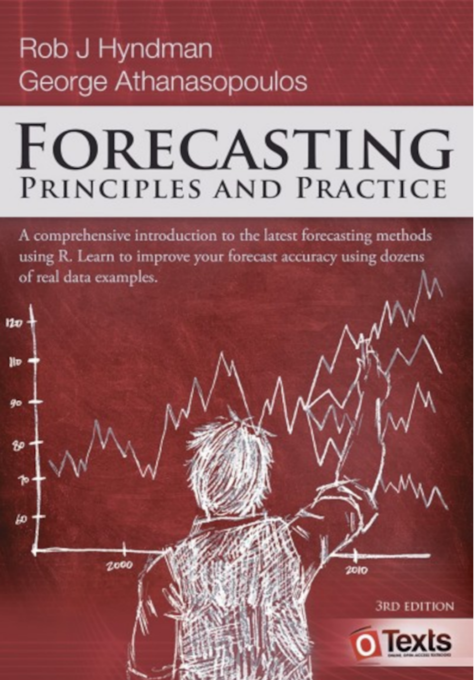


7. Time series regression models

7.1 The linear model

OTexts.org/fpp3/

Multiple regression and forecasting

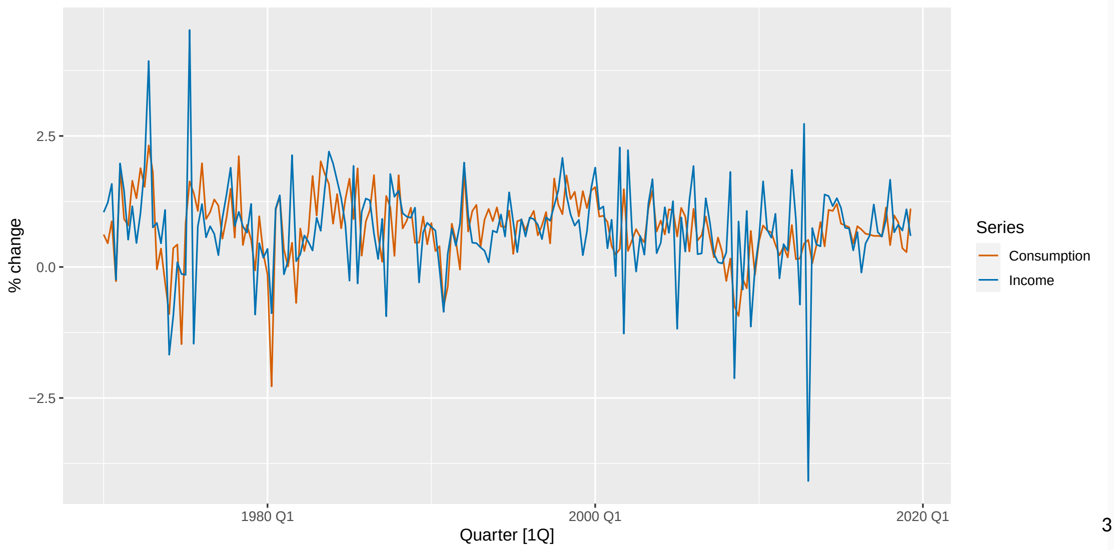
$$y_t = \beta_0 + \beta_1 x_{1,t} + \beta_2 x_{2,t} + \cdots + \beta_k x_{k,t} + \varepsilon_t.$$

- 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.

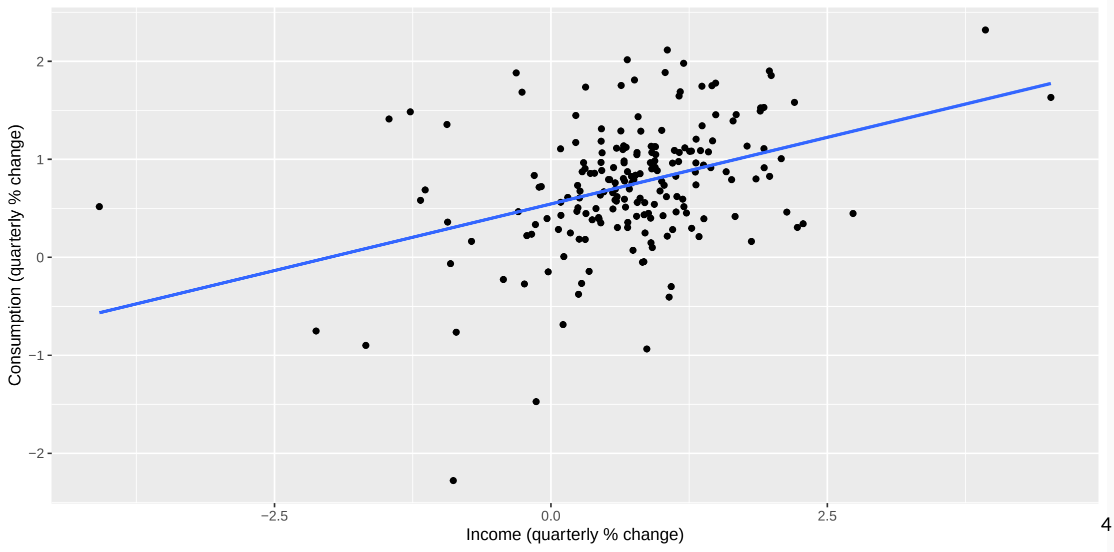
That is, the coefficients measure the marginal effects.

- ε_t is a white noise error term

Example: US consumption expenditure



Example: US consumption expenditure

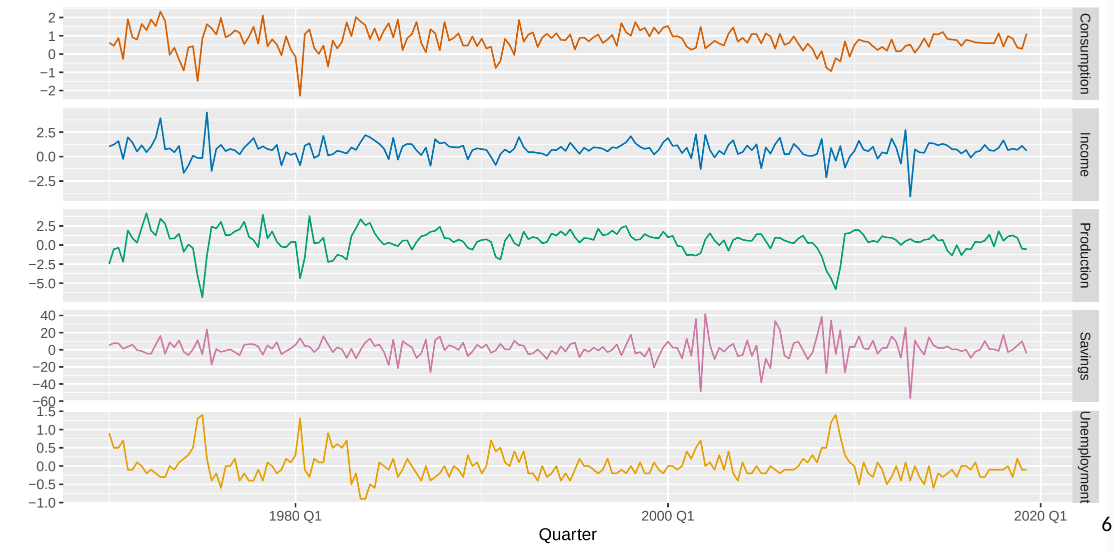


Example: US consumption expenditure

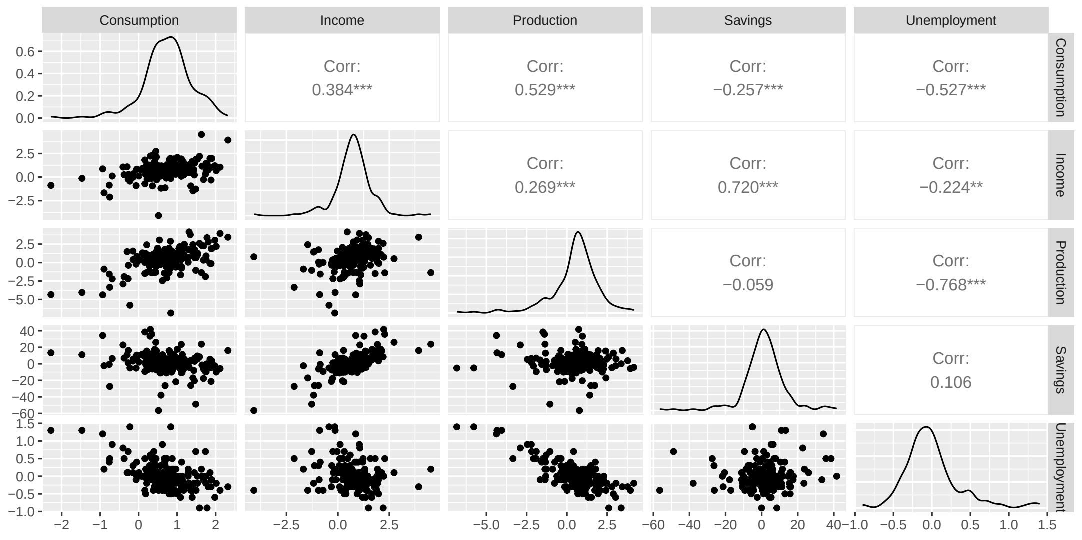
```r
fit_cons <- us_change %>%
  model(lm = TSLM(Consumption ~ Income))
report(fit_cons)
```

```
## Series: Consumption
## Model: TSLM
##
## Residuals:
##     Min      1Q Median      3Q     Max
## -2.582 -0.278  0.019  0.323  1.422
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)   0.5445     0.0540   10.08  < 2e-16 ***
## Income        0.2718     0.0467    5.82  2.4e-08 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.591 on 196 degrees of freedom
## Multiple R-squared: 0.147,   Adjusted R-squared: 0.143
## F-statistic: 33.8 on 1 and 196 DF, p-value: 2e-08
```

Example: US consumption expenditure



Example: US consumption expenditure



Assumptions for the linear model

For forecasting purposes, we require the following assumptions:

- ε_t have mean zero and are uncorrelated.
- ε_t are uncorrelated with each $x_{j,t}$.

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- ε_t are uncorrelated with each $x_{j,t}$.

It is useful to also have $\varepsilon_t \sim \text{N}(0, \sigma^2)$ when producing prediction intervals or doing statistical tests.