

## Tutorial 1: Stationary Time Series

### Empirical Exercises

1. The excel file USdata.xlsx contains the monthly time series of the US industrial production (IP), unemployment rate (UNR), money supply (M1) and month-on-month percentage change in the Wilshire 5000 stock prices (SP) over the period from Jan 1985 to Feb 2024. The dataset is collected from the Federal Reserve Economic Data (FRED).
  - (a) Plot IP, UNR, M1 and SP. Which of them are likely stationary?
  - (b) Define  $\Delta IP = \log(IP_t) - \log(IP_{t-1})$ ,  $\Delta(UNR) = UNR_t - UNR_{t-1}$ , and  $\Delta(M1) = \log(M1_t) - \log(M1_{t-1})$ . Again, plot these three time series. Now, which of them are likely stationary?
2. Romer and Romer 2010 examines the effect of tax changes on real economic activity in the US. In the data file RRdata.xlsx you will find the dataset used in this paper.
  - *PGDP*: price index of real GDP
  - *PCGDPI*: first difference of the logarithm of real GDP,  $PCGDPI = \log(PGDP_t) - \log(PGDP_{t-1})$ .
  - *EXOGENRRATIO*: a ratio of the exogenous tax changes to nominal GDP at time t.
  - (a) What is the economic meaning of PCGDPI? Plot  $\log(PGDP)$  and PCGDPI. Based on the plot, which ones you think are stationary?
  - (b) EXOGENRRATIO is a new measure of the exogenous fiscal shock that is essentially not serially correlated. One simple way to check the autocorrelations of lag order up to  $k=12$  is to look at the autocorrelogram. Plot the autocorrelogram for the fiscal shock. Do they exhibit significant autocorrelation? Plot the autocorrelogram for PCGDPI ( $k=12$ ) and make a comparison with that of EXOGENRRATIO.