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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.



3RD EDITION

 **OTexts**  
OPEN TEXTS FOR PRACTICE

## 7. Time series regression models

### 7.1 The linear model

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

# Multiple regression and forecasting

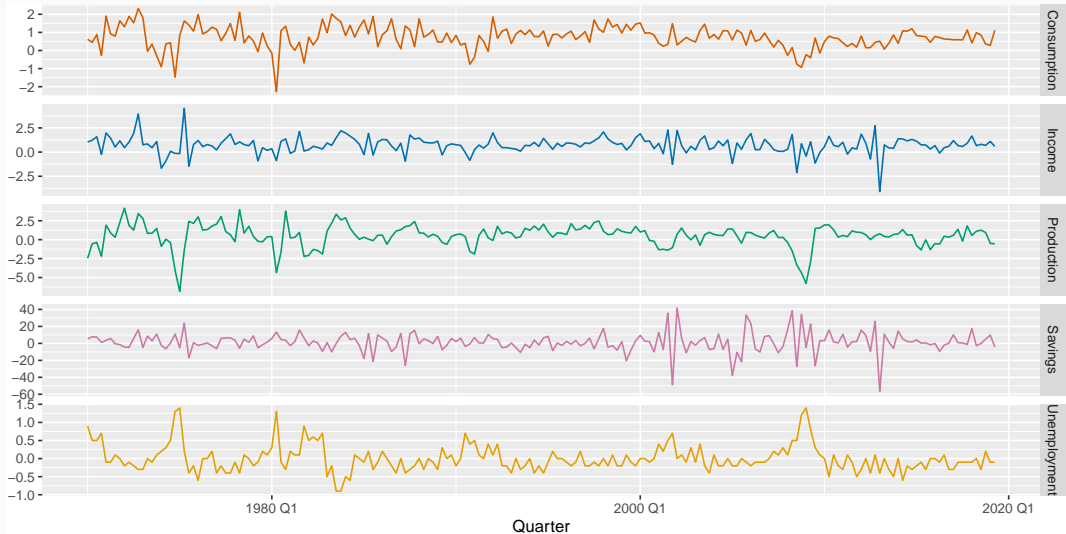
$$y_t = \beta_0 + \beta_1 x_{1,t} + \beta_2 x_{2,t} + \cdots + \beta_k x_{k,t} + \varepsilon_t.$$

- $y_t$  is the variable we want to predict: the “response” variable
- Each  $x_{j,t}$  is numerical and is called a “predictor”. They are usually assumed to be known for all past and future times.
- The coefficients  $\beta_1, \dots, \beta_k$  measure the effect of each predictor after taking account of the effect of all other predictors in the model.

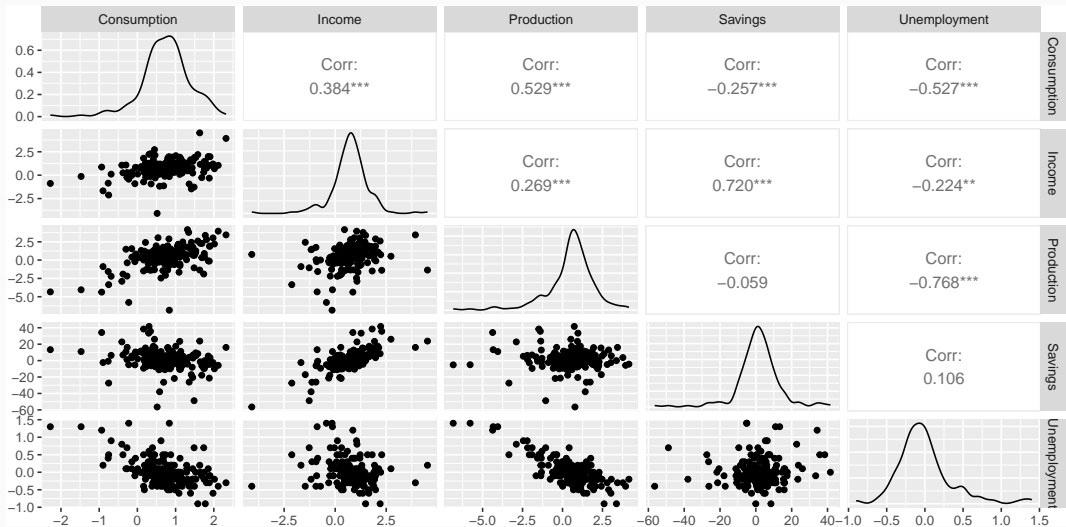
That is, the coefficients measure the **marginal effects**.

- $\varepsilon_t$  is a white noise error term

# Example: US consumption expenditure



# Example: US consumption expenditure

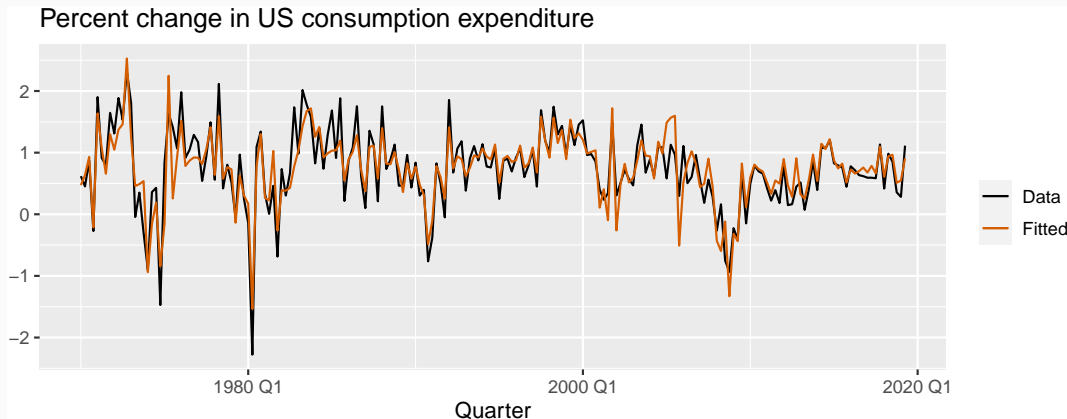


# Example: US consumption expenditure

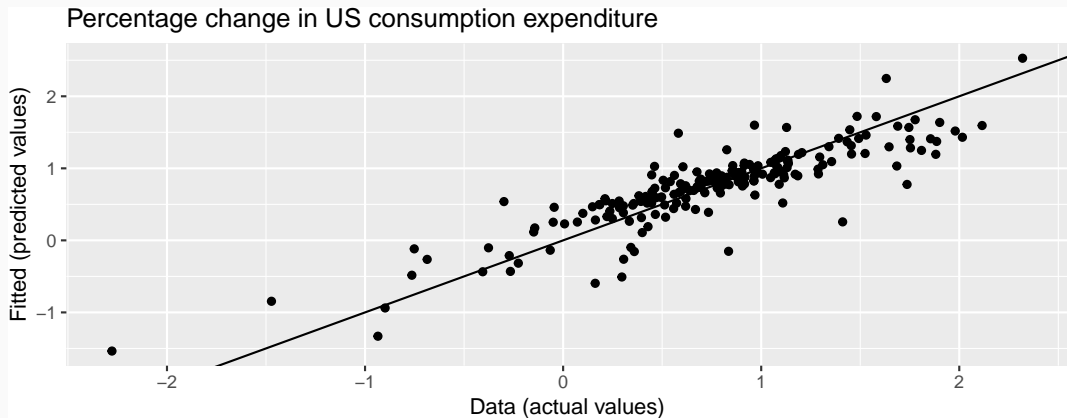
```
fit_consMR <- us_change |>
  model(lm = TSLM(Consumption ~ Income + Production + Unemployment + Savings))
report(fit_consMR)
```

```
## Series: Consumption
## Model: TSLM
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.906 -0.158 -0.036  0.136  1.155
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   0.25311    0.03447   7.34 5.7e-12 ***
## Income        0.74058    0.04012  18.46 < 2e-16 ***
## Production    0.04717    0.02314   2.04  0.043 *
## Unemployment -0.17469    0.09551  -1.83  0.069 .
## Savings       -0.05289    0.00292 -18.09 < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.31 on 193 degrees of freedom
## Multiple R-squared:  0.768,    Adjusted R-squared:  0.763
## F-statistic: 160 on 4 and 193 DF, p-value: <2e-16
```

# Example: US consumption expenditure



# Example: US consumption expenditure



# Example: US consumption expenditure

```
fit_consMR |> gg_tsresiduals()
```

