Download 2 datasets on your duo:

1. FMBF_Prac2(1).xls
2. ppp(1).xls

Cointegration

Dzulfian Syafrian

February 2019

3 ways to conduct cointegration analysis

1. Engle-Granger (EG) procedure
2. Johansen approach
3. Engle-Yoo (EY)

1. Engle-Granger Procedure: 2 steps

1.1 Check whether Yt and Xt are non-stationary, I(1) or I(2)

1.2 Check whether the error term/residuals, $\hat{u}_{t-1}$, is I(0)

2. If we satisfy both conditions, we conclude that Yt and Xt are cointegrated so can run the ECM.

$$\Delta y_t = \beta_1 \Delta x_t + \beta_2(\hat{u}_{t-1}) + u_t \qquad (1)$$

$$\Delta y_t = \beta_1 \Delta x_t + \beta_2(y_{t\text{-}1} - \gamma x_{t\text{-}1}) + u_t \qquad (2)$$

Why Johansen approach?

Engle-Granger (EG) Weaknesses	Solutions
1 Unit root and cointegration tests have low power in finite samples	Large sample
2 We are forced to treat the variables asymmetrically and to specify one as the dependent and the other as independent variables.	Johansen approach
3 Cannot perform any hypothesis tests about the actual cointegrating relationship estimated at stage 1.	Johansen or Engle-Yoo approach

Source: Brooks, Lecture 7, p.48

Some models at Johansen Approach

Option/assumption	Cointegrating Equation (CE)		VAR intercept	Algebraic form
	Intercept	Trend		
1. no deterministic trend	-	-	-	$= \alpha\beta' y_{t-1}$
2. no deterministic trend	V	-	-	$= \alpha(\beta' y_{t-1} + \rho_0)$
3. linear deterministic trend	V	-	V	$= \alpha(\beta' y_{t-1} + \rho_0) + \alpha_\perp \gamma_0$
4. linear deterministic trend	V	V	-	$= \alpha(\beta' y_{t-1} + \rho_0 + \rho_1 t) + \alpha_\perp \gamma_0$
5. quadratic deterministic trend	V	V	V	$= \alpha(\beta' y_{t-1} + \rho_0 + \rho_1 t) + \alpha_\perp (\gamma_0 + \gamma_1 t)$
6	Provides the summary all of the options			

More details about those options go to:
http://www.eviews.com/help/helpintro.html#page/content/coint-Johansen_Cointegration_Test.html

How to decide the lag?

Run VAR:

- Click all the variables > right click: open as a group
- Proc > make vector autoregression …
- Choose ‘unrestricted VAR’
- Input the lag intervals ‘1 3’ (well, it does not matter in this context) > ok
- View > lag structure > lag length criteria
- Finally, now we can choose the lag! Lets choose 3 (based on AIC)

2 Johansen test statistics

1. λ_{trace}

2. $\lambda_{\max}$

Date: 02/11/19 Time: 12:01
Sample (adjusted): 1981M05 1996M06
Included observations: 182 after adjustments
Trend assumption: Linear deterministic trend
Series: LNX LNIT LNFR
Lags interval (in first differences): 1 to 3

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.210564	53.07868	29.79707	0.0000
At most 1	0.045930	10.04729	15.49471	0.2771
At most 2	0.008154	1.490050	3.841466	0.2222

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.210564	43.03138	21.13162	0.0000
At most 1	0.045930	8.557245	14.26460	0.3248
At most 2	0.008154	1.490050	3.841466	0.2222

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

LNX	LNIT	LNFR
7.400775	-54.20124	101.9697
-15.39709	57.19850	-83.44228
-6.329392	-13.72273	25.70504

Unrestricted Adjustment Coefficients (alpha):

D(LNX)	-0.002410	0.002096	0.001421
D(LNIT)	-0.000576	-0.000450	0.000106
D(LNFR)	-0.000881	9.16E-05	-3.48E-05

Johansen test statistics

$\lambda_{trace/max}$ hypotheses:

$H_0: r = 0$ vs $H_1: 0 < r \leq g$

$H_0: r = 1$ vs $H_1: 1 < r \leq g$

$H_0: r = 2$ vs $H_1: 2 < r \leq g$

...

$H_0: r = g\text{-}1$ vs $H_1: r = g$

Full rank, so the variables=I(0)

- r=rank, number of cointegration(s);
- g=number of variables.
- T-stat $(\lambda_{trace} / \lambda_{max}) > CV$: *reject H0*

Date: 02/11/19 Time: 12:01
Sample (adjusted): 1981M05 1996M06
Included observations: 182 after adjustments
Trend assumption: Linear deterministic trend
Series: LNX LNIT LNFR
Lags interval (in first differences): 1 to 3

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.210564	53.07868	29.79707	0.0000
At most 1	0.045930	10.04729	15.49471	0.2771
At most 2	0.008154	1.490050	3.841466	0.2222

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.210564	43.03138	21.13162	0.0000
At most 1	0.045930	8.557245	14.26460	0.3248
At most 2	0.008154	1.490050	3.841466	0.2222

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

LNX	LNIT	LNFR
7.400775	-54.20124	101.9697
-15.39709	57.19850	-83.44228
-6.329392	-13.72273	25.70504

Unrestricted Adjustment Coefficients (alpha):

D(LNX)	-0.002410	0.002096	0.001421
D(LNIT)	-0.000576	-0.000450	0.000106
D(LNFR)	-0.000881	9.16E-05	-3.48E-05

How to get the p-values

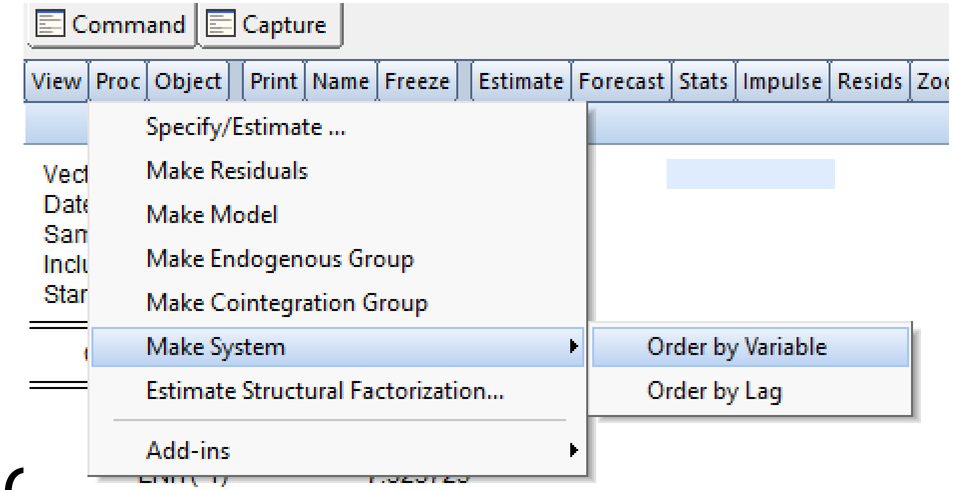
Vector Error Correction Estimates
Date: 02/11/19 Time: 12:01
Sample (adjusted): 1981M05 1996M06
Included observations: 182 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
LNX(-1)	1.000000
LNIT(-1)	-7.323725 (0.91587) [-7.99650]
LNFR(-1)	13.77825 (1.72219) [8.00041]
C	-34.95677

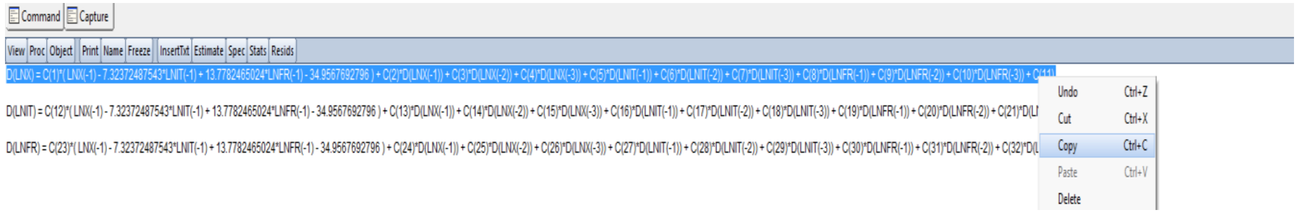
Coefficient
(Standard errors)
[T-stat]

Error Correction:	D(LNX)	D(LNIT)	D(LNFR)
CointEq1	-0.017838 (0.01081) [-1.64947]	-0.004262 (0.00150) [-2.84163]	-0.006520 (0.00102) [-6.39890]
D(LNX(-1))	0.025798 (0.07696) [0.33520]	-0.001177 (0.01067) [-0.11023]	0.005631 (0.00725) [0.77659]
D(LNX(-2))	-0.060404 (0.07525) [-0.80273]	0.008394 (0.01044) [0.80438]	0.011538 (0.00709) [1.62733]
D(LNX(-3))	0.090001 (0.07574) [1.18824]	0.001448 (0.01050) [0.13784]	-0.003868 (0.00714) [-0.54203]
D(LNIT(-1))	0.536944 (0.57352) [0.93622]	0.284263 (0.07954) [3.57395]	-0.132223 (0.05404) [-2.44691]
D(LNIT(-2))	-1.231853 (0.60718) [-2.02883]	-0.005679 (0.08420) [-0.06745]	0.085820 (0.05721) [1.50016]
D(LNIT(-3))	0.140394 (0.60207)	0.030498 (0.08350)	-0.051692 (0.05673)

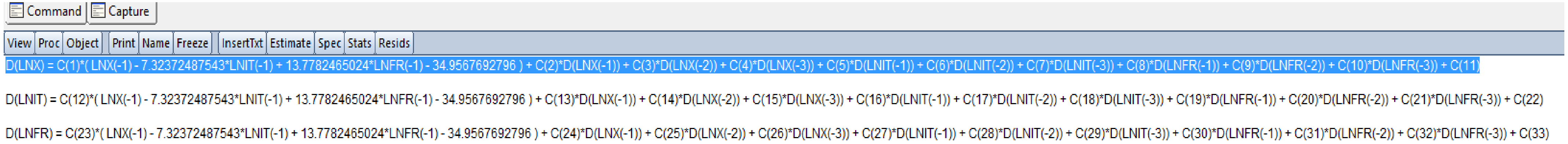
- But there is no p-value, how to get it?
- Proc > make system > order by variable

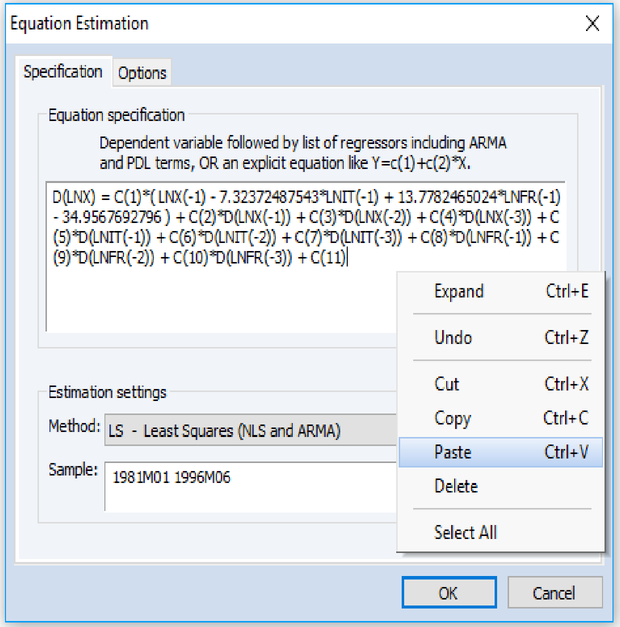


- Copy the model the 1st model



quick > estimate equation > right click: paste > ok





View | Proc | Object | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Dependent Variable: D(LNX)
Method: Least Squares (Gauss-Newton / Marquardt steps)
Date: 02/11/19 Time: 13:41
Sample (adjusted): 1981M05 1996M06
Included observations: 182 after adjustments
D(LNX) = C(1)*(LNX(-1) - 7.32372487543*LNIT(-1) + 13.7782465024
*LNFR(-1) - 34.9567692796) + C(2)*D(LNX(-1)) + C(3)*D(LNX(-2)) +
C(4)*D(LNX(-3)) + C(5)*D(LNIT(-1)) + C(6)*D(LNIT(-2)) + C(7)*D(LNIT(
-3)) + C(8)*D(LNFR(-1)) + C(9)*D(LNFR(-2)) + C(10)*D(LNFR(-3)) +
C(11)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.017838	0.010814	-1.649470	0.1009
C(2)	0.025798	0.076963	0.335199	0.7379
C(3)	-0.060404	0.075249	-0.802727	0.4232
C(4)	0.090001	0.075744	1.188237	0.2364
C(5)	0.536944	0.573525	0.936217	0.3505
C(6)	-1.231853	0.607175	-2.028826	0.0440
C(7)	0.140394	0.602074	0.233184	0.8159
C(8)	-0.520290	0.760372	-0.684257	0.4947
C(9)	0.023461	0.787664	0.029785	0.9763
C(10)	-1.702787	0.725115	-2.348298	0.0200
C(11)	0.013197	0.006035	2.186572	0.0301

R-squared	0.084431	Mean dependent var	0.001811
Adjusted R-squared	0.030889	S.D. dependent var	0.020025
S.E. of regression	0.019713	Akaike info criterion	-4.956558
Sum squared resid	0.066450	Schwarz criterion	-4.762909
Log likelihood	462.0468	Hannan-Quinn criter.	-4.878056
F-statistic	1.576910	Durbin-Watson stat	1.985281
Prob(F-statistic)	0.117086		

- The p-values
- If the C1 is negative and significant, we conclude that there is long run relationship among the variables.

The short run relationship between Yt and Xt

View | Proc | Object | Print | Name | Freeze | Estimate | Forecast | Stats | R

Wald Test:
Equation: Untitled

Test Statistic	Value	df	Probability
F-statistic	1.475132	(3, 171)	0.2231
Chi-square	4.425395	3	0.2190

Null Hypothesis: C(5)=C(6)=C(7)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(5)	0.536944	0.573525
C(6)	-1.231853	0.607175
C(7)	0.140394	0.602074

Restrictions are linear in coefficients.

- Next, lets check the short run relationship between LnX and LnIT which are captured by C(5), C(6) and C(7)
  - Do wald test: view > coeff diagnostics > wald test
  - Type: C(5)=c(6)=c(7)=0, (H0)
  - P-value < 5%: not reject H0, no short run relation between LnX and LnIT.
- Then, check the short run relation for the other variables

View | Proc | Object | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Dependent Variable: D(LNX)
Method: Least Squares (Gauss-Newton / Marquardt steps)
Date: 02/11/19 Time: 13:41
Sample (adjusted): 1981M05 1996M06
Included observations: 182 after adjustments
D(LNX) = C(1)*(LNX(-1) - 7.32372487543*LNIT(-1) + 13.7782465024
*LNFR(-1) - 34.9567692796) + C(2)*D(LNX(-1)) + C(3)*D(LNX(-2)) +
C(4)*D(LNX(-3)) + C(5)*D(LNIT(-1)) + C(6)*D(LNIT(-2)) + C(7)*D(LNIT(
-3)) + C(8)*D(LNFR(-1)) + C(9)*D(LNFR(-2)) + C(10)*D(LNFR(-3)) +
C(11)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.017838	0.010814	-1.649470	0.1009
C(2)	0.025798	0.076963	0.335199	0.7379
C(3)	-0.060404	0.075249	-0.802727	0.4232
C(4)	0.090001	0.075744	1.188237	0.2364
C(5)	0.536944	0.573525	0.936217	0.3505
C(6)	-1.231853	0.607175	-2.028826	0.0440
C(7)	0.140394	0.602074	0.233184	0.8159
C(8)	-0.520290	0.760372	-0.684257	0.4947
C(9)	0.023461	0.787864	0.029785	0.9763
C(10)	-1.702787	0.725115	-2.348298	0.0200
C(11)	0.013197	0.006035	2.186572	0.0301

R-squared	0.084431	Mean dependent var	0.001811
Adjusted R-squared	0.030889	S.D. dependent var	0.020025
S.E. of regression	0.019713	Akaike info criterion	-4.956558
Sum squared resid	0.066450	Schwarz criterion	-4.762909
Log likelihood	462.0468	Hannan-Quinn criter.	-4.878056
F-statistic	1.576910	Durbin-Watson stat	1.985281
Prob(F-statistic)	0.117086		

Next:

- Check R-squared, the larger = the better model
- Prob(F-stat)<5%: significant, model is fine