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FORECASTING

PRINCIPLES AND PRACTICE

A comprehensive introduction to the latest forecasting methods using R. Learn to improve your forecast accuracy using dozens of real data examples.



3. Time series decomposition

3.5 Methods used in official statistics

OTexts.org/fpp3/

History of time series decomposition

- Classical method originated in 1920s.
- Census II method introduced in 1957. Basis for X-11 method and variants (including X-12-ARIMA, X-13-ARIMA)
- STL method introduced in 1983
- TRAMO/SEATS introduced in 1990s.

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National Statistics Offices

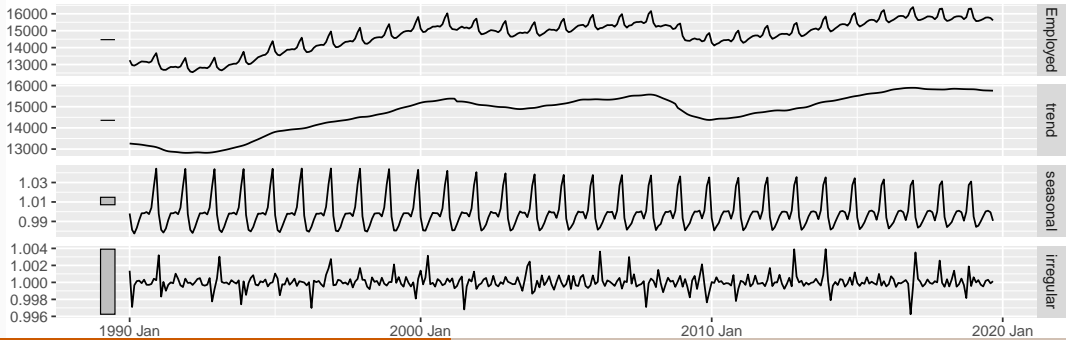
- ABS uses X-12-ARIMA
- US Census Bureau uses X-13ARIMA-SEATS
- Statistics Canada uses X-12-ARIMA
- ONS (UK) uses X-12-ARIMA
- EuroStat use X-13ARIMA-SEATS

X-11 decomposition

```
x11_dcmp <- us_retail_employment |>  
  model(x11 = X_13ARIMA_SEATS(Employed ~ x11())) |>  
  components()  
autoplot(x11_dcmp)
```

X-13ARIMA-SEATS using X-11 adjustment decomposition

$\text{Employed} = \text{trend} * \text{seasonal} * \text{irregular}$



X-11 decomposition

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- Relatively robust to outliers
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Disadvantages

- No prediction/confidence intervals
- Ad hoc method with no underlying model
- Only developed for quarterly and monthly data

Extensions: X-12-ARIMA and X-13-ARIMA

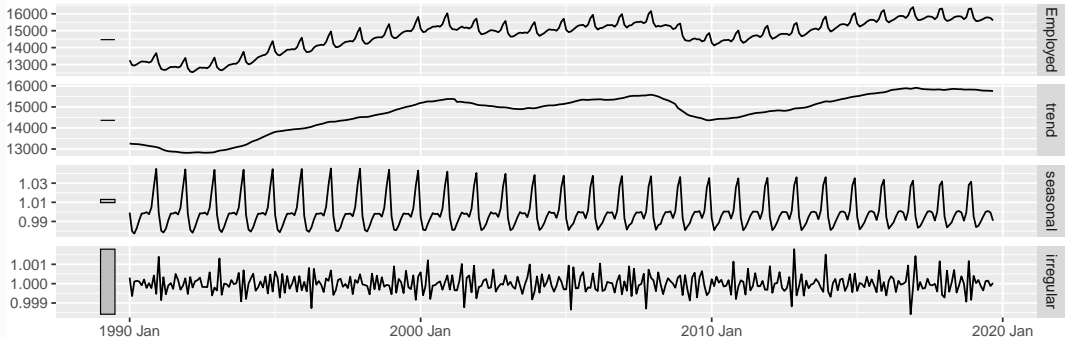
- The X-11, X-12-ARIMA and X-13-ARIMA methods are based on Census II decomposition.
- These allow adjustments for trading days and other explanatory variables.
- Known outliers can be omitted.
- Level shifts and ramp effects can be modelled.
- Missing values estimated and replaced.
- Holiday factors (e.g., Easter, Labour Day) can be estimated.

X-13ARIMA-SEATS

```
seats_dcmp <- us_retail_employment |>  
  model(seats = X_13ARIMA_SEATS(Employed ~ seats())) |>  
  components()  
autoplot(seats_dcmp)
```

X-13ARIMA-SEATS decomposition

$\text{Employed} = f(\text{trend}, \text{seasonal}, \text{irregular})$



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