

# fpp3

## Chapter 1

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# Outline

- 1 What can we forecast?
- 2 Forecasting, planning and goals
- 3 Determine what to forecast
- 4 Forecasting models and data
- 5 How to present forecast
- 6 The statistical forecasting perspective
- 7 Some case studies

# Outline

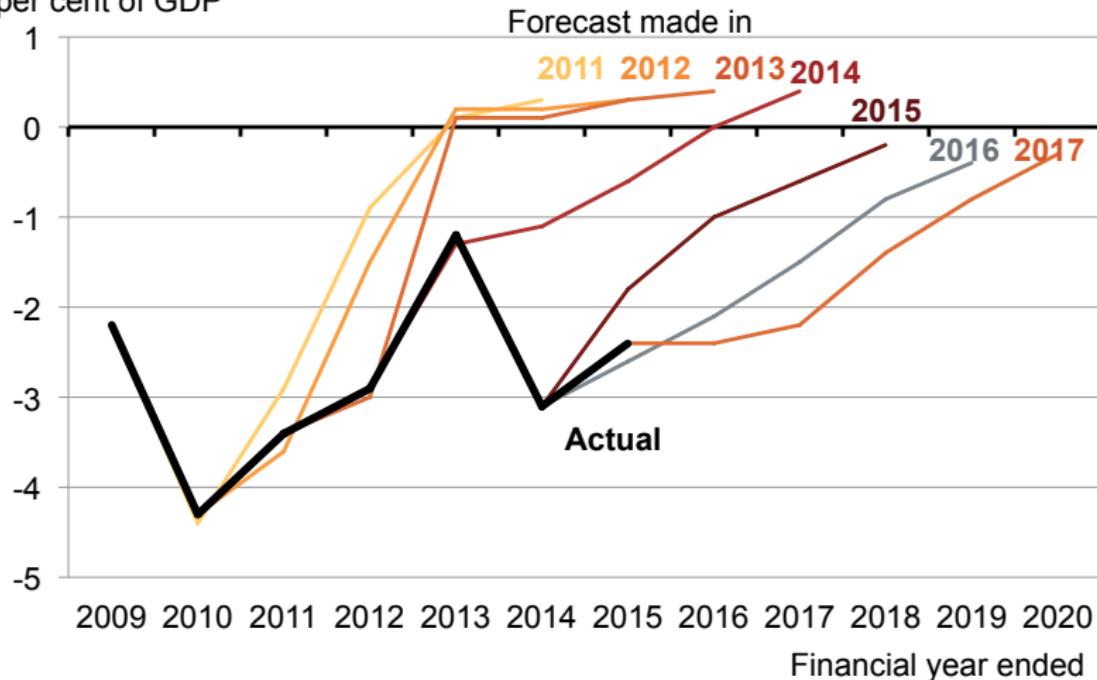
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# Forecasting is difficult

Commonwealth plans to drift back to surplus  
show the triumph of experience over hope

GRATTAN  
Institute

Actual and forecast Commonwealth underlying cash balance  
per cent of GDP



# Forecasting is difficult

## A Timeline of Very Bad Future Predictions

1800



“Rail travel at high speed is not possible, because passengers, unable to breathe, would die of asphyxia.”

Dr. Dionysys Larder, Professor of Natural Philosophy & Astronomy, University College London

1859



“Drill for oil? You mean drill into the ground to try and find oil? You’re crazy!”

Associates of Edwin L. Drake refusing his suggestion to drill for oil in 1859 (Later that year, Drake succeeded in drilling the first oil well.)

1876



“This telephone has too many shortcomings to be seriously considered as a means of communication.”

Western Union internal memo

1880



“Everyone acquainted with the subject will recognize it as a conspicuous failure.”

Henry Morton, president of the Stevens Institute of Technology, on Edison's light bulb

1902



“Flight by machines heavier than air is unpractical and insignificant, if not utterly impossible.”

Simon Newcomb, Canadian-American astronomer and mathematician, 18 months before the Wright Brothers' flight at Kittyhawk

1916



“The idea that cavalry will be replaced by these iron coaches is absurd. It is little short of treasonous.”

Comment of Aide-de-camp to Field Marshal Haig, at tank demonstration

1916



“The cinema is little more than a fad. It's canned drama. What audiences really want to see is flesh and blood on the stage.”

Charlie Chaplin, actor, producer, director, and studio founder

1921



“The wireless music box has no imaginable commercial value. Who would pay for a message sent to no one in particular?”

Associates of commercial radio and television pioneer, David Sarnoff, responding to his call for investment in the radio

1946



“Television won't last because people will soon get tired of staring at a plywood box every night.”

Darryl Zanuck, movie producer, 20th Century Fox

1977



“There is no reason for any individual to have a computer in his home.”

Ken Olson, president, chairman and founder of Digital Equipment Corporation

1995



“Read newspapers online.”

“The truth is no online database will replace your daily newspaper.”

Clifford Stoll, Newsweek article entitled *The Internet? Bah!*

# What can we forecast?



# What can we forecast?



# What can we forecast?



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# What can we forecast?



# Which is easiest to forecast?

- 1 daily electricity demand in 3 days time
- 2 timing of next Halley's comet appearance
- 3 time of sunrise this day next year
- 4 Google stock price tomorrow
- 5 Google stock price in 6 months time
- 6 maximum temperature tomorrow
- 7 exchange rate of \$US/AUS next week
- 8 total sales of drugs in Australian pharmacies next month

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- what makes something easy/difficult to forecast?

# Factors affecting forecastability

Something is easier to forecast if:

- we have a good understanding of the factors that contribute to it
- there is lots of data available;
- the forecasts cannot affect the thing we are trying to forecast.
- there is relatively low natural/unexplainable random variation.
- the future is somewhat similar to the past

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# Forecast

Forecast is :

about predicting the future as accurately as possible,  
given all of the information available, including  
historical data and knowledge of any future events  
that might impact the forecasts.

# Goals/Targets

are what you would like to have happen. Goals should be linked to forecasts and plans, but this does not always occur. Too often, goals are set without any plan for how to achieve them, and no forecasts for whether they are realistic.

# Planning

is a response to forecasts and goals. Planning involves determining the appropriate actions that are required to make your forecasts match your goals.

# Why do organisations need forecasting?

## Why do you need forecast?

- A forecast does not exist for its own purpose.  
There is at least one reason why we want a forecast, typically multiple reasons;
- Most often the reason or reasons will make it adamantly clear what to forecast;
- Tailor forecasting to decisions.

# From operational to strategic forecasting

- Short-term forecasts
- Medium-term forecasts
- Long-term forecasts

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# What to forecast

## Determine what to forecast

- Forecast variable/s
- Time granularity
- Frequency
- Horizon
- Hierarchy/group granularity
- *How to report accuracy*

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# Available data/information

- 1 Historical data/time series of the forecast variable
- 2 Knowledge of any other events/variables
  - ▶ Deterministic variables
  - ▶ Stochastic variables
  - ▶ New information

# Different forecasting models

- The choice of model depends on data availability and forecast situation.

	No data	Past data	Exogenous variable
Judgmental	X		
Time series		X	
Explanatory			X

# Time series

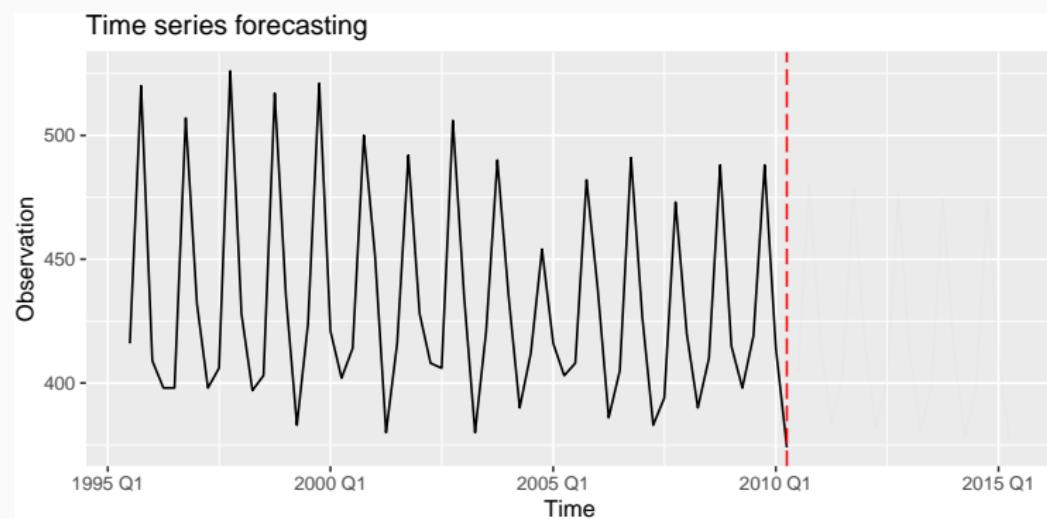
- Time series consist of sequences of observations collected over time.
- We will assume the time periods are equally spaced.

# Time series data

- Four-yearly Olympic winning times
- Annual Google profits
- Quarterly Australian beer production
- Monthly rainfall
- Weekly retail sales
- Daily IBM stock prices
- Hourly electricity demand
- 5-minute freeway traffic counts
- Time-stamped stock transaction data

# What will happen next?

- Time series forecasting is estimating how the sequence of observations will continue into the future.



# Time Series forecasting models

- There are many different kinds of time series models:
  - ▶ Simple methods, e.g. naive
  - ▶ Exponential smoothing
  - ▶ AutoRegressive Integrated Moving Average(ARIMA)
  - ▶ Regression
  - ▶ etc

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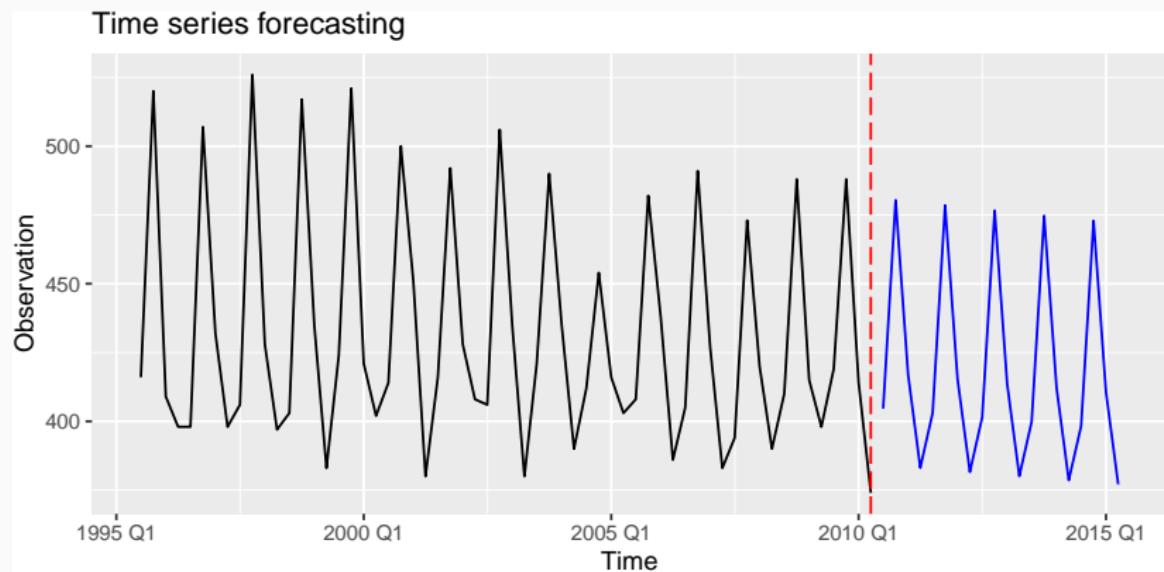
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# How to present forecasts?

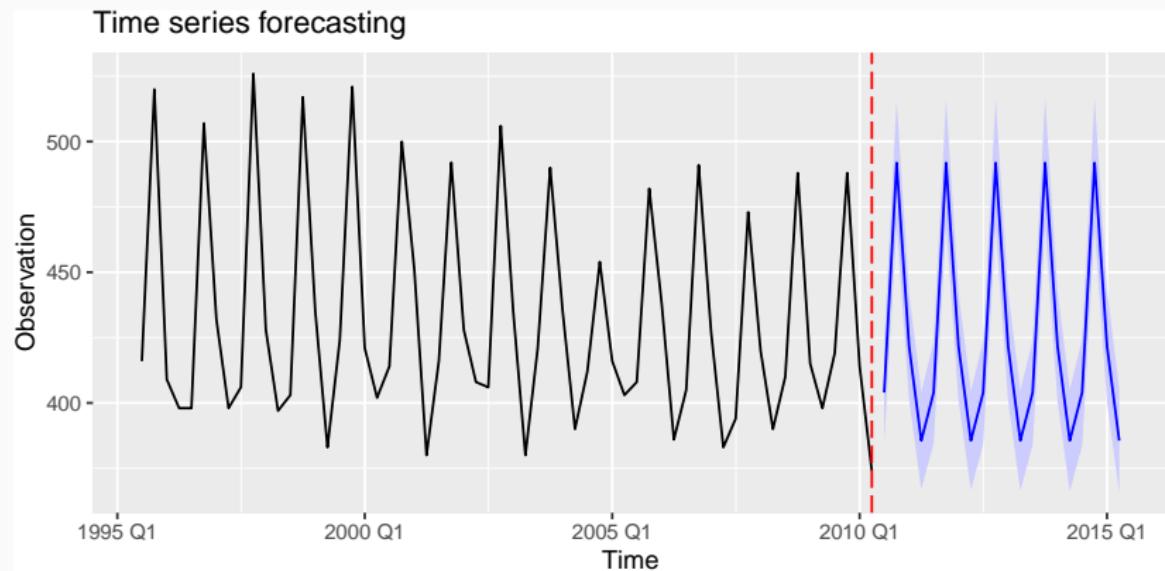
- Point forecasts
- Prediction intervals
- Forecast as probability distribution

A forecast should acknowledge that the future is uncertain and provide information of that uncertainty.

# Point forecasts



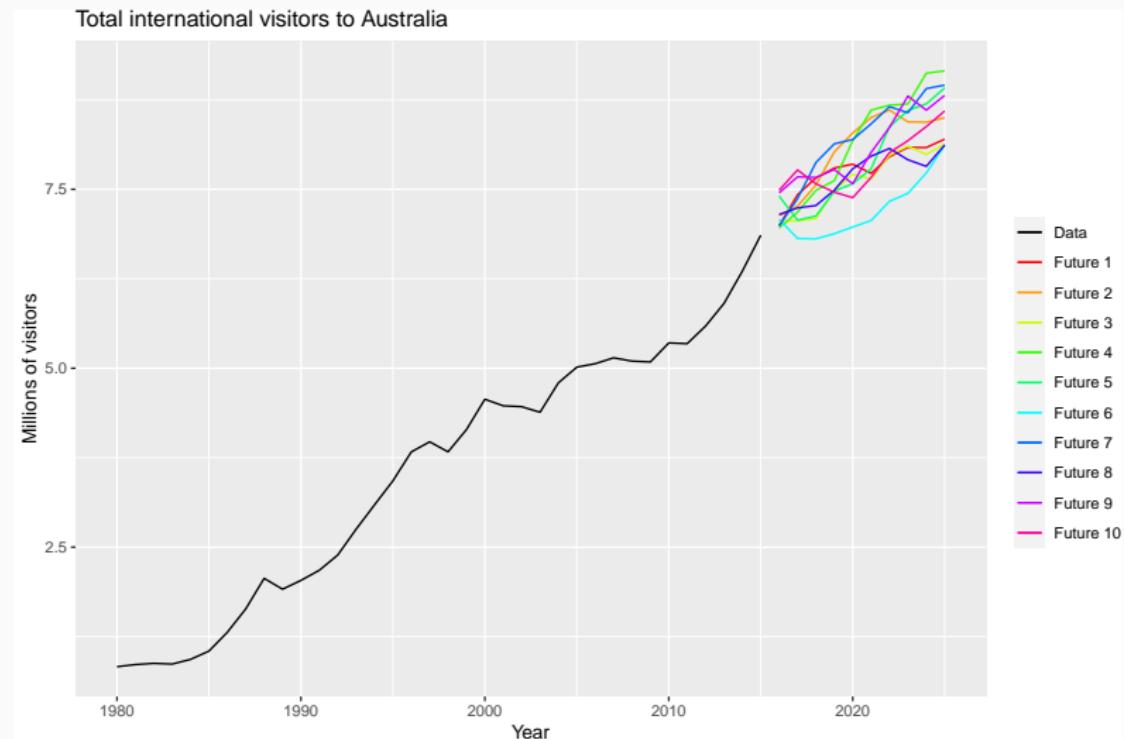
# Prediction interval forecasts



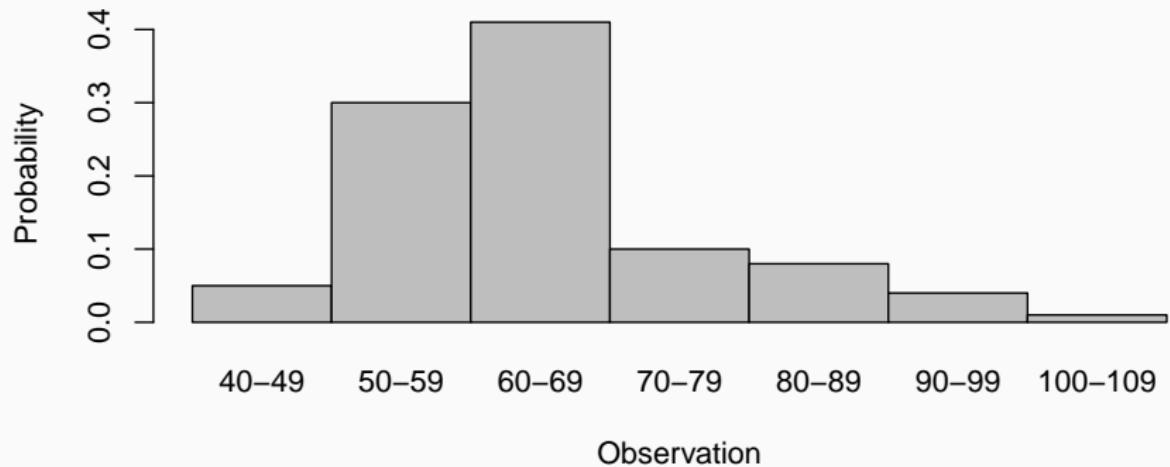
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# Sample futures



# Forecast as probability distribution



# Statistical forecasting

- Thing to be forecast: a random variable,  $y_t$ .
- Forecast distribution: If  $\mathcal{I}$  is all observations, then  $y_t|\mathcal{I}$  means “the random variable  $y_t$  given what we know in  $\mathcal{I}$ ”.
- The “point forecast” is the mean (or median) of  $y_t|\mathcal{I}$
- The “forecast variance” is  $\text{var}[y_t|\mathcal{I}]$
- A prediction interval or “interval forecast” is a range of values of  $y_t$  with high probability.
- With time series,  $y_{t|t-1} = y_t|\{y_1, y_2, \dots, y_{t-1}\}$ .
- $\hat{y}_{T+h|T} = E[y_{T+h}|y_1, \dots, y_T]$  (an  $h$ -step forecast taking account of all observations up to time  $T$ ).

# Current situation in your organisation

- Which decisions need to be informed by forecasts?
- What do you forecast?
  - ▶ variable
  - ▶ granularity
  - ▶ frequency
  - ▶ horizon
- How do you present forecasts?
- Do you need to adjust statistical forecasts?
  - ▶ When and how you do it?

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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 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

# 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



## CASE STUDY 2: PBS

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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AUSTRALIAN BROADCASTING CORPORATION

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## 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.

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## 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

**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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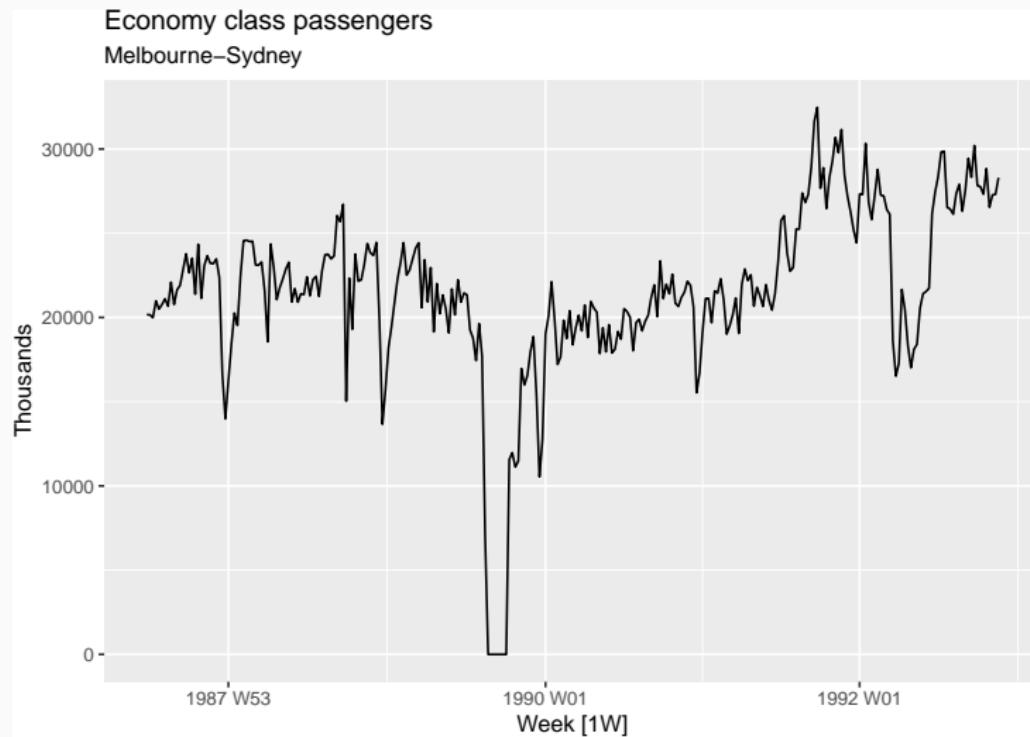
## Additional information

- 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.

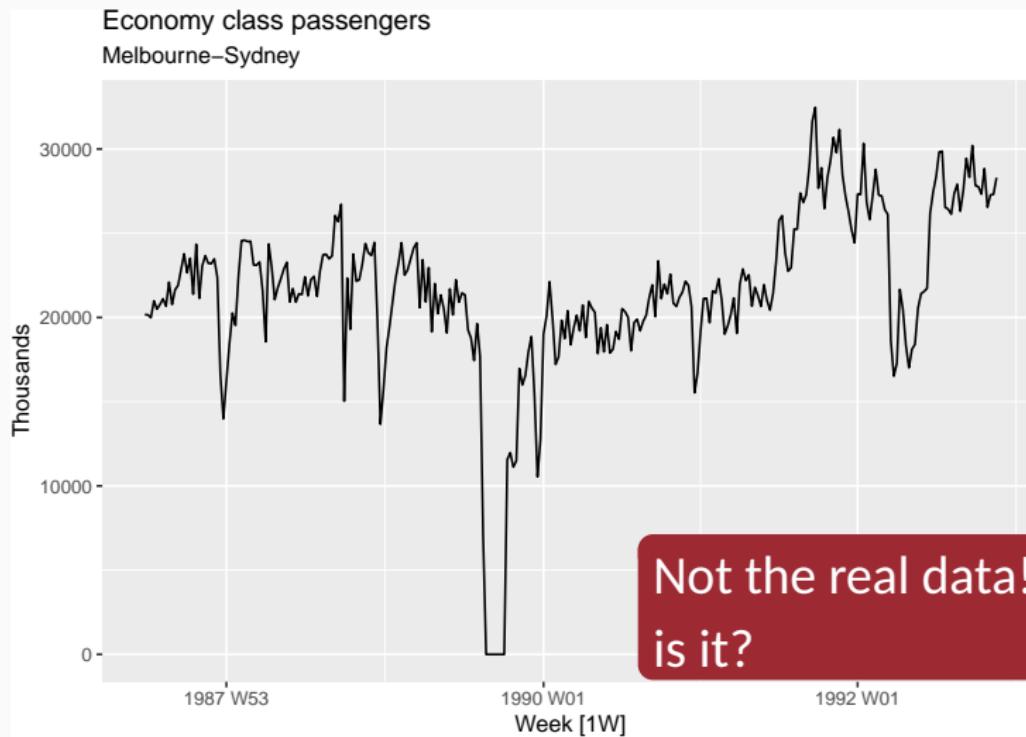
# CASE STUDY 4: Airline



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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.