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# ETC3550/ETC5550

## Applied forecasting

Week 3: Time series decomposition



# Outline

- 1 White noise and random walks
- 2 Transformations
- 3 Time series decomposition
- 4 The ABS stuff-up

# Outline

1 White noise and random walks

2 Transformations

3 Time series decomposition

4 The ABS stuff-up

# White noise

White noise data consists of purely random draws from the same distribution with mean zero and constant variance.

$$y_t = \varepsilon_t, \quad \text{where } \varepsilon_t \stackrel{\text{iid}}{\sim} N(0, \sigma^2)$$

```
my_data <- tsibble(t = seq(100), y = rnorm(100), index = t)
my_data |> autoplot(y)
```



# White noise

White noise data consists of purely random draws from the same distribution with mean zero and constant variance.

$$y_t = \varepsilon_t, \quad \text{where } \varepsilon_t \stackrel{\text{iid}}{\sim} N(0, \sigma^2)$$

```
my_data |> ACF(y) |> autoplot()
```



# Random walks

Random walks are a type of time series where the value at time  $t$  is equal to the previous value plus a random amount from a white noise process.

$$y_t = y_{t-1} + \varepsilon_t, \quad \text{where } \varepsilon_t \stackrel{\text{iid}}{\sim} N(0, \sigma^2)$$

Equivalently, we can take the cumulative sum of a white noise process.

$$y_T = y_0 + \sum_{t=1}^T \varepsilon_t, \quad \text{where } \varepsilon_t \stackrel{\text{iid}}{\sim} N(0, \sigma^2)$$

# Random walks

```
my_data |> autoplot(y)
```



# Random walks

```
my_data |> ACF(y) |> autoplot()
```





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**BREAKING NEWS**

Police arrest man in connection with stabbing death of 17-year-old Masa Vukotic in M



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## Treasurer Joe Hockey calls for answers over Australian Bureau of Statistics jobs data

By [Michael Vincent](#) and [Simon Frazer](#)

Updated 9 Oct 2014, 12:17pm

**Federal Treasurer Joe Hockey says he wants answers to the problems the Australian Bureau of Statistics (ABS) has had with unemployment figures.**

Mr Hockey, who is in the US to discuss Australia's G20 agenda, said last month's unemployment figures were "extraordinary".

The rate was 6.1 per cent after jumping to a 12-year high of 6.4 per cent the previous month.

The ABS has now taken the rare step of



# The ABS stuff-up



## BREAKING NEWS

Police arrest man in connection with stabbing death of 17-year-old Masa Vukotic in Mel

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## ABS abandons seasonal adjustment for latest jobs data

By business reporter [Michael Janda](#)

Updated 8 Oct 2014, 4:19pm

**The Australian Bureau of Statistics is taking the rare step of abandoning seasonal adjustment for its latest employment data.**

The ABS uses seasonal adjustment, based on historical experience, to account for the normal variation between hiring and firing patterns between different months.

However, after a winter where the seasonally adjusted unemployment rate swung wildly from 6.1 to 6.4 and back to 6.1 per cent, [the bureau released a statement](#) saying it will not adjust the original figure for September for seasonal factors.

Sorry, this video has expired

**VIDEO:** [Westpac chief economist Bill Evans discusses the ABS jobs data changes](#) (ABC News)

**RELATED STORY:** [Doubt the record breaking jobs figures? So does the ABS](#)

**RELATED STORY:** [Jobs increase record sees unemployment slashed](#)

# The ABS stuff-up

## ABS jobs and unemployment figures – key questions answered by an expert

A professor of statistics at Monash University explains exactly what is seasonal adjustment, why it matters and what went wrong in the July and August figures



📷 School leavers come on to the jobs market at the same time, causing a seasonal fluctuation. Photograph: Brian Snyder/Reuters

The Australian Bureau of Statistics has [retracted its seasonally adjusted employment data for July and August](#), which recorded huge swings in the jobless rate. The ABS is also planning to review the methods it uses for seasonal

# The ABS stuff-up

```
employed
```

```
# A tsibble: 440 x 4 [1M]
      Time Month  Year Employed
    <mth> <ord> <dbl>    <dbl>
1 1978 Feb Feb    1978    5986.
2 1978 Mar Mar    1978    6041.
3 1978 Apr Apr    1978    6054.
4 1978 May May    1978    6038.
5 1978 Jun Jun    1978    6031.
6 1978 Jul Jul    1978    6036.
7 1978 Aug Aug    1978    6005.
8 1978 Sep Sep    1978    6024.
9 1978 Oct Oct    1978    6046.
10 1978 Nov Nov    1978    6034.
# i 430 more rows
```

# The ABS stuff-up

```
employed | >  
  autoplot(Employed) +  
  labs(title = "Total employed", y = "Thousands")
```





# The ABS stuff-up

```
employed |>  
  filter(Year >= 2005) |>  
  autoplot(Employed) +  
  labs(title = "Total employed", y = "Thousands")
```



# The ABS stuff-up

```
employed |>  
  filter(Year >= 2005) |>  
  gg_season(Employed, labels = "right") +  
  labs(title = "Total employed", y = "Thousands")
```



# The ABS stuff-up

```
employed |>
  mutate(diff = difference(Employed)) |>
  filter(Month == "Sep") |>
  ggplot(aes(y = diff, x = 1)) +
  geom_boxplot() +
  coord_flip() +
  labs(title = "Sep - Aug: total employed", y = "Thousands") +
  scale_x_continuous(breaks = NULL, labels = NULL)
```

Sep - Aug: total employed

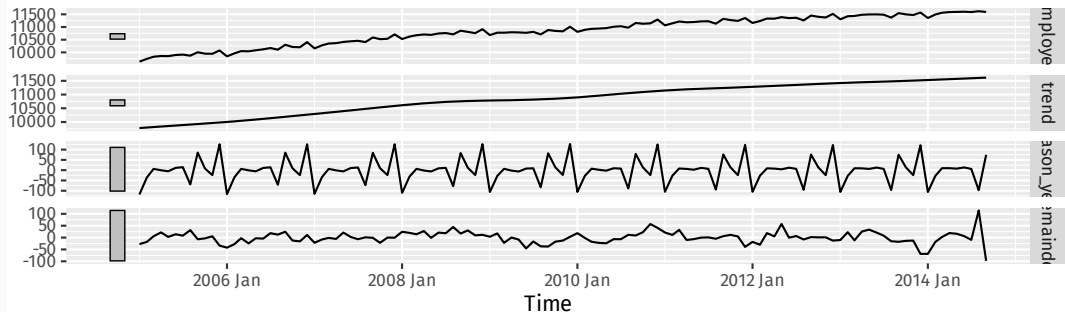


# The ABS stuff-up

```
dcmp <- employed |>
  filter(Year >= 2005) |>
  model(stl = STL(Employed ~ season(window = 11), robust = TRUE))
components(dcmp) |> autoplot()
```

## STL decomposition

Employed = trend + season\_year + remainder



# The ABS stuff-up

```
components(dcmp) |>  
  filter(year(Time) == 2013) |>  
  gg_season(season_year) +  
  labs(title = "Seasonal component") + guides(colour = "none")
```



# The ABS stuff-up

```
components(dcmp) |>  
  as_tsibble() |>  
  autoplot(season_adjust)
```



# The ABS stuff-up

- August 2014 employment numbers higher than expected.
- Supplementary survey usually conducted in August for employed people.
- Most likely, some employed people were claiming to be unemployed in August to avoid supplementary questions.
- Supplementary survey not run in 2014, so no motivation to lie about employment.
- In previous years, seasonal adjustment fixed the problem.
- The ABS has now adopted a new method to avoid the bias.