FIN3380 Final Review

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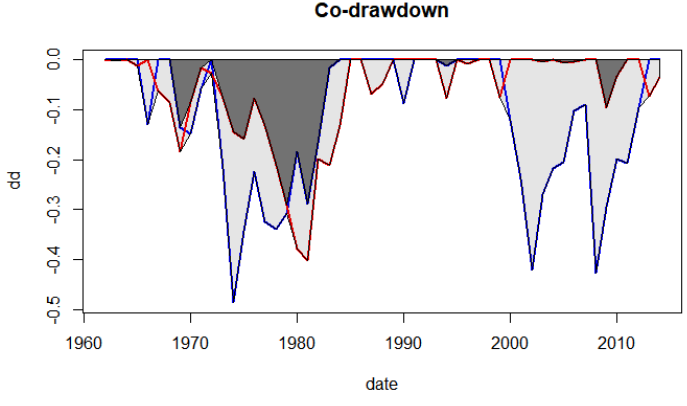
Lecture 3 Risk Management

- VaR
  - Gaussian VaR, historical VaR: steps to calculate VaR
  - Property for Gaussian VaR: subadditivity
- Expected Shortfall
  - Gaussian ES, historical ES: steps to calculate ES
- Drawdown
  - How much an investment or trading account is down from the peak before it recovers back to the peak
  - Calculate drawdown: cummax()
  - Find out the longest dd period and the maximum dd

Lecture 3 Risk Management

- Co-drawdown
  - The probability that two assets simultaneously experience drawdowns taking into account of the size of drawdown
  - Steps to calculate co-drawdown



Lecture 4 Factor Model

- Simple excess return model
- CAPM model
  - Formula: $r_i = r_f + \beta_i (r_m - r_f),$
- Multi-Factor model – FF 3 Factor model
  - Formula: $r_i = r_f + \beta_i (r_m - r_f) + h_i HML + s_i SMB$

Lecture 4 Factor Model

- Regression
  - Simple linear regression
    - what is alpha and beta
    - t statistic and p value
    - Make prediction
  - Rolling window regression
    - What is rolling window
    - Implement: define a rolling function - tibbletime::rollify()
    - Summarize the regression results - broom::tidy(); purrr::map() and tidyr::unnest()
    - Visualize regression results

Lecture 5 Times Series

- Stationary
  - Definition of weak stationary
  - How to test whether a time series is stationary
  - How to deal with the non-stationary series
- ACF
  - Calculation: $\hat{\rho}_k = \frac{\sum_{t=k+1}^{T}(x_t - \overline{x})(x_{t-k} - \overline{x})}{\sum_{t=1}^{T}(x_t - \overline{x})^2}, \quad 0 \le k < T - 1.$
  - Test
    - Test individual ACF
    - Joint test: Box.test()

Lecture 5 Times Series

- PACF

$$
\begin{aligned}
x_t &= \phi_{0,1} + \phi_{1,1}x_{t-1} + e_{1t}, \\
x_t &= \phi_{0,2} + \phi_{1,2}x_{t-1} + \phi_{2,2}x_{t-2} + e_{2t}, \\
x_t &= \phi_{0,3} + \phi_{1,3}x_{t-1} + \phi_{2,3}x_{t-2} + \phi_{3,3}x_{t-3} + e_{3t}, \\
x_t &= \phi_{0,4} + \phi_{1,4}x_{t-1} + \phi_{2,4}x_{t-2} + \phi_{3,4}x_{t-3} + \phi_{4,4}x_{t-4} + e_{4t}, \\
&\vdots
\end{aligned}
$$

  - Estimate the parameters in the above equations to get the PACF
  - For an AR(p) model, the lag-p sample PACF should not be 0, but the PACF of lag-j with j>p should be 0.

Lecture 5 Times Series

- AR(p) model
  - AR(p): $x_t = \phi_0 + \phi_1 x_{t-1} + \cdots + \phi_p x_{t-p} + a_t,$
  - Detect lag order p
    - Use the PACF
    - Use information critieria: AIC, BIC
  - The long term average of a stationary AR(p) model: $E(x_t) = \frac{\phi_0}{1 - \phi_1 - \cdots - \phi_p}$
  - Forecast
    - Make one step/ multiple steps prediction

Lecture 5 Times Series

- MA(q) model
  - MA(q): $x_t = c_0 + a_t - \theta_1 a_{t-1} - \cdots - \theta_q a_{t-q}$
  - Detect lag order q
    - Use the ACF
    - Use information critieria: AIC, BIC
  - The long term average of a stationary MA(q) model: $E(x_t) = c_0$
  - Forecast
    - Make one step/ multiple steps prediction

Lecture 5 Times Series

- ARIMA(p,d,q) model
  - ARIMA(p,d,q): $y'_t = c + \phi_1 y'_{t-1} + \cdots + \phi_p y'_{t-p} + \theta_1 \varepsilon_{t-1} + \cdots + \theta_q \varepsilon_{t-q} + \varepsilon_t,$
  - Detect lag orders
    - Use auto.arima()
    - Use information critieria: AIC, BIC
  - Forecast
    - Make one step/ multiple steps prediction

Lecture 5 Times Series

- Co-integration
  - Definition: two time series is cointegrated if their linear difference is stationary.

$$u_t = Y_t - (\alpha + \beta X_t)$$

$$u_t : \sim I(0), \boxed{\text{stationary process}}$$

$$X_t, Y_t : \sim I(1)$$

- Construct Pair trading
  - S1: test whether the log price of each pair is cointegrated − Johansen test (urca::ca.jo)
  - S2: Calculate the spread of log prices of paired stocks and test whether the spread is stationary
  - S3: Examine whether the spread is too high or to low and generate 'buy' signals.
  - S4: calculate return on each day and the cumulative returns