MGMT 675

AI-ASSISTED FINANCIAL ANALYSIS

RICE | BUSINESS
Jones Graduate School of Business

AUTOCORRELATION

- Correlation of a variable with its own lagged value

- First order autocorrelation = first lag

- Second order autocorrelation = second lag

EXAMPLE

Time	Variable
1	2.1
2	4.5
3	5.3
4	3.2
5	1.6

EXAMPLE

Time	Variable	Lag
1	2.1	
2	4.5	2.1
3	5.3	4.5
4	3.2	5.3
5	1.6	3.2

EXAMPLE

Time	Variable	Lag
1	2.1	
2	4.5	2.1
3	5.3	4.5
4	3.2	5.3
5	1.6	3.2

Correlation of a variable with its lag is first-order autocorrelation.

SECOND-ORDER AUTOCORRELATION

Time	Variable	2nd Lag
1	2.1	
2	4.5	
3	**5.3**	**2.1**
4	**3.2**	**4.5**
5	**1.6**	**5.3**

Correlation of a variable with its 2nd lag is second-order autocorrelation.

AUTOCORRELATION FUNCTION

- The autocorrelation function (acf) shows autocorrelation at multiple lags.

- Lag 0 is usually presented too, even though the correlation at lag 0 is always 100%.

- The band is a confidence interval under the null hypothesis that the autocorrelation is zero.

- Estimates outside the band are statistically significant.

FAMA-FRENCH FACTORS

- Ask Julius to use pandas datareader to get the monthly Fama-French factors for the maximum history available.

- Ask Julius to plot the acf's of Mkt-RF, HML, and SMB.

AUTOREGRESSIONS

FIRST-ORDER AUTOREGRESSION

- A first-order autoregression is the equation

$$x_t = \alpha + \beta x_{t-1} + \varepsilon_t$$

- Positive $\beta \Leftrightarrow$ positive first-order autocorrelation.

- Positive beta $\Rightarrow$ momentum.

- Negative beta $\Rightarrow$ reversals.

HIGHER ORDER AUTOREGRESSIONS

- A pth order autoregression is the equation

$$x_t = \alpha + \beta_1 x_{t-1} + \cdots + \beta_p x_{t-p} + \varepsilon_t$$

- There are standard methods for choosing the optimal p, trading off goodness of fit and parsimony.

- Ask Julius to fit an AR(p) to HML and find the optimal p.

LEVELS OR CHANGES?

WHAT SHOULD WE TRY TO FORECAST?

- Price of AAPL?

- Change in price of AAPL?

- Percent change in price of AAPL (return)?

- A forecast of changes or percent changes implies a forecast of the price and vice versa, so only need to forecast one of them directly.

- What variable should we use in an autoregression?

STATIONARITY

- One issue is that autocorrelation or autoregression estimates are reliable only for stationary variables.

- Prices grow over time (unstationary).

- Changes in prices become larger over time (in absolute value)

- Returns are the right thing to use in an autoregression.

OTHER VARIABLES

- Autoregression for crude oil price or change in crude price or percent change in crude price?

- Autoregression for interest rate or change in interest rate or percent change in interest rate?

AUTOREGRESSION AND $\triangle x$

Rearrange

$$x_t = \alpha + \beta x_{t-1} + \varepsilon_t$$

as

$$\Delta x_t = \alpha + (\beta - 1)x_{t-1} + \varepsilon_t$$

$$\Delta x_t = (\beta - 1)\left(x_{t-1} - \frac{\alpha}{1 - \beta}\right) + \varepsilon_t$$

MEAN REVERSION

- An AR(1) is

$$\Delta x_t = (\beta - 1) \left(x_{t-1} - \frac{\alpha}{1 - \beta} \right) + \varepsilon_t$$

- $\beta < 1$ implies reregression towards the mean.

- The mean is $\alpha/(1 - \beta)$.

- $\beta > 1$ implies nonstationary.

SIMULATIONS

- Ask Julius to simulate the process x_t = 1 + 0.5*x_{t-1} + e_t by drawing 1,000 standard normals for e_t. Ask Julius to plot the process.

- Repeat for x_t = 1 + 2*x_{t-1} + e_t

AUTOCORRELATIONS

- Autocorrelation = correlation of a variable with its lagged value

- First-order autocorrelation $= \text{corr}(x_t, x_{t+1})$

- p–th order autocorrelation $= \text{corr}(x_t, x_{t+p})$

  - E.g., $p = 12$ in monthly data or $p = 4$ in quarterly data because of seasonality

AUTOCORRELATION OF HML

- Ask Julius to use pandas-datareader to download the monthly Fama-French factors from Ken French's data library.

- Ask Julius to produce a plot of the autocorrelation function (acf) for HML.

AUTOREGRESSIONS

- An autoregression is a regression of a variable on its own lags:

$$x_t = \alpha + \beta_1 x_{t-1} + \cdots + \beta_p x_{t-p} + \varepsilon_t$$

- Ask Julius to fit an AR(1) for HML.

- Ask Julius to use the AR(1) model to forecast HML for the next 12 months and to plot the last 2 years and the forecasts.

MORE EXAMPLES

Ask Julius to plot the ACF, fit an AR model, and forecast the following:

- Percent change in crude price: Ask Julius to use pandas-datareader to download crude oil prices starting in 1980 from FRED, to downsample to end-of-month, and to compute percent changes.

- Change in Treasury yields: Ask Julius to use pandas-datareader to download 10-year Treasury yields starting in 1980 from FRED, to downsample to monthly, and to compute changes.

VECTOR AUTOREGRESSION

- Forecast related variables based on their mutual lags

- Example: does this month's SMB return forecast next month's HML return?

- Ask Julius to run a VAR(1) on the Fama-French factors and provide a summary of the results.