Time: 2 hours. Each problem worths 20 points and each question worths 12.5 points. Good luck!

Name:
Student ID:

Problems (choose 1 out of 2)

Problem 1

Consider a recursive-dynamic general equilibrium model.

- There are two households: a **rich household** that lives of its ownership of all the capital available in the economy and a **poor household** that earns a living from supplying the labor endowment to firms. Neither of the households derive any utility from the factors of productions directly but from the consumption of goods, so they will rent all their endowments to firms. The structure of consumption of both households is the same. Good 1 is capital-intensive, good 2 is labor-intensive.
- There is also a **government** that spends its income on good 1 and 2 (the structure of spending is the same as the one of consumers). Income of the government is derived from household income taxes.
- There is also an **investment activity** that uses Good 2 much more intensively than in consumption and government demand. Capital accumulates using the standard investment equation (i.e., capital in the next period is going to be the previous period capital after depreciation plus the amount of investment).

Suppose that the government reduces the spending public consumption by 10% in period 1 while keeping the income tax rate constant and allowing the budget balance to adjust. Overall labor force is constant over time, and the economy without the shock does not grow nor shrink. **Discuss** (answers without an explanation get zero points) the following questions:

(a) What would be the immediate (period 1) of the government policy on GDP? What would happen to the relative prices of good 1 and 2? What would happen to household consumption of goods and investment demand?

(b) Consider the economy in period 2. What is the likely change in GDP relative to the scenario without the shock? How this shock can affect the situation of the two types of households (discuss all the possible effects, the overall answer might not be unambiguous). What about the production of both goods?

Problem 2

Consider the following Solow-Swan economy:

$$K_{t+1} = I_t + (1 - \delta)K_t$$

$$I_t = s(1 - \tau)Y_t$$

$$Y_t = K_t^\alpha L_t^{1-\alpha}$$

where Y is output, K is the level of capital stock, L is the number of workers, growing over time at rate n ($L_{t+1} = (1 + n)L_t$), I is investment, s is the saving rate, and δ is the capital depreciation rate. Income in this economy is taxed with rate τ and the tax revenues are used for government consumption which is useless from the point of view of households.

(a) Rewrite the three equations in the per worker form. i.e. divide them by L_t. Make use of notational convention $x_t \equiv X_t/L_t$.

(b) Find the steady state level of output per worker as a function of model parameters.

(c) Discuss the effects of changes in income tax rate, τ, on the steady state level of output per worker (pls provide economic intuition in your answer).

Questions (choose 4 out of 5)

Question 1

Consider a simple closed economy general equilibrium model with one consumer and two sectors GOO, 1 and 2. Main features of the model:

- The consumer are endowed with factors of production FAC, capital K and labor L, endowments are denoted with ω_K, ω_L. Consumer income INC is derived from renting factors of production to the firms. Utility function (aggregate consumption) of the consumer is $W(x_1, x_2)$ and consumer expenditure per unit of aggregate consumption is $e(p_1, p_2) = P$, where P is the consumer price index, p_1, p_2 are the prices of goods and x_1, x_2. The demand functions for goods are: $x_{GOO} = x_d(p_{GOO}, P, W)$.
- Production function in sectors are $x_{sGOO} = F_{GOO}(K, L)$, the demands for factors of production in both sectors are: $K_{GOO} = k(pfac_K, p_{GOO}, x_{sGOO})$, $L_{GOO} = l(pfac_L, p_{GOO}, x_{sGOO})$, where $pfac_{SEC}$ are the factor prices. The unit costs of production of both goods are denoted by $c_{GOO} = c_{GOO}(pfac_K, pfac_L)$.

Write down the **complete model** using the above components (nothing to calculate, provide equations, explain each). The list of equations is: 1) determination of the consumer price index, 2) zero profit equations 3) market clearing for goods, 4) market clearing for factors, 5) budget constraint and 6) determination of the consumer's income.

Question 2

The Solow model augmented with technology has the below BGP (balanced growth path) level of GDP per worker:

$$y_t^* = A_t \left(\frac{s}{\delta + n + g} \right)^{\alpha/(1-\alpha)}$$

where s is saving rate, δ is depreciation, n is population growth rate, and g is the growth rate of technology A_t. According to the above, is it true that countries with higher investment share of GDP will have higher **level** of GDP per worker and enjoy higher **growth rate** of GDP per worker along BGP (steady-state)? Explain why or why not.

Question 3

The standard Ramsey-Cass-Koopmans (RCK) model with government has the following steady state equations for capital and consumption per capita:

$$k^* = \left[\frac{\alpha}{\frac{\rho}{[(1-\tau^a)(1-\tau^f)]} + \delta} \right]^{1/(1-\alpha)}$$

$$c^* = (k^*)^\alpha - \delta k^* - g$$

Based on the standard Ramsey model discuss the likely effects of the following fiscal policy on steady state levels of consumption and capital per capita. Please provide economic intuition in your answers.

(a) A country's government plans to increase wage tax (τ^w) and use this tax revenue for government spending.

(b) A country's government plans to increase asset income (capital) tax (τ^a) and return this tax revenue back to households as **transfer**.

Question 4

Assume you are analyzing business cycles of US and you derived the following relations:

Variables	Std. Dev.	Corr. w. y	Autocorr.
Output (y)	1.68	1.00	0.78
Consumption (c)	1.11	0.76	0.63
Investment (i)	4.48	0.77	0.86
Wages (w)	0.89	-0.06	0.64

Based on the above table and assuming that all variables have the same mean (average), answer the followings:

(a) Which variable has the lowest and which one has the highest volatility?

(b) Does consumption have higher or lower volatility relative to the output? Provide at least one economic argument to support your answer.

(c) What does procyclical and countercyclical mean? Which variables are procyclical and which are countercyclical in the above table?

Question 5

A 3-equation New Keynesian model is given by the following equations.

New Keynesian Phillips Curve: $\pi_t = \beta E_t \pi_{t+1} + \kappa x_t + \epsilon_t^\pi$

New Keynesian IS curve: $x_t = E_t x_{t+1} - \frac{1}{\sigma}(i_t - E_t \pi_{t+1} - r_t^*) + \epsilon_t^x$

Monetary policy rule (Taylor type): $i_t = \rho_i i_{t-1} + (1 - \rho_i)(\gamma_\pi(\pi_t - \pi^*) + \gamma_x x_t) + \epsilon_t^i$

where π_t is inflation, x_t is output gap, and i_t is nominal interest rate. Based on the above 3-equation New Keynesian model and assuming that the economy is initially at the steady state, describe the likely effects of following shocks on the inflation, output gap, and interest rate (answers without an explanation get zero points).

(a) A positive demand shock.

(b) An expansionary monetary policy shock.