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ADVANCED MACROECONOMICS
PROBLEM SET 8

Exercise 1: Empirical Business Cycles

Download data for GDP, consumption, and investment for Germany. Choose quarterly data for at least 10 years (for example, from 1996 to 2025). A reliable source for aggregate time series is provided by FRED or Eurostat. Make sure to choose *real* (at constant prices) and *seasonally-adjusted* time series. For the following exercises, you might use the software package of your choice (e.g., Matlab, Stata, R).[1]

1. Take the logarithm of the series before detrending the data. Why is the logarithm a useful transformation?

2. Using time series data on German GDP, estimate a linear trend model using ordinary least squares (OLS). Once you have estimated the linear trend, plot the observed GDP values and the fitted trend line on the same graph. Briefly discuss the limitations of using a linear trend model to capture GDP fluctuations over time.

3. Use the Hodrick-Prescott filter to detrend the data with a smoothing coefficient of $\lambda = 1600$ (built-in function in Matlab/Stata/EViews, otherwise available here).

4. Plot the detrended series, the trend component, and the raw data for all three variables.

5. Briefly discuss the role of λ for the estimated trend. What are the potential disadvantages of the Hodrick-Prescott filter?

6. Calculate the standard deviations of consumption and investment relative to the standard deviation of GDP.

Exercise 2: Stochastic Processes

Consider the stochastic process for technology in the baseline RBC model from the lecture given by

$$\ln A_t = \bar{A} + gt + \tilde{A}_t \quad \text{with} \quad \tilde{A}_t = \rho_A \tilde{A}_{t-1} + \varepsilon_{A,t},$$

where $\bar{A}$ is a constant, g denotes the deterministic growth rate and $\varepsilon_{A,t} \overset{i.i.d.}{\sim} N(0, \sigma_A^2)$ is a technology shock. A_0 is given.

1. Express $\ln A_1$, $\ln A_2$ and $\ln A_3$ in terms of $\ln A_0$, $\varepsilon_{A,1}$, $\varepsilon_{A,2}$, $\varepsilon_{A,3}$, $\bar{A}$ and g.

2. What are the time-zero expectations of $\ln A_1$, $\ln A_2$, $\ln A_3$ and $\ln A_\infty$?

3. Suppose that technology is only driven by the stochastic term $\tilde{A}_t$, i.e. set $\bar{A} = g = 0$, and assume $A_0 = 1$ and $\rho_A = 0.5$. Compute $\ln A_t$ for $t = \{1, ..., 5\}$ given that

   a) no shock hits the economy.

   b) a one-time unity shock hits the economy in period 1, i.e. $\varepsilon_{A,1} = 1$.

4. Repeat 3b) for the cases $\rho_A = 0$, $\rho_A = 1$, $\rho_A = 1.5$.

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[1] In the tutorial, we will use Matlab. Use can request a Matlab license at the Rechenzentrum.