

# ECON 623: Forecasting Financial Markets

## Course outline

Andrew Patton

*Duke University*

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### Course synopsis

This course will introduce students to some widely-used models used to study and forecast financial markets and familiarize them with the properties of financial data. The models to be covered include autoregressive and ARMA models, GARCH models for volatility forecasting, Value-at-Risk models, and models using high frequency (intra-day) asset prices. Students will be expected to learn and apply the statistical software package MATLAB to implement the models covered in class on real data. Previous knowledge of MATLAB is *not* required.

### Introduction to the course

This course provides an introduction to the main models and methods used in the statistical analysis of financial data, a field known as *financial econometrics*. Such data often comes in the form of time series, and thus much of the course will use methods from time series analysis. One of the main problems in financial economics is to forecast certain properties of financial data in the future (expected returns, measures of risk, measures of correlation) and we will focus heavily on methods for forecasting. The emphasis on forecasting means we will place less emphasis than usual for an econometrics course on distribution theory for estimated parameters (e.g., the construction of standard errors), and place greater emphasis on methods for evaluating and comparing competing models.

Throughout the course, we will compliment the presentation of theoretical material with empirical examples and applications. Homework exercises will be based on addressing empirical problems using the statistical software package MATLAB.

## Objectives of the course

Students completing this course will have seen and applied many of the latest models used in financial econometrics. They will understand some of the key features (both positive and negative) of these models. Further, students will be able to implement these models in statistical software packages, apply them to new data, and interpret the output from these models.

This course can be viewed as an applied econometrics course, with a focus on financial data, and as such may be useful for students interested in econometrics more generally. This course will also provide a basis for advanced study in econometrics and empirical finance, by building familiarity with financial data and with econometric methods for analyzing such data.

## Syllabus

Topics to be covered in this course, subject to time constraints, include:

1. Review of statistics and econometrics (including linear regression and hypotheses tests)
2. Introduction to time series analysis (autocorrelations, AR, MA and ARMA models)
3. The efficient markets hypothesis and financial market predictability
4. Forecasting with ARMA models and model selection methods
5. Forecasting financial market volatility (ARCH/GARCH models and extensions)
6. Methods of evaluating and comparing forecasts (Mincer-Zarnowitz regressions, Diebold-Mariano tests, and extensions)
7. Sensitivity and robustness analyses
8. Multivariate volatility forecasting and correlations
9. High frequency financial data (diurnality, market microstructure)
10. Spurious regressions and cointegration
11. Value-at-Risk and Expected Shortfall forecasting
12. Realized volatility and realized correlation for forecasting
13. Univariate density forecasting (models, methods for evaluating forecasts)
14. Multivariate density forecasting and copulas

## Useful text books

There is no text book for this course: my lecture notes are the only required reading.

**Related books:** The books by Tsay (2010), Campbell, Lo and MacKinlay (1997) and Taylor (2005) cover some similar topics to those in this course. Hamilton (1994) is a good reference for PhD-level time series econometrics. Diebold (2006) provides a nice introduction to economic forecasting at the upper-division undergraduate level, and Christoffersen (2011) presents both methods and empirical tools for risk management applications, again at the upper-division undergraduate level. Brooks (2008) is also aimed at the upper-division undergraduate level. Bodie, Kane and Marcus (2010) and Elton, Gruber, Brown and Goetzmann (2009) are classic introductory text books for finance and investments. Stock and Watson (2010) and Wooldridge (2012) provide good, modern, introductions to econometrics and regression analysis. I assume that students have taken econometrics at least at the level of Stock and Watson (2010) and Wooldridge (2012).

1. Bodie, Z., A. Kane and A.J. Marcus, 2010, *Investments*, 9<sup>th</sup> Ed., McGraw-Hill, USA
2. Brooks, C., 2008, *Introductory Econometrics for Finance*, 2<sup>nd</sup> Ed., Cambridge University Press, Cambridge.
3. Campbell, J. Y., A.W. Lo, and A.C. MacKinlay, 1997, *The Econometrics of Financial Markets*, Princeton University Press, Princeton, New Jersey.
4. Christoffersen, P., 2011, *Elements of Financial Risk Management*, 2<sup>nd</sup> Ed., Academic Press.
5. Diebold, F.X., 2006, *Elements of Forecasting*, 4<sup>th</sup> Ed., South-Western.
6. Elton, E.J., M.J. Gruber, S.J. Brown and W.N. Goetzmann, 2009, *Modern Portfolio Theory and Investment Analysis*, 8<sup>th</sup> Ed., John Wiley & Sons, New York.
7. Hamilton, J.D., 1994, *Time Series Analysis*, Princeton University Press, New Jersey.
8. Stock, J.H. and M.W. Watson, 2010, *Introduction to Econometrics*, 3<sup>rd</sup> Ed., Pearson Education, Boston.
9. Taylor, S, 2005, *Asset Price Dynamics, Volatility, and Prediction*, Princeton University Press, Princeton, New Jersey.
10. Tsay, R.S., 2010, *Analysis of Financial Time Series*, 3<sup>rd</sup> Ed., John Wiley & Sons.
11. Wooldridge, J.M., 2012, *Introductory Econometrics: A Modern Approach*, 5<sup>th</sup> Ed., South-Western.

## Course requirements

Students are required to submit all pieces of assessment by their due dates and to sit for any examinations that are scheduled (see next section for details). Students are also expected to attend all lectures and to work consistently through the homeworks. (Leaving the homeworks until the last minute will reveal itself to be a bad strategy.) The exams will contain a mix of theoretical and empirical questions, and students will need to master both aspects of the course in order to do well.

## Assessment

This course will be assessed using a mix of practical homework assignments and exams:

1. **Four homework assignments**, each worth 7.5%. These will require you to make progress learning Matlab (or applying what you know to financial data). See the separate hand-out for details on these homeworks.

- (a) 4pm, Friday February 2, 2018
- (b) 4pm, Friday February 23, 2018
- (c) 4pm, Friday March 30, 2018
- (d) 4pm, Friday April 20, 2018

No late submissions will be accepted. Students have at least two weeks to complete each assignment, and if away on the due date then the homework must be submitted *early*.

2. **Mid-term examination**, worth 30%. The mid-term exam will be closed-book, no notes. You should bring a basic calculator (*not* a programmable calculator). The exam will contain a mix of theoretical questions and applied questions, and you will be expected to be able to interpret and discuss empirical output.

- In class, Tuesday March 6, 2018.

3. **Final examination**, worth 40%. The final exam will be closed-book, no notes. You should bring a basic calculator (*not* a programmable calculator). The exam will contain a mix of theoretical questions and applied questions, where you will be expected to be able to interpret and discuss empirical output.

- To be held in exam week (April 30 – May 5, 2018), with the exact date and time to be decided by the University. (It is currently scheduled for Friday, May 4, 9am-noon, but the date and time not confirmed yet.)

## Office hours and TA details

**Econ 623 teaching assistant:** Peter Horvath

**Email:** `peter.horvath@duke.edu`

**Office hours:** Mondays and Thursdays, 4:40-5:55pm, in Soc Psy 126. (First session: Jan 22.)

Peter can answer questions about the theoretical material that we cover in class, but he is primarily here to help students with Matlab. For the first two weeks his office hours will be entirely spent giving an introduction to Matlab, including basic commands, loading data sets, etc. Students who have never used Matlab before should be sure to attend those two sessions.

My details are below:

**Email:** `andrew.patton@duke.edu`

**Office hours:** Mondays, 3:30-4:30pm, in Social Sciences 228-F.