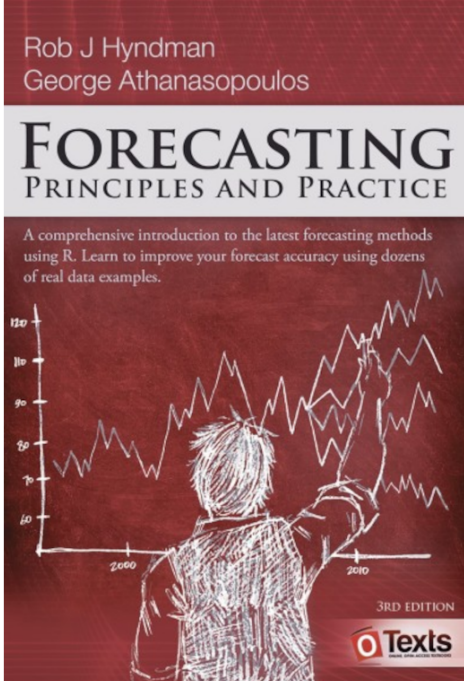
ETC3550/ETC5550
Applied forecasting

Revision

OTexts.org/fpp3/



Outline

1. Assignment 1
2. Some case studies
3. Review of topics covered
4. Exam

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Assignment 1

Stock price forecasting (Q1 and Q5)

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Maximum temperature at Melbourne airport on 12 April 2021. (Q2)

- Weather is relatively stationary over similar time of year and recent years.
- So take mean and var of max temp in April over last 10 years.

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Difference in points in AFL match (Q3)

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Seasonally adjusted estimate of total employment (Q4)

- Probably locally trended.
- Perhaps use drift method based on average monthly change in last 2 years.

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CASE STUDY 1: Paperware company

Problem: Want forecasts of each of hundreds of items. Series can be stationary, trended or seasonal. They currently have a large forecasting program written in-house but it doesn't seem to produce sensible forecasts. They want me to fix it.

Additional information

- Program written in COBOL making numerical calculations limited. It is not possible to do any optimisation.
- Their programmer has little experience in numerical computing.
- They employ no statisticians and want the program to produce forecasts automatically.

CASE STUDY 1: Paperware company

Methods currently used

- **A** 12 month average
- **C** 6 month average
- **E** straight line regression over last 12 months
- **G** straight line regression over last 6 months
- **H** average slope between last year's and this year's values. (Equivalent to differencing at lag 12 and taking mean.)
- **I** Same as H except over 6 months.
- **K** I couldn't understand the explanation.

CASE STUDY 2: PBS

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The Pharmaceutical Benefits Scheme (PBS) is the Australian government drugs subsidy scheme.

- Many drugs bought from pharmacies are subsidised to allow more equitable access to modern drugs.
- The cost to government is determined by the number and types of drugs purchased. Currently nearly 1% of GDP.
- The total cost is budgeted based on forecasts of drug usage.

CASE STUDY 2: PBS

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- In 2001: $4.5 billion budget, under-forecasted by $800 million.
- Thousands of products. Seasonal demand.
- Subject to covert marketing, volatile products, uncontrollable expenditure.
- Although monthly data available for 10 years, data are aggregated to annual values, and only the first three years are used in estimating the forecasts.
- All forecasts being done with the `FORECAST` function in MS-Excel!

CASE STUDY 3: Car fleet company

Client: One of Australia's largest car fleet companies

Problem: how to forecast resale value of vehicles? How should this affect leasing and sales policies?

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Additional information

- They can provide a large amount of data on previous vehicles and their eventual resale values.
- The resale values are currently estimated by a group of specialists. They see me as a threat and do not cooperate.

CASE STUDY 4: Airline

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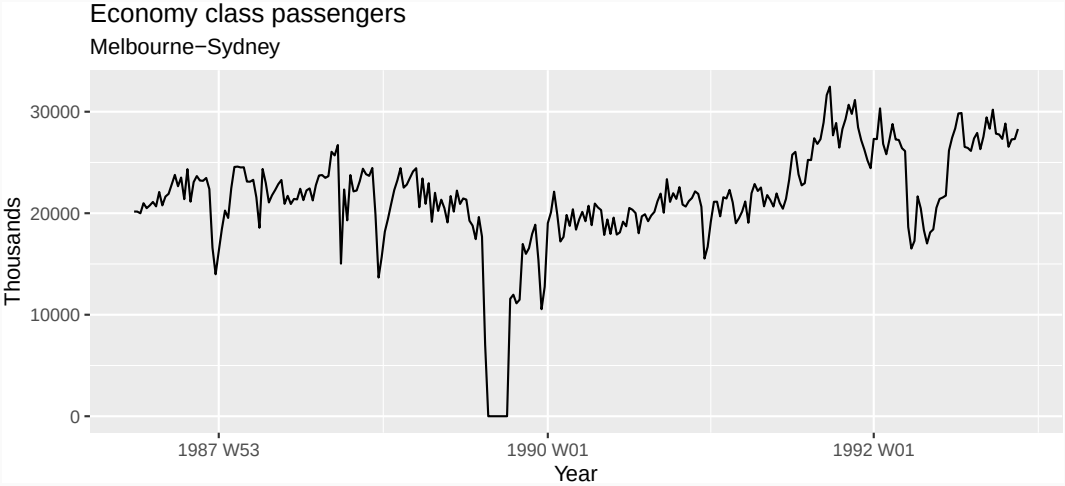

CASE STUDY 4: Airline

Problem: how to forecast passenger traffic on major routes?

Additional information

- They can provide a large amount of data on previous routes.
- Traffic is affected by school holidays, special events such as the Grand Prix, advertising campaigns, competition behaviour, etc.
- They have a highly capable team of people who are able to do most of the computing.

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- Time series data and `tsibble` objects.
- What makes things hard/easy to forecast.

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2. Time series graphics

- Time plots
- Seasonal plots
- Seasonal subseries plots
- Lag plots
- ACF
- White noise

3: Time series decomposition

- Describing a time series: seasonality, trend, cycles, changing variance, unusual features.
- Transformations (and adjustments)
- Difference between seasonality and cyclicity.
- Interpreting a decomposition.
- Seasonal adjustment.
- Forecasting and decomposition.

5. The forecasters' toolbox

- Four benchmark methods: naïve, seasonal naïve, drift, mean.
- Forecasting involves distributions of future observations.
- Residual diagnostics: white noise, ACF, LB test.
- Problem of over-fitting.
- Out-of-sample accuracy. Training/test sets.
- Measures of forecast accuracy: MAE, MSE, RMSE, MAPE, MASE.
- Time series cross-validation.
- One-step prediction intervals based on RMSE from residuals.

8: Exponential smoothing

- Simple exponential smoothing.
- Holt's local trend method.
- Damped trend methods.
- Holt-Winters seasonal method (additive and multiplicative versions).
- ETS state space formulation.
- Interpretation of output in R.
- Computing forecasts by setting future ε_t to 0.
- Assumptions for prediction intervals.
- You have access to formula in the textbook.

9: ARIMA models

- Stationarity.
- Transformations
- Differencing (first- and seasonal-differences). What to use when.
- White noise, random walk, random walk with drift, AR(p), MA(q), ARMA(p,q), ARIMA(p, d, q), ARIMA$(p, d, q)(P, D, Q)_m$.
- ACF, PACF. Model identification.
- ARIMA models, Seasonal ARIMA models
- Order selection and goodness of fit (AICc)
- Interpretation of output in R.

9: ARIMA models (cont'd)

- Backshift operator notation.
- Expanding out an ARIMA model for forecasting.
- Finding point forecasts for given ARIMA process.
- Assumptions for prediction intervals.
- One-step prediction intervals based on RMSE.
- Effect of differencing on forecasts.
- Effect of a constant on forecasts.
- ARIMA vs ETS.

7: Multiple regression

- Interpretation of coefficients and R output and residual diagnostics.
- Dummy variables, seasonal dummies, piecewise linear trends, interventions.
- Harmonic regression.
- Variable selection.
- AIC, AICc, BIC, R^2, adjusted R^2.
- Ex ante vs ex post forecasts.
- Scenario forecasting.
- (Matrix formulation.)

10: Dynamic regression models

- Problems with OLS and autocorrelated errors.
- Regression with ARIMA errors.
- Difference between regression residuals and ARIMA (innovation) residuals.
- Dynamic harmonic regression (and other specifications). Review the last lecture examples.
- Stochastic vs deterministic trends.
- Using lagged predictors
- Forecasting for dynamic regression models with ARIMA errors

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Exam: 9.00am (AEST) 15 June

Five Sections, all to be attempted.

A Short answers/explanations. Write about 1/4 page on four topics (out of six possible topics). Nuanced answers required.

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- **E-Assessment**
- Open access
- Invigilated
- 2 hours 10 minutes + (30 minutes to upload images).

Preparing for the exam

- Exams from 2019–2021 on Moodle already.
- Solutions to follow soon.
- Exercises. Make sure you have done them all (especially the last two topics - revise the lecture examples)!
- Identify your weak points and practice them.
- Write your own summary of the material.
- Practice explaining the material to a class-mate.

Help available

- See us during the consultation times (for details refer to the moodle page.
- Discuss on the moodle forum.

Useful resources for forecasters

Organization:

- International Institute of Forecasters.

Annual Conference:

- International Symposium on Forecasting
  - Oxford, UK, July 4-7, 2022.
  - Free to our student members ($25).

Journals:

- International Journal of Forecasting
- Foresight (the practitioner's journal)

Links to all of the above at **www.forecasters.org**

IIF Best Student Award

- https://forecasters.org/programs/research-awards/students/
- US$100
- A certificate of achievement from the IIF
- One year free membership of the Institute with all attendant benefits. Subscriptions to:
  - the International Journal of Forecasting
  - the practitioner journal: Foresight
  - The Oracle newsletter

Discounts on conference and workshop fees, and links to a worldwide community of forecasters in many disciplines.

Happy forecasting

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Please fill in your SETU