AQR. OR SHANTA OR Scott from GMO**

Readings: Read Michael Maubissian “Active vs. Passive: Easy Games”, Credit Suisse Research Report; Acadian Asset Management Report, “Smart Beta, Constrained Quant”; Financial Times, “Smart Beta Going MultiFactor”; Financial Times, “Smart Beta versus Traditional Alpha Managers”; FTSE Russell “Survey Results on the Use of Smart Beta”; BlackRock Marketing Materials on Factor Investing.

Monday, May 20 (DATE TO BE CONFIRMED) – Final Exam in class.

This will be a closed book exam. If you can thoroughly and completely debate and understand the issues involved with the “Thought Questions” at the end of each lecture note, have done the readings, and understand the issues involved in the cases you should be well-prepared for the exam. There should be no real surprises on the exam but it will test your understanding of the materials and topics discussed in class.