

# **ETC3550**

## **Applied forecasting for business and economics**

Ch12. Some practical forecasting  
issues

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

# Outline

- 1 Models for different frequencies
- 2 Ensuring forecasts stay within limits
- 3 Forecast combinations
- 4 Missing values
- 5 Outliers

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# Models for different frequencies

## Models for annual data

- ETS, ARIMA, Dynamic regression

# Models for different frequencies

## Models for annual data

- ETS, ARIMA, Dynamic regression

## Models for quarterly data

- ETS, ARIMA/SARIMA, Dynamic regression, Dynamic harmonic regression, STL+ETS, STL+ARIMA

# Models for different frequencies

## Models for annual data

- ETS, ARIMA, Dynamic regression

## Models for quarterly data

- ETS, ARIMA/SARIMA, Dynamic regression, Dynamic harmonic regression, STL+ETS, STL+ARIMA

## Models for monthly data

- ETS, ARIMA/SARIMA, Dynamic regression, Dynamic harmonic regression, STL+ETS, STL+ARIMA

# Models for different frequencies

## Models for weekly data

- ARIMA/SARIMA, Dynamic regression, Dynamic harmonic regression, STL+ETS, STL+ARIMA, TBATS

# Models for different frequencies

## Models for weekly data

- ARIMA/SARIMA, Dynamic regression, Dynamic harmonic regression, STL+ETS, STL+ARIMA, TBATS

## Models for daily, hourly and other sub-daily data

- ARIMA/SARIMA, Dynamic regression, Dynamic harmonic regression, STL+ETS, STL+ARIMA, TBATS

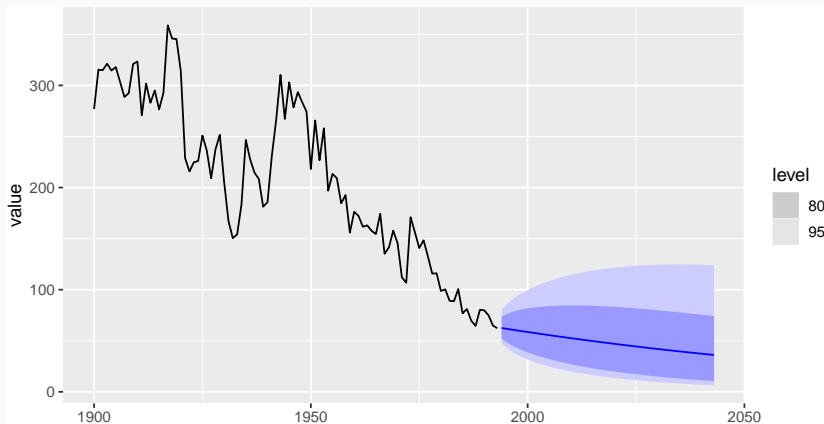


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# Positive forecasts

```
eggs <- as_tsibble(fma::eggs)
eggs %>%
  model(ETS(log(value) ~ error("A") + trend("A") + season("N"))) %>%
  forecast(h=50) %>%
  autoplot(eggs)
```



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# Forecast combinations

## Clemen (1989)

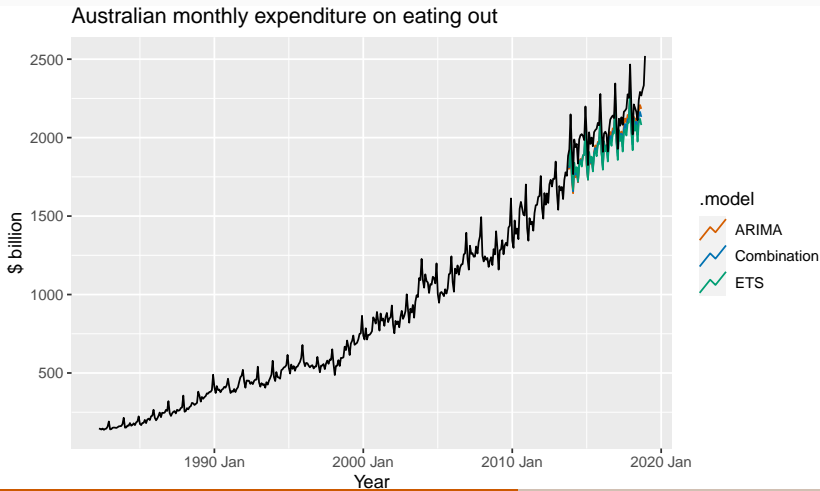
“The results have been virtually unanimous: combining multiple forecasts leads to increased forecast accuracy. ... In many cases one can make dramatic performance improvements by simply averaging the forecasts.”

# Forecast combinations

```
aus_cafe <- aus_retail %>%  
  filter(Industry == "Cafes, restaurants and catering services") %>%  
  summarise(Turnover = sum(Turnover))  
fc <- aus_cafe %>%  
  filter(Month <= yearmonth("2013 Sep")) %>%  
  model(  
    ETS = ETS(Turnover),  
    ARIMA = ARIMA(Turnover)  
  ) %>%  
  mutate(  
    Combination = (ETS + ARIMA)/2  
  ) %>%  
  forecast(h = "5 years")
```

# Forecast combinations

```
fc %>% autoplot(aus_cafe, level = NULL) +  
  labs(x = "Year", y = "$ billion",  
        title = "Australian monthly expenditure on eating out")
```



# Forecast combinations

```
fc %>% accuracy(aus_cafe)
```

```
## # A tibble: 3 x 10
```

##	.model	.type	ME	RMSE	MAE	MPE	MAPE	MASE	RMSSE
##	<chr>	<chr>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>
## 1	ARIMA	Test	112.	122.	112.	5.44	5.44	1.80	1.50
## 2	Combinati~	Test	120.	125.	120.	5.81	5.81	1.93	1.55
## 3	ETS	Test	128.	133.	128.	6.18	6.18	2.06	1.64

```
## # ... with 1 more variable: ACF1 <dbl>
```

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# Missing values

## Functions which can handle missing values

- ARIMA()
- TSLM()
- NNETAR()
- VAR()
- FASSTER()

## Models which cannot handle missing values

- ETS()
- STL()
- TBATS()

# Missing values

## Functions which can handle missing values

- `ARIMA()`
- `TSLM()`
- `NNETAR()`
- `VAR()`
- `FASSTER()`

## Models which cannot handle missing values

- `ETS()`
- `STL()`
- `TBATS()`

## What to do?

- 1 Model section of data after last missing value.
- 2 Estimate missing values with `interpolate()`.

# Missing values

```
gold <- as_tsibble(forecast::gold)  
gold %>% autoplot(value)
```



# Missing values

```
gold_complete <- gold %>%  
  model(ARIMA(value)) %>%  
  interpolate(gold)  
gold_complete %>%  
  autoplot(value, colour = "red") +  
  autolayer(gold, value)
```



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# Outliers

```
fit <- gold %>%  
  model(ARIMA(value))  
augment(fit) %>%  
  mutate(stdres = .resid/sd(.resid, na.rm=TRUE)) %>%  
  filter(abs(stdres) > 10)
```

```
## # A tsibble: 2 x 7 [1]  
## # Key:           .model [1]  
##   .model      index value .fitted .resid .innov stdres  
##   <chr>      <dbl> <dbl>   <dbl>  <dbl>  <dbl>  <dbl>  
## 1 ARIMA(value)   770  594.    499.   94.7   94.7   16.4  
## 2 ARIMA(value)   771  487.    562.  -74.8  -74.8   -  
12.9
```