

# ETC3550/ETC5550

## Applied forecasting

Revision

[OTexts.org/fpp3/](https://OTexts.org/fpp3/)



# Outline

- 1 Some case studies
- 2 Review of topics covered
- 3 Exam

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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

**ABC News Online**  
AUSTRALIAN BROADCASTING CORPORATION

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This Bulletin: **Wed, May 30 2001 6:22 PM AEST**

**POLITICS**

## Opp demands drug price restriction after PBS budget blow-out

The Federal Opposition has called for tighter controls on drug prices after the Pharmaceutical Benefits Scheme (PBS) budget blew out by almost \$800 million.

The money was spent on two new drugs including the controversial anti-smoking aid Zyban, which dropped in price from \$220 to \$22 after it was listed on the PBS.

**the Public Record**  
For full election coverage

**FEATURES**

**the Public Record**  
Federal Election 2001

[For a fresh perspective on the federal election, reach into ABC Online's campaign weblog, The Poll Vault.](#)

Audio News Online



## 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!

## CASE STUDY 3: Car fleet company

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

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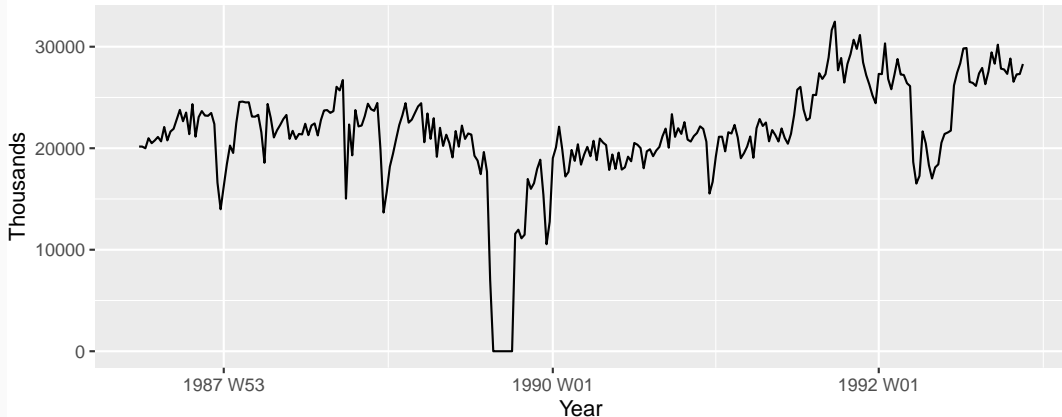
- They can provide a large amount of data on previous vehicles and their eventual resale values.
- The resale values are currently estimated by a group of specialists. They see me as a threat and do not cooperate.

## CASE STUDY 4: Airline



# CASE STUDY 4: Airline

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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- Time series data and `tsibble` objects.
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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  $\varepsilon_t$  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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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](http://www.forecasters.org)

# IIF Best Student Award

- <https://forecasters.org/programs/research-awards/students/>
- US\$100
- A certificate of achievement from the IIF
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  - ▶ The Oracle newsletter

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

# Happy forecasting

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

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Please fill in your SETU