ETC3550: Applied forecasting for business and economics

Revision

OTexts.org/fpp2/

Outline

1 **Some case studies**

2 Review of topics covered

3 Exam

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 tell them what is wrong and 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

- 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!

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Problem: How to do the forecasting better?

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.

Economy class passengers: Melbourne–Sydney
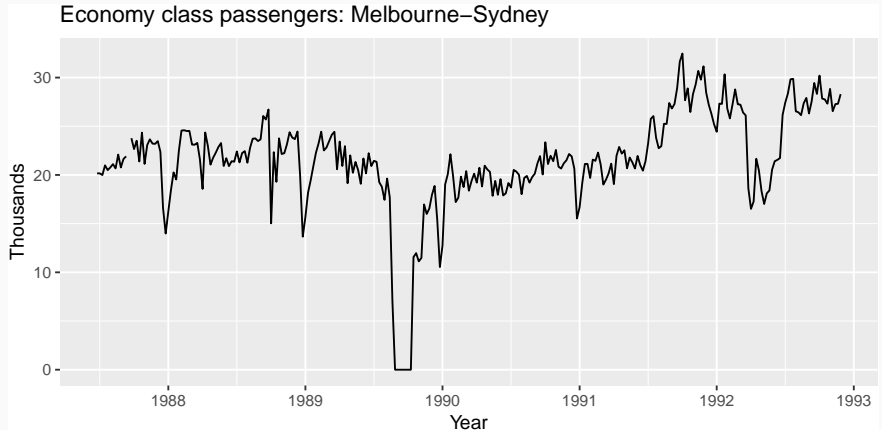
CASE STUDY 4: Airline

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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1. Introduction to forecasting and R

- `ts` objects
- seasonal periods
- frequency, start, end
- You don't have to write R code for the exam, but you do have to read and understand R code.

2. Time series graphics

- time plot
- season plot
- subseries plot
- lag plot
- ACF

3. The forecasters' toolbox

- Measures of forecast accuracy: MAE, MSE, RMSE, MAPE, MASE
- Training/test sets. Out-of-sample accuracy
- Problem of over-fitting.
- Time series cross-validation
- Box-Cox transformations to stabilize changing variance. Back-transformations after forecasting.
- Residual diagnostics: ACF, white noise, LB test.
- Simple methods: naive, seasonal naive, drift, mean.
- Simple models: Random walk (with drift).
- One-step prediction intervals based on RMSE

6: Time series decomposition

- Describing a time series: seasonality, trend, cycles, changing variance, unusual features.
- Difference between seasonality and cyclicity
- Seasonal adjustment
- Classical decomposition: should know how to do
- Moving averages
- X-12-ARIMA and STL: should know how to interpret
- Advantages/disadvantages of each method
- Forecasting and decomposition

7: 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 `ets()` output in R.
- Computing forecasts by setting future ε_t to 0.
- Assumptions for prediction intervals
- Formula sheet provided

8: ARIMA models

- Stationarity.
- Differencing: first-differences and seasonal-differences. What to use when.
- Unit root tests: how to interpret results.
- White noise, random walk, AR(p), MA(q), ARMA(p,q), ARIMA(p, d, q), ARIMA(p, d, q)(P, D, Q)$_s$.
- Backshift operator notation
- ACF, PACF. Model identification.
- ARIMA models, Seasonal ARIMA models
- Order selection and goodness of fit (AICc)

8: ARIMA models (cont'd)

- 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

5: Multiple regression

- Interpretation of coefficients as marginal effects (taking account of the effect of all other predictors in the model)
- Residual diagnostics: scatterplots of residuals vs predictors and residuals vs fitted values.
- Dummy variables, seasonal dummies, piecewise linear trends, interventions
- AIC, AICc, BIC, R^2, adjusted R^2
- Matrix formulation
- Multicollinearity
- Interpretation of R output.

9: Dynamic regression models

- Regression with ARMA errors
- Using lagged predictors
- Difference between regression residuals and ARIMA residuals.
- When estimating, need to difference all variables if errors non-stationary
- Problems with OLS and autocorrelated errors
- Forecasting for regression models with ARMA errors

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Exam

- Five questions, all to be attempted.
- Q1: Short answers/explanations. Write about 1/4 page on four topics (out of six possible topics). Nuanced answers required.
- Q2: Describing a time series, choosing a forecasting method
- Q3: ETS models
- Q4: ARIMA model
- Q5: Regression or dynamic regression.
- Formula page as for ETC2450 2017.

Exam

Preparing for the exam

- 2015, 2016 and 2017 exams from ETC2450 to be put on Moodle with solutions.
- Exercises. Make sure you have done them all!
- Identify your weak points and practice them.
- Write your own summary of the material covered.
- Practice explaining the material to a class-mate.

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Help available

See Puwasala in first instance.

Useful resources for forecasters

Organization:

- International Institute of Forecasters.

Annual Conference:

- International Symposium on Forecasting, Boulder. June 2018.

Journals:

- International Journal of Forecasting
- Foresight

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

Happy forecasting

Good forecasters are not smarter than everyone else,
they merely have their ignorance better organised.