ECON30009/90080 – Assignment 2

This Version: Semester 2, 2025

(Due no later than October 9, Thursday, 4pm)

Assignment Overview

- This assignment is graded out of 70 points. While the assignment is scored out of 70 points, it is worth 7% of your total grade for this course.
- Please type the solutions to your assignment (e.g., in Word or LaTeX) and convert them to a PDF file for online submission on the LMS.
- **Please note this is a group assignment with up to 3 students per group. You can form your groups directly in LMS.** You don't need to be in the same tutorial to form a group and you can submit your assignment individually if you prefer.
- All students within the same group will receive the same mark and no two groups may submit the same assignment. You can collaborate with members of your own group (and all group members must provide input), but not with other groups. **Please list all members of your group clearly on the first page of your submission** and make sure you keep draft copies of your own working (for each member of the group).
- **This assignment should reflect your own work and ideas** (see also the section: **Artificial Intelligence Software in the Preparation of Material for Assessment** in the Subject Guide). AI assistance tools are not required for this assignment, but if you do use them it should be for **editing and proofing of your work only**. Any use of AI tools for editing purposes needs to be clearly acknowledged at the start of your assignment. Further information on the acceptable use of these tools can be found here.

Question 1: Co-movement and volatility (15 points)

In class, we looked at how consumption spending co-moves with output and found that consumption spending tends to fluctuate as much as output. In this question, you will look at how the different categories of consumption spending vary with GDP.

a Download **quarterly** data from FRED on real GDP, real personal consumption expenditure on durables, real personal consumption expenditure on non-durables and real personal consumption expenditure on services for the period covering 1960q1-2025q1. (You may use the following link: here and in the search bar on the FRED website, look up the following data series: DDURRA3M086SBEA_PC1, DNDGRA3M086SBEA_PC1, DSERRA3Q086SBEA_PC1 and A191RA3Q086SBEA_PC1. Note some series in FRED are recorded at a monthly frequency so remember to aggregate them up to a quarterly frequency.) Take natural logs of each series and first difference the data to make it stationary. Then plot how each consumption spending category varies with GDP. Based on your plots, state how each series co-moves with GDP.

b Now compute the standard deviation of each series. What can you say about the volatility of each consumption spending category relative to GDP? Provide some brief intuition to accompany your answer.

c Finally calculate the cross-correlations of each consumption spending category with GDP. Do this for lags = 0, 1, 2 and 3. For example, to calculate the cross-correlation between GDP and consumption durables lagged by 1 period, you would calculate the correlation between the series GDP_t to GDP_{t+h}, and the series CD_{t-1} to CD_{t+h-1} where CD is short-form for consumer durables. From your calculations, which series is a leading indicator of GDP? [Note if a lagged series has high correlation with contemporaneous GDP, this series leads GDP because past values of this series lead the turning points in GDP.]

[Final Note: you'll notice that we did this exercise for the US economy. However, you can always try to replicate this exercise on your own for the Australian economy by searching through the Australian Bureau of Statistics website for the relevant data series.]

Question 2: Tracking the unemployment rate (20 points)

Suppose we make the assumption that all individuals are in the labour force. We want to see, given a matching function, and data on the separation rate, the level of unemployed and vacancies, how well our law of motion for the unemployment rate that we characterized in class can track the actual unemployment rate.

Download **monthly** data from FRED on the unemployment rate, the level of unemployed, the level of vacancies, the level of hires, and the total separation rate for the period covering 2001m1-2025m7. (You may use the following link: here and in the search bar on the FRED website, look up the following data series: UNRATE, UNEMPLOY, JTSJOL, JTSHIL, JTSTSR).

a) Consider the matching function we discussed in class: $M(U_t, V_t) = \xi \frac{U_t V_t}{(U_t^\alpha + V_t^\alpha)^{1/\alpha}}$ where ξ is the matching efficiency parameter and α is the elasticity of the matching function with respect to unemployment and $0 < \alpha < 1$. Denote $\theta = V_t/U_t$ and given this matching function, write down an expression for the job-finding rate, $p(\theta_t)$ in terms of θ_t and parameters of the matching function.

b) Assume $\xi = 2.9$, and $\alpha = 0.5$. Given data on the level of unemployed and vacancies, compute the job-finding rate, $p(\theta_t)$. Plot the job-finding rate over time.

c) Write down an equation characterizing the law of motion of the unemployment rate. Using information on the unemployment rate in period t, the job-finding rate in period t and the total separation rate in period t, compute what the implied unemployment rate would be in period $t + 1$. [Note: we are implicitly assuming here that the unemployment rate recorded in the data at period t is the unemployment rate at the start of period t.] Plot your computed implied unemployment rate series against the actual unemployment rate observed in data.

d) How well does the implied unemployment rate series line up against the actual unemployment rate? Provide some brief intuition as to why there might be discrepancies (if any) between the two series.

Question 3: A static RBC model with an externality (35 points)

Consider the RBC model. The economy only lasts for one period. There are only households and firms in the economy, and there is no government.

There exists N households in the economy. Households get utility from consumption, but also suffer disutility from working *and* from pollution $\mathcal{P}$, which is a by-product of aggregate labour used in production. Specifically, the utility function of the household is given by:

$$\max_{c,\ell} U(c, \ell, \mathcal{P}) = \ln c - \ell - \mathcal{D}(\mathcal{P})$$

where $\mathcal{D}(\mathcal{P})$ is a function representing the (dis)utility the household gets from pollution and is given by $\mathcal{D}(\mathcal{P}) = L^2$. Note that c and ℓ represent consumption and labour of the individual household, respectively. Importantly, the household can choose consumption and her own labour to maximize her utility, but she cannot choose aggregate labour. Households are born with a physical asset a. They earn rental income from renting out their capital (the physical asset), they earn a wage w for each unit of labour supplied and they receive dividends from the firm.

Firms produce output via a Cobb-Douglas production function $Y = zK^{\alpha}L^{1-\alpha}$ where $0 < \alpha < 1$. They rent capital from the households at rate R and hire labour at rate w. Firms seek to maximize their profits.

a Set up the household problem and derive the household's optimality conditions. [Hint: there should be two optimality conditions.]

b Set up the firm's problem and derive the firm's optimality conditions

c Suppose $N = 1$, $\alpha = 0.5$. Solve for ℓ. [Note once you know ℓ, you know c. So you've effectively solved the model once you have recovered ℓ.]

d Consider now a social planner who wants to maximize the utility of households given the resources in the economy. Note that unlike the individual household in the market economy, the social planner can tell all households how much they should work. Set-up the social planner's problem and derive the planner's optimality conditions.

e Again assume $N = 1$ and $\alpha = 0.5$. Solve for the social planner's choice of ℓ^{SP}. Is the planner's choice the same as that observed in the market economy? Briefly explain why there may or may not be differences. [Note: you may find it useful to remember the quadratic formula. Discard any negative root since ℓ cannot be negative]