Macroeconometrics
Fall 2021
Problem Set 2

- The problem set is due by **Monday, November 1st at midnight** (the night before the class in the computer room on Tuesday, November 2th). Please send the material by e-mail to Alireza Aghaee Shahrbabaki, alireza.aghaee@phd.unibocconi.it).
- Work in groups of maximum 3 people.
- You are expected to follow the same rules as for problem set 1.

1. A special case of unit root testing.
a. Generate data under the data generating process (DGP):

$$y_t = \alpha + y_{t-1} + \varepsilon_t$$

and estimate the following regression:

$$y_t = \alpha + \rho y_{t-1} + \varepsilon_t$$

to test the null hypothesis $H_0 : \rho = 1$ by means of a t-test.

What happens to the distribution of the t-test in this case? How do you intuitively explain this? *(Hint: the formal proof, which is beyond what we have learnt in the course, can be found in Hamilton, chapter 17 and it is based on results in Sims, Stock and Watson, Econometrica, 1990. An intuitive explanation can be found in the following sentence from Enders: "If the data-generating process contains any deterministic regressors (i.e., an intercept or a time trend) and the estimating equation contains these deterministic regressors, inference on all coefficients can be conducted using a t-test or an F-test. This is because a test involving a single restriction across parameters with different rates of convergence is dominated asymptotically by the parameters with the slowest rates of convergence",* [which is the one on the deterministic regressor (my note)].

b. Do you notice anything interesting on the mean of the distribution of the t-statistic? Discuss.

c. Based on what we have learnt at point a., add a time trend (another deterministic regressor) to both the DGP and the testing equation at point a. and check that also in this case the results of Sims, Stock and Watson (summarized in Rule 2 in Enders, p.267) hold.

2. Spurious regression.

Design a Monte Carlo to show that the regression coefficient, the t-test and the R^2 are meaningless in the case of a spurious regression.

In particular, show what happens in each of the 4 cases discussed in Enders, Edition 3 or 4, pp. 195-199.

3. Granger causality.

Read the paper "A New Measure of Monetary Shocks: Derivation and Implications", by Christina D. Romer and David H. Romer, The American Economic Review, Vol. 94, No. 4 (Sep., 2004), pp. 1055-1084 available on the blackboard. Download the file Romer_Romer.xlsx. There, you will find 4 time series: US inflation, US unemployment, US federal funds rate, the Romer and Romer monetary policy shocks from 1969Q1 to 1996Q4. Run a VAR with 4 lags and test for Granger causality of the Romer and Romer shocks. Are the Romer and Romer shocks Granger-causing other variables or not? If yes, what does that mean?

4. Invertibility.

Suppose that the DGP is

$$\begin{bmatrix} x_t \\ y_t \end{bmatrix} = \begin{bmatrix} 1 & L^2 \\ \frac{\beta}{1-\beta} & \frac{\beta^2}{1-\beta} + \beta L \end{bmatrix} \begin{bmatrix} \eta_t \\ \varepsilon_t \end{bmatrix}$$

where the shocks are uncorrelated, $u_t = [\eta_t \quad \varepsilon_t]'$, $VCov(u_t) = \begin{bmatrix} 1 & 0 \\ 0 & 0.8 \end{bmatrix}$ and $0 < \beta < 1$ (assume $\beta = 0.6$). Generate 500 observations from $[x_t \quad y_t]'$, estimate a VAR with 4 lags and identify the structural shocks using a Choleski identification scheme (which is consistent with the DGP, right?). Do the simulations N times and store the impulse responses for the N simulations. Compare the true impulse response functions and the estimated ones (for the estimated ones, you can compute the mean of the empirical distribution of the estimated impulse responses and, say, the 5th and the 95th percentile). Are they similar? What's wrong with the DGP? Discuss.