McGILL UNIVERSITY
Department of Economics
Economics 661: Applied Time Series and Forecasting

Course outline and reading list 2024 (tentative)

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This course treats predictive models, both in the time domain (prediction of future values or events) and in cross-section (prediction of the actions of individuals). We study the theory and principles necessary to understand and guide our predictive models, and a set of methods which can be applied to a variety of prediction problems.

Official statements:

1. Academic integity.

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2. Language of Submission:

In accord with McGill University's Charter of Students' Rights, students in this course have the right to submit in English or in French any written work that is to be graded.

3. Text matching software:

Work submitted for evaluation as part of this course may be checked with text matching software within myCourses.

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In the event of extraordinary circumstances beyond the University's control, the content and/or evaluation scheme in this course is subject to change.

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7. Etiquette Statement:

The University recognizes the importance of maintaining teaching spaces that are respectful and inclusive for all involved. To this end, offensive, violent, or harmful language arising in contexts including the following may be cause for disciplinary action: 1. Username (use only your legal or preferred name) 2. Visual backgrounds 3. "Chat" boxes.

To maintain a clear and uninterrupted learning space for all, you should keep your microphone muted throughout your class, unless invited by the instructor to speak. You should follow instructor's directions about the use of the chat function on remote learning platforms.

Books:

Here are a number of potentially useful books. You do not need to read all of these. You may wish to refer to some of them for your projects as well as for particular topics. We will discuss their relative strengths and weaknesses in class.

Reference texts:

Diebold, F.X. Elements of Forecasting. Thomson.

Elliot, G. and A. Timmermann Economic Forecasting. Princeton University Press, Princeton, 2016.

Hyndman, R. J. and G. Athanasopoulos. Forecasting: Principles and Practice. Available free online from https://otexts.com/fpp2/ .

These are good general texts that cover many aspects of forecasting and give overviews of the subject. References to chapters in these books will be given under the topic headings below. It is not necessary to read each of them; various alternatives are given for several topics and you should read at least one of the texts for these topics.

The Diebold book is less technical, but provides a very good overview of the subject and much useful advice. Hyndman's book is similar in coverage and level and I like it also. The Elliott-Timmerman treatment is technically sophisticated and thoroughly covers a number of topics not covered in the others. We can discuss their relative strengths and weaknesses further in class.

For statistical review:

Mood, Graybill and Boes Introduction to the Theory of Statistics. McGraw-Hill, 1974.

For background in econometrics and time series:

Hamilton, J. Time Series Analysis. Princeton University Press, 1994.

Davidson, R. and J.G. MacKinnon Estimation and Inference in Econometrics. Oxford University Press, New York, 1993.

For non-stationary time series and co-integration:

Banerjee, A., J.J. Dolado, J.W. Galbraith and D.F. Hendry Co-Integration, Error-Correction, and the Econometric Analysis of Non-stationary Data. Oxford University Press, Oxford and New York.

For machine learning:

Hastie, T., R. Tibshirani and J. Friedman The Elements of Statistical Learning: data mining, inference and prediction. Springer, New York, 2009. Available free online through McGill library.

We will refer to books hereafter by the surname of the author. References to other books and to selected papers will be given under the appropriate section headings.

Software:

For text editing, you can get TEX and LaTEX free from (among other sources) www.miktex.org (beware of the spoof site, www.miktek.org, whch exploits the pronunciation of TEX).

For programming and data analysis, I recommend that you become familiar with one of: Matlab, Python, R. If you are familiar already with Stata, EViews, RATS or a similar program, you can use whichever you are familiar with.

Evaluation:

Evaluation will be based on a project, in two parts, and a final examination. The project will be worth 40% of your grade, and the exam 60% of the grade. There will be some informal assignments, which you do not need to hand in, but which will be reviewed by the course TA in tutorials.

Tentatively, the project will be submitted in two stages. The first stage is a literature review for the area of forecasting which the original forecasting work will address. I plan to look at the literature reviews to help make sure that your projects are on the right track, but to evaluate them only as part of the final project. The final project will combine these two elements into an overall study of a particular forecasting problem. Both the literature review and the overall combined project should be written in the form of a journal article.

For the literature review part of this project, evaluation will be based on the breadth of the work reviewed, precision of the description of results (including numerical results for comparison of methods), clarity and scope of the overview of the literature that is presented, and quality of exposition, graphics and production of the text. For the original forecasting work, evaluation will be based on quality of the data analysis, work that went into data set construction, originality, care and thoroughness of interpretation of the results, quality of exposition, graphics and production of the text. In each case, the general standard of argumentation is of course an important global factor.

Both writing and analysis for the project are of course to be entirely your own work, without help from either artificial or other human intelligences. (Of course, it's ok to use search algorithms or other AI to identify potentially relevant papers that you might want to read.)

Office:

Leacock 321A (third floor, south-east corner, behind the outer door).

Office hours: 2×1.5 hours each week; times to be determined.

Links for readings:

Many of the readings can be obtained online through this single link (which may be updated in January):

https://mcgill.on.worldcat.org/courseReserves/course/id/17363859

Topics:

The first topics are well covered in textbooks; later topics rely more on journal articles. References to book chapters are given first below, followed by journal articles.

1. Review of statistical concepts

–density and distribution
– kernel density estimation for data examination and verification
–information content of correlated processes
–informal data characterization and transformation

· Mood, Graybill, Boes is an excellent reference for this section.
· Diebold, ch. 2
· I will also post my constantly-under-revision *Economic Statistics* notes for undergraduate Honours Economic Statistics.

2. Background and aims of forecasting

–characterizing distributions
–exploiting information efficiently
–effective presentation of point, interval and density and other forecasts
–time series forecasting vs cross-sectional prediction
–decision-theoretic interpretation
–loss and risk functions: MSE, MAE, Linex
–forecast properties: smoothness, convergence to unconditional mean and variance

· Diebold, ch. 3
· Elliott-Timmermann, ch 2,3
· Hyndman, ch 1-4
· Ioannidis (2005), van Norden (2020)

3. Basic concepts of time series analysis (univariate processes)

—autocorrelation, autocovariance, partial autocorrelation functions
—AR, MA, ARMA processes
—estimation methods
—model selection: penalty function methods, information criteria
—long-memory models (optional)

· Box and Jenkins (1970)
· Choi (1992), esp. ch. 3 on penalty function methods
· Diebold, ch. 7,8
· Elliott-Timmermann, ch 7
· Hyndman, ch 8 (also 5,6)

4. Non-stationarity and modeling non-stationary processes
- – unit root processes, integration and co-integration
- – modeling co-integrated processes; spurious regression
- – statistical inference with stochastic trends

· Banerjee et al.
· Diebold, ch. 13
· Elliott-Timmermann, ch. 20

5. Models and methods: conditional mean and probability forecasts
- –parsimonious modelling: reasoning
- –forecasts from time series models and regression methods
- –multiple-horizon iterated forecasts vs direct projection
- –data mining, overfitting, in-sample, out-of-sample and pseudo-out-of-sample
- –Out-of-sample and pseudo-out-of-sample evaluations
- –data 'snooping' and p-value hacking
- –forecast combination

· Diebold, ch. 10-12
· Elliott-Timmermann, ch 14
· Bates and Granger (1969), Ioannidis (2005), White, H. (2000)

6. Models and methods: overview of more advanced methods
- –model selection
- –machine learning (automated model selection) methods; LASSO, PCA
- –dynamic factor models
- –classification algorithms
- –probability forecast models

· Hastie et al.
· Elliott-Timmermann, ch 6
· Boivin and Ng (2006), Mullainathan and Spiess (2017), Stock and Watson (2002)

7. Forecasting models and methods: conditional variances
- –ARCH, GARCH and variants
- –Realized volatility
- –stochastic volatility models

· Diebold, ch. 14
· Elliott-Timmermann, ch 13

8. Forecast evaluation
- –point, interval, probability and density
- –loss functions for conditional mean, variance forecasts

–probability forecast evaluation: PIT, ROC, kernel methods
–statistical inference

· Elliott-Timmermann, ch 15-18
· Brier (1950), Chong and Hendry (1986), Christoffersen (1998), Clark and McCracken (2001), Corradi and Swanson (2006), Diebold and Mariano (1995), Diebold et al. (1998), Galbraith and van Norden (2011), Gneiting (1998), Gneiting et al (2007), Mitchell and Wallis (2011), Murphy (1973), Murphy and Winkler (1987) Patton and Timmerman (2012)

9. Forecast horizons, content horizons and skill
–correlation of optimal forecast errors at horizon h
–forecast skill and maximum attainable horizons in time series models
–empirical values

· Diebold, ch 9, 12 (some subsections)
· Galbraith (2003), Johannsen et al. (2020) (https://www.ecmwf.int/en/publications/technical-memoranda)

10. Presentation of forecasts and scientific reporting
–scientific reporting for specialist and non-specialist audiences
–densities, shorths, confidence intervals
–forecasting fallacies to address

· Brittan (1998), Wallis (1999)

11. Nowcasting and real-time data
–real-time and vintage data
–mixed-frequency models (bridge, MIDAS)
–archives and forecast method evaluation
–non-traditional data sources

· Bańbura et al. (2013), Croushore and Stark (2001), Schumacher (2016)

References

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