Problem Set # 3

Due date: March 30

Please show your work carefully in answer the following questions. As mentioned in class, you are encouraged to work in groups but must write your own answers.

1. **(Romer, 5th ed. 6.16) Observational Equivalence.**[1] (Sargent, 1976). Suppose that the money supply is determined by $m_t = cz_{t-1} + e_t$, where c is a coefficient, and z an economic variable and e_t is an i.i.d. disturbance uncorrelated with z_{t-1}. e_t is unpredictable and unobservable. Thus the expected component of m_t is cz_{t-1}, and the unexpected component is e_t. In setting the money supply, the Federal Reserve responds only to variables that matter for real activity; that is, the variables in z directly affect y.

   Now consider the following two models: (i) Only unexpected money matters, so $y_t = az_{t-1} + be_t + v_t$; (ii) all money matters, so $y_t = \alpha z_{t-1} + \beta m_t + v_t$. In each specification, the disturbance is i.i.d. and uncorrelated with z_{t-1} and e_t.

   (a) Is it possible to distinguish between these two theories? That is, given a candidate set of parameter values under, say, model (i), are there parameter values under model (ii) that have the same predictions? Explain.

   (b) Suppose that the Federal Reserve also responds to some variables that do not directly affect output; that is, suppose $m_t = cz_{t-1} + \gamma w_{t-1} + e_t$ and that models (i) and (ii) are as before (with their disturbances now uncorrelated with w_{t-1} as well as with z_{t-1} and e_t). In this case, is it possible to distinguish between the two theories? Explain.

2. **(Matlab question: more on autorregressive processes)** Consider the following autorregressive process of the second order, AR(2):

$$y_t = \alpha_1 y_{t-1} + \alpha_2 y_{t-2} + \epsilon_t$$

   Where $\epsilon_t \overset{i.i.d.}{\sim} N(0,1)$. Suppose that the process begins at $t = 0$, so all values before that are equal to zero. At $t = 0$, the system is shocked with $\epsilon_0 = 1$, thereafter the shocks are all zero ($\epsilon_1 = 0, \epsilon_2 = 0$ and so on).

   With everything else constant but the shock, we call the resulting sequence of y_t's an impulse response to a shock in ϵ.

   (a) Show that $\{y_0, y_1, y_2\} = \{1, \alpha_1, \alpha_1^2 + \alpha_2\}$. Also, obtain y_3.

   (b) Now assume $\alpha_1 = 0.9$, $\alpha_2 = -0.1$. Using Matlab, obtain and plot the impulse responses for 24 periods after the shock, i.e. get $\{y_0, y_1, y_3, \cdots, y_{24}\}$. For your submission report the plot only

[1] The original exercise in the book treats a, α, c and γ as a vector of coefficients, and z and w as a vectors of economic variables. Feel free to solve this simpler version of the original one. The idea behind is the same.

(not the values).

[*Hint:* this would be a pain to do by hand, but in Matlab, it can be implemented very easily with a for loop.]

Can you see how the process returns to its expected value after some time (once the effect of the shock dies out)? That is the typical behaviour we expect to see in an impulse response describing a standard "stationary" process. In the rest of the exercise you will see a process where this does not happen.

(c) Now let's assume $\alpha_1 = 1$, $\alpha_2 = 0$. The resulting process (no longer AR(2)), is called a Random Walk process (a special type of AR(1) where the autorregressive coefficient is equal to one). It is called "random" because the effect of a shock does not dissapear over time and then, after a shock the process does not revert to its mean value, which ultimately implies that the shocks (which are random and stochastic by nature) will dictate where the process goes.

I want you to see this yourself, first algebraically, and then with a program.

Find expressions for $\{y_0, y_1, y_2, y_3, y_4\}$

Does the effect of the shock fade out as time goes on?

(d) Now, again with $\alpha_1 = 1$, $\alpha_2 = 0$, plot the impulse response for the 24 periods after the shock, i.e., $\{y_0, y_1, y_3, \cdots, y_{24}\}$.

Does the effect of the shock fade out as time goes on even more periods?

[*Hint:* the code bit bellow shows how to create the impulse for another process and a different number of periods. If it helps, make your own code based on this simpler case]

```
y = zeros(8,1); %first we create a matrix to fill with our results

eps0 = 2;
epsOther = 0;

%we have to create  outside the loop the first elements so that the loop
%has enough elements for initial periods to run in all cases
% (the more lags in the AR the more elements we must create outside).

y(1) = 0.8*0 + eps0; %the first position is t=0

%now we create y_t for the rest of periods:
for i = 2:8
y(i) = 0.8*y(i-1) + epsOther;
end

%plot for y below:
%(make sure to start the x axis in zero, the initial shock period)

plot(0:(length(y)-1),y) %x part in plot represents time, then starts at zero
title("Impulse Response Function of Y to a shock in \epsilon"); xlabel("time")
```

3. Explain whether the following statement is *true, false or uncertain*:

   (a) **(Lucas Island Model)** According to the Lucas imperfect information model, a 5% drop in the money supply will have a larger effect on output in an economy where monetary conditions are stable, compared to an economy with volatile monetary conditions.

   (b) **Fischer Model** According to the Fischer wage contracting model, a change in money supply affects real economic activity only if it is not fully expected at the time contracts are signed.

4. **(Policy question)** Pick one among the presentations in each of these links:

   - Paul Krugman on how to think about trade imbalances:
     https://bcf.princeton.edu/events/paul-krugman-on-how-to-think-about-trade-imbalances/
   - Professor Charles Goodhart, on the dynamics of inflation and interest rates since the second half of the XX century and expected economic outlook:
     https://bcf.princeton.edu/events/charles-goodhart/
   - Fed chair Jerome Powell on Inflation policy framework and the Federal Reserve responses to the COVID crisis:
     https://bcf.princeton.edu/events/federal-reserve-chair-jerome-powell/

   Provide a 1/2 to 1 page summary with the main policy and macroeconomic ideas behind the talk, as well as the main mechanisms and insights that explain them. As possible, draw your conclusions in terms of the topics, tools and methods introduced in the lectures.

   Remember to explain the talk **in your own words**. Please do not copy from the executive summary in the link.