Tutorial 4: Cointegration
Engle-Granger Procedure

Empirical Exercises

1. Beaudry and Portier (AER 2006) analyze the relationship between total factor productivity (TFP) and stock prices. They find that (i) TFP and stock prices are I(1) and cointegrated, and (ii) the shock which drives the common stochastic trend has a zero contemporaneous effect on TFP but a strong contemporaneous effect on stock prices indicating that the stock market anticipates permanent changes in production opportunities. Their dataset covers period from 1948Q1 to 2000Q4. In the Matlab file `BPdata.xlsx` you can find the time series tfp, the log of total factor productivity, and sp, the log of capital stock index. They are the preferred measures of TFP and stock prices.

   (a) Plot tfp and sp. Do you expect these two variables to be I(1) and cointegrated?

   (b) Perform ADF test for tfp and sp at the 5 percent level. Carefully state hypotheses, test statistics, critical values, and test decision.

   (c) Use the Engle-Granger procedure to test the null of no cointegration between tfp and sp. Carefully state hypotheses, test statistic, critical values, and test decision.

2. Carstensen et al. (SJPE, 2009) estimate the long-run money demand function of the euro area (and of Germany, France and Spain) using synthetic data from 1979Q4 (the start of EMS I) to 2004Q4. Money demand is often modeled as

$$m_t^r = \beta_1 y_t^r + \beta_2 i_t + u_t$$

   where m_t^r denote log real money balances, y_t^r log real GDP to account for the transaction motive of holding money, and i_t a nominal interest rate to account for the opportunity cost of holding money (instead of bonds etc). Money supply is assumed to fully accommodate demand.

Ceteris parabus the transaction volume increases one-to-one with GDP. Therefore, one would expect $\beta_1 = 1$. Higher interest rates for bonds make holding money more costly, which is why one would expect $\beta_2 < 0$. As all variables are typically found to be I(1), the long-run money demand function implies a cointegration relationship. In the paper, the variables $LM3real$ (log of real M3 money balances), $LGDPreal$ (log of real GDP), and LT (long-term interest rate) are used but the dataset `Carstensen.xlsx` additional contains ST (short-term interest rate) and $INFL$ (inflation rate).

(a) Plot $LM3real$, $LGDPreal$, and LT. Do you expect these variables to be I(1)?

(b) Perform ADF tests for $LM3real$, $LGDPreal$, and LT. Carefully state hypotheses, test statistics, critical values, and test decision.

(c) Use the Engle-Granger procedure to test the null of no cointegration between $LM3real$, $LGDPreal$, and LT. Carefully state hypotheses, test statistics, critical value, and test decision.