2 regressions and more

Simple OLS is the work horse of econometrics. During this session, we will run it in RStudio, test OLS assumptions, look for a way to live in a world where they fail to hold, and do some regression diagnostics.

0. Load `s2_data.txt` into RStudio. This dataset contains monthly data on the following variables:

name	description	source
FI	Hedge funds index: Fixed Income Arbitrage	Credit Suisse
DIST	Hedge funds index: Distressed Securities	
MAC	Hedge funds index: Global Macro	
MULT	Hedge funds index: Multi-strategy	
ELS	Hedge funds index: Equity Long-Short	
mktrf	S&P500 return in excess of the risk-free rate	Kenneth French's website
smb	Returns of the Small Minus Big strategy	
hml	Returns of the High Minus Low strategy	
rmw	Returns of the Robust Minus Weak strategy	
cma	Returns of the Conservative Minus Aggressive strategy	
rf	Risk-free rate, in percent per month	

In what follows we will operate on excess returns only. Every time a "return" is mentioned, an excess (over the risk-free rate) return is meant.

1. A quick way to look at the relationship between two random variables is by means of a scatterplot. Plot *MAC* return vs. *mktrf*.

2. Estimate the linear market model:

$$r_{i,t} = \alpha_i + \beta_i r_{m,t} + u_t$$

   on *MAC* return. Familiarize yourself with the regression output.

3. Compute the R-squared and the Adjusted R-squared. Explore the ANOVA table.

4. "Alpha" is *the* word in the hedge fund industry, a measure of "managerial skills" and "outperformance". Is the alpha of *MAC* funds statistically different from zero? Is it economically significant?

5. By looking at the market beta of these funds, tell if they can be considered equity market neutral.

6. Plot the residuals on the time line and do some eyeball econometrics to detect autocorrelation/heteroskedasticity.

7. One way to derive the small-sample distributional properties of $\hat{\beta}$ is to assume that regressors are fixed and residuals have a known distribution. A common choice is $u_t \sim \mathcal{N}(0, \sigma^2)$. Test this assumption using a Jarque-Bera test.

8. The good news is that in finance we tend to have very large histories of data and, since estimators are usually an average of some sort, we can rely on the asymptotic results. However, we still need the assumption of no autocorrelation and homoskedasticity of residuals to draw correct inference in the standard OLS framework. Plot the correlogram of u_t and test the null hypothesis of no autocorrelation at the first 10 lags.

9. Perform White's heteroskedasticity test and report the results.

10. Pretty bad, but we'll have to live with that. A standard practice in finance is to use OLS nonetheless but to compute the covariance matrix of coefficient estimates in a smart way. That way is called the Newey-West covariance estimator (see details in the Lecture Notes). Redo the regression of *MAC* on the market with a HAC[1] correction. Are the coefficients as significant as before?

11. Let's test the Fama-French three-factor model using the returns of *MAC* and *DIST*. Estimate a SURE system of equations:

$$r_{i,t} = \alpha_i + \beta_{1,i} f_{1,t} + \beta_{2,i} f_{2,t} + \beta_{3,i} f_{3,t} + u_t$$

where $i = \{MAC, DIST\}$. What is the correlation between the residuals?

12. Test if the two alphas are jointly different from 0 at the 5% significance level. For that we perform a chi-square test of the form:

$$a' V^{-1} a \sim \mathcal{X}(\nu),$$

where a is the vector of alphas, ν is the number of alphas (length of a). Note that the covariance matrix is not HAC.

[1] Heteroskedasticity and autocorrelation consistent

homework

0. Load `s2_data.txt` into RStudio if you have not done so yet. Calculate the excess returns of the hedge fund indices. Then take out the first observation (2000-12-31).

1. Estimate the market model on *FI* returns. Report the alpha and the beta as well as the R^2. Is the alpha statistically significant at the 10% level? **(2 points)**

2. Plot the residuals from the model above on the time line. Highlight (e.g. with a circle) two areas of different apparent volatility of residuals or leave the plot blank if you do not see distinct differences. Test for heteroskedasticity, reporting the test you use, the p-value and your conclusion. **(2 points)**

3. Plot a correlogram of residuals with 4 lags. Test for autocorrelation at the 1st lag using the Durbin-Watson test; report the test statistic and your conclusion. **(2 points)**

   Hint: A Durbin-Watson test can notably be performed with the `dwtest()` *function from the package* `lmtest`*.*

4. Do you expect the regression coefficients to change when errors are corrected for heteroskedasticity and autocorrelation? Why? **(1 point)**

5. Calculate HAC standard errors of the coefficients. Report the results and determine whether the alpha is statistically significant at the 10% level. **(1 point)**

6. Estimate the CAPM on the returns of *FI, MULT* and *ELS* in a SURE fashion, using a non-HAC covariance estimator. Report the correlation matrix of residuals. **(2 points)**

7. Test for the joint significance of the three alphas at the 10% level. Report the test-statistic and the critical value at the 10% level as well as your conclusion.
   (2 points)

8. Create a new time series object in order to subsample the dataset, starting in 2009:07 (that's the end of the recent recession). Re-estimate the CAPM on *FI* with robust standard errors. Test if the post-crisis alpha is statistically different from 0.4 at the 5% level, reporting the t-statistic, the critical value and your conclusion. **(2 points)**

9. Consider again the full range. Looking at Equity Long-Short funds (*ELS*), compare the significance of alpha under CAPM and Fama-French five-factor model. Use HAC standard errors in both models. Report the two alphas and your conclusion. **(2 points)**

10. Estimate the Fama-French five-factor model on the returns of *FI, MULT* and *ELS* in a SURE fashion, using a non-HAC covariance estimator. Report the variance of the residuals.
    (2 points)

11. Now we have one very significant alpha and two insignificant ones, so it is not straightforward to tell if they will be jointly significant. Anyway, perform a chi-square test of joint significance of the three alphas at the 5% level. Report the test-statistic, the critical value at the 5% level as well as your conclusion.
(2 points)