Econometrics
Lab Hour – Session 6

Agustín Bénétrix
benetria@tcd.ie
Office hour:
Wednesday 4-5
Room 3021

Martin Schmitz
schmitzm@tcd.ie
Office hour:
Monday 5-6
Room 3021

Outline

- Importing the dataset
- Time Series
  - Unit roots
  - Spurious regressions
  - Cointegration
- Project time

We have to

- Confirm that *lsp500* and *lip* contain unit roots using
  - Augmented Dickey-Fuller test
    - Need logs and log changes
    - 4 lags
    - With and without time trend
  - **H_0:** Series contains unit root

We need to generate and run…

- LSP500 = log(SP500)
- DLSP500 = LSP500 - LSP500(-1)

- Run:
  - DLSP500 CONSTANT LSP500(-1) DLSP500(-1) DLSP500(-2) DLSP500(-3) DLSP500(-4)
- Run:
  - DLSP500 CONSTANT TREND LSP500(-1) DLSP500(-1) DLSP500(-2) DLSP500(-3) DLSP500(-4)

We need to generate and run…

- LIP = log(IP)
- DLIP = LIP - LIP (-1)

- Run:
  - DLIP CONSTANT LIP(-1) DLIP(-1) DLIP(-2) DLIP(-3) DLIP(-4)
- Run:
  - DLIP CONSTANT TREND LIP(-1) DLIP(-1) DLIP(-2) DLIP(-3) DLIP(-4)

Output (LSP500)

Ordinary Least Squares Estimation

Dependent variable is DLSP500
553 observations used for estimation from 1947M7 to 1993M7

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
CONSTANT	.010416	.0072957	1.4277[.154]
LSP500(-1)	-.0012843	.0016182	**-.79365[.428]**
DLSP500(-1)	.26446	.042682	6.1960[.000]
DLSP500(-2)	-.083192	.044133	-1.8850[.060]
DLSP500(-3)	.016918	.044073	.38386[.701]
DLSP500(-4)	.043858	.042547	1.0308[.303]

R-Squared	.068961	R-Bar-Squared	.060451
S.E. of Regression	.032646	F-stat. F(5, 547)	8.1032[.000]
Mean of Dependent Variable	.0062240	S.D. of Dependent Variable	.033680
Residual Sum of Squares	.58297	Equation Log-likelihood	1110.7
Akaike Info. Criterion	1104.7	Schwarz Bayesian Criterion	1091.8
DW-statistic	2.0015		

Output (with time trend) (LSP500)

Ordinary Least Squares Estimation

Dependent variable is DLSP500
553 observations used for estimation from 1947M7 to 1993M7

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
CONSTANT	.042418	.017152	2.4731[.014]
T	**.6331E-4**	**.3073E-4**	**2.0603[.040]**
LSP500(-1)	-.012585	.0057175	**-2.2012[.028]**
DLSP500(-1)	.26845	.042600	6.3015[.000]
DLSP500(-2)	-.076987	.044105	-1.7455[.081]
DLSP500(-3)	.022086	.044014	.50179[.616]
DLSP500(-4)	.050926	.042560	1.1966[.232]

R-Squared	.076143	R-Bar-Squared	.065991
S.E. of Regression	.032550	F-stat. F(6, 546)	7.5001[.000]
Mean of Dependent Variable	.0062240	S.D. of Dependent Variable	.033680
Residual Sum of Squares	.57847	Equation Log-likelihood	1112.9
Akaike Info. Criterion	1105.9	Schwarz Bayesian Criterion	1090.8
DW-statistic	2.0032		

Output (LIP)

```
           Ordinary Least Squares Estimation
*******************************************************************************
 Dependent variable is DLIP
 553 observations used for estimation from 1947M7  to 1993M7
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 CONSTANT                 .0063813          .0036230             1.7613[.079]
 LIP(-1)                 -.0012191          .8888E-3            -1.3717[.171]
 DLIP(-1)                   .34870           .042713             8.1639[.000]
 DLIP(-2)                  .070817           .045123             1.5694[.117]
 DLIP(-3)                  .064392           .045119             1.4272[.154]
 DLIP(-4)                 .0026028           .042666            .061005[.951]
*******************************************************************************
 R-Squared                    .17051   R-Bar-Squared                   .16293
 S.E. of Regression          .010077   F-stat.    F(  5, 547)   22.4883[.000]
 Mean of Dependent Variable .0028634   S.D. of Dependent Variable     .011014
 Residual Sum of Squares     .055542   Equation Log-likelihood         1760.8
 Akaike Info. Criterion       1754.8   Schwarz Bayesian Criterion      1741.8
 DW-statistic                 1.9988
*******************************************************************************
```

Output (with time trend) (LIP)

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Ordinary Least Squares Estimation
*******************************************************************************
 Dependent variable is DLIP
 553 observations used for estimation from 1947M7  to 1993M7
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 CONSTANT                  .042852           .016169             2.6502[.008]
 T                        .3565E-4          .1541E-4             2.3139[.021]
 LIP(-1)                  -.012786           .0050765           -2.5186[.012]
 DLIP(-1)                  .35046            .042551             8.2364[.000]
 DLIP(-2)                 .076835            .045020             1.7067[.088]
 DLIP(-3)                 .072041            .045062             1.5987[.110]
 DLIP(-4)                 .015306            .042851              .35720[.721]
*******************************************************************************
 R-Squared                    .17857   R-Bar-Squared                    .16954
 S.E. of Regression          .010037   F-stat.    F(  6, 546)   19.7818[.000]
 Mean of Dependent Variable .0028634  S.D. of Dependent Variable     .011014
 Residual Sum of Squares     .055002  Equation Log-likelihood         1763.5
 Akaike Info. Criterion       1756.5  Schwarz Bayesian Criterion      1741.4
 DW-statistic                 1.9970
*******************************************************************************
```

Both variables are I(1)

- For ***lsp*500**, the ADF statistic without a trend is ***t* = –.79**; with a trend, the *t* statistic is **–2.20**. This are both well above their respective 10% critical values.

- In addition, the estimated roots are quite close to one. For ***lip***, the ADF statistic without a trend is **–1.37** without a trend and **–2.52** with a trend. Again, these are not close to rejecting even at the 10% levels, and the estimated roots are very close to one.

- critical value at 10%:-2.57 and -3.12 (with time trend)

spurious regression?

Ordinary Least Squares Estimation

Dependent variable is **LSP500**
553 observations used for estimation from 1947M7 to 1993M7

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
CONSTANT	-2.3764	.097474	-24.3794[.000]
LIP	1.6882	.023986	**70.3820**[.000]

R-Squared	**.89990**	R-Bar-Squared	.89972
S.E. of Regression	.27208	F-stat. F(1, 551)	4953.6[.000]
Mean of Dependent Variable	4.4356	S.D. of Dependent Variable	.85920
Residual Sum of Squares	40.7902	Equation Log-likelihood	-63.8606
Akaike Info. Criterion	-65.8606	Schwarz Bayesian Criterion	-70.1760
DW-statistic	**.019551**		

- The *t* statistic for *lip* is over 70, and the *R*-squared is around .90. These are hallmarks of spurious regressions.

- Spurious regressions includes two independent I(1) time series

Test for co-integration

- Use the residuals to test whether lsp500 and lip are cointegrated
  - Only if both variables are I(1), i.e. have a unit root
  - Dickey Fuller and ADF
    - 2 lags

Test for co-integration

- Save residuals
- Generate difference
- ADF test of residuals
- H_0: **No** Co-integration

Run again and keep residuals

```
          Ordinary Least Squares Estimation
*******************************************************************************
 Dependent variable is LSP500
 553 observations used for estimation from 1947M7  to 1993M7
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 CONSTANT                  -2.3764           .097474           -24.3794[.000]
 LIP                        1.6882           .023986            70.3820[.000]
*******************************************************************************
 R-Squared                          .89990   R-Bar-Squared                  .89972
 S.E. of Regression                 .27208   F-stat.    F(  1, 551)    4953.6[.000]
 Mean of Dependent Variable        4.4356   S.D. of Dependent Variable      .85920
 Residual Sum of Squares           40.7902   Equation Log-likelihood       -63.8606
 Akaike Info. Criterion           -65.8606   Schwarz Bayesian Criterion    -70.1760
 DW-statistic                       .019551
*******************************************************************************
```

Apply ADF to residuals

```
              Ordinary Least Squares Estimation
*******************************************************************************
 Dependent variable is DRESID
 550 observations used for estimation from 1947M10 to 1993M7
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 RESID(-1)               -.0090597          .0058012            -1.5617[.119]
 DRESID(-1)                .28404            .042570             6.6724[.000]
 DRESID(-2)               -.059141           .042578            -1.3890[.165]
*******************************************************************************
 R-Squared                      .076296   R-Bar-Squared                  .072919
 S.E. of Regression             .036516   F-stat.    F(  2, 547)   22.5906[.000]
 Mean of Dependent Variable    .0012610   S.D. of Dependent Variable     .037925
 Residual Sum of Squares        .72940   Equation Log-likelihood         1041.6
 Akaike Info. Criterion         1038.6   Schwarz Bayesian Criterion      1032.1
 DW-statistic                   1.9982
*******************************************************************************
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Errors are I(1), -> no CO-I

- The ADF statistic (with two lagged changes) is –1.57. There is no evidence of cointegration. (The 10% critical value is –3.04.)
- Add time trend to initial model

Add the time trend estimate and keep residuals

```
Ordinary Least Squares Estimation
*******************************************************************************
 Dependent variable is LSP500
 558 observations used for estimation from 1947M2  to 1993M7
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 CONSTANT                   1.8696             .38320             4.8790[.000]
 T                        .0041557          .3633E-3            11.4382[.000]
 LIP                       .34389             .11993             2.8674[.004]
*******************************************************************************
 R-Squared                  .92155   R-Bar-Squared                    .92126
 S.E. of Regression         .24432   F-stat.    F(  2, 555)    3259.6[.000]
 Mean of Dependent Variable  4.4201  S.D. of Dependent Variable      .87071
 Residual Sum of Squares    33.1295  Equation Log-likelihood        -3.8902
 Akaike Info. Criterion     -6.8902  Schwarz Bayesian Criterion    -13.3768
 DW-statistic               .019204
*******************************************************************************
```

Apply ADF to residuals

```
 Ordinary Least Squares Estimation
*******************************************************************************
 Dependent variable is DRESID1
 555 observations used for estimation from 1947M5  to 1993M7
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 RESID1(-1)               -.010751          .0057203            -1.8795[.061]
 DRESID1(-1)               .26867            .042212             6.3647[.000]
 DRESID1(-2)              -.080072           .042301            -1.8929[.059]
*******************************************************************************
 R-Squared                      .071936   R-Bar-Squared                  .068573
 S.E. of Regression             .032608   F-stat.    F(  2, 552)   21.3933[.000]
 Mean of Dependent Variable   .9645E-3    S.D. of Dependent Variable     .033787
 Residual Sum of Squares         .58694   Equation Log-likelihood         1113.9
 Akaike Info. Criterion          1110.9   Schwarz Bayesian Criterion      1104.4
 DW-statistic                    1.9993
*******************************************************************************
```

- After adding a linear time trend to the regression, the ADF statistic applied to the residuals is –1.88.
- Even with a time trend there is no evidence of cointegration (critical value at 10% is -3.50)
- It appears that *lsp*500 and *lip* are not cointegrated, even if we allow them to have unrestricted linear time trends. The analysis does not point to a long-run equilibrium relationship.

- Project time….