

Foundations of Modern Macroeconomics

Ben J. Heijdra
University of Groningen

December 2001

Problem set for Chapter 1

The questions with a star (★) are difficult.

Question 1

[*The Keynesian Cross model*] Consider a closed economy described by the following equations:

$$Y = C + I + G \tag{1}$$

$$C = C_0 + c(Y - T), \quad 0 < c < 1, \tag{2}$$

where Y , C , I , G , and T are, respectively, output, consumption, investment, government consumption, and taxes. C_0 represents the exogenous part of consumption and c is the marginal propensity to consume. Assume that prices are fixed and that I , G , and T are all exogenous.

- Recall that $Y = C + S + T$. Derive the *savings equation*, i.e. the expression relating S to aggregate income and the parameters of the model.
- Derive an expression for the equilibrium condition involving the savings equation.
- Demonstrate the so-called *paradox of thrift* by computing the effects on output, saving, and consumption, of a decrease in C_0 . Why do we call this phenomenon a paradox of thrift?
- Compute the output multiplier with respect to government consumption, dY/dG , under the assumption that the government finances its additional spending by raising the tax (i.e. $dT = dG$). Explain the intuition behind this so-called *Haavelmo* (balanced-budget) multiplier. Show the different rounds of the multiplier process.
- Now assume that taxes depend positively on output, i.e. $T = tY$, where t is the marginal (and average) tax rate (it is assumed that $0 < t < 1$). Compute the output

multiplier with respect to government consumption, dY/dG , under the assumption that the government finances its additional spending by selling bonds. Is the multiplier obtained here greater or smaller than the Haavelmo multiplier? Show what happens to consumption and the government deficit ($G - T$). Explain your answers both formally and intuitively.

Question 2

[*The Import Leakage*] We extend the model of question 1 by assuming that the economy is open to trade in goods and services. Assume that prices are fixed and that I , G , and T are all exogenous. The economy is described by the following equations:

$$Y = C + I + G + X \quad (1)$$

$$C = C_0 + c(Y - T), \quad 0 < c < 1, \quad (2)$$

$$X = X_0 - mY, \quad 0 < m < 1, \quad (3)$$

where X is net exports (exports minus imports), and m is the marginal propensity to import goods and services. The exogenous component of net exports is given by X_0 .

- (a) Solve the model by finding expressions for the endogenous variables (Y , C , and X) in terms of the exogenous variables (I , G , C_0 , X_0 , and T) and the parameters (c and m). These are the so-called *reduced-form* expressions for output, consumption, and net exports.
- (b) Compute the output multiplier with respect to government consumption. Does the propensity to import increase or decrease this multiplier? Explain the intuition behind the import leakage.
- (c) Compute the effect on output, consumption, and net exports of an increase in world trade (represented by an increase in X_0). Explain the intuition behind your results.

Question 3

[*The Mundell-Fleming Model*] Consider an open economy IS-LM model with perfect capital mobility. Assume that we extend the IS-LM model by introducing international trade. Assume furthermore that the price level is fixed (say $P = P_0$) and that domestic and foreign

bonds are perfect substitutes. The extended model is given by:

$$Y = C + I + G + X \quad (1)$$

$$C = C(Y - T) \quad 0 < C_{Y-T} < 1 \quad (2)$$

$$I = I(R), \quad I_R < 0 \quad (3)$$

$$T = T(Y), \quad 0 < T_Y < 1 \quad (4)$$

$$M/P = k(Y) + l(R) \quad (5)$$

$$X \equiv EX(E) - IM(E, Y)E, \quad EX_E > 0, \quad IM_E < 0, \quad IM_Y > 0 \quad (6)$$

$$R = R^* + \dot{E}/E \quad (7)$$

where Y , C , I , G , T , and R are, respectively, output, consumption, investment, government consumption, taxes, and the interest rate. Furthermore, R^* is the foreign interest rate, EX is exports, IM is imports, E is the exchange rate (guilders per unit of foreign currency), and X is net exports. Use this model to answer the following questions. Assume that the expectations regarding the exchange rate are perfectly inelastic (so that there is no speculation on the market for foreign exchange and the \dot{E}/E term can be put equal to zero).

- Interpret the equations.
- Explain the so-called *Marshall-Lerner condition*.
- Why is there less scope for Keynesian countercyclical policy in an open economy with flexible exchange rate? How effective is monetary policy in such a situation?
- Can the government of an less-than-fully employed economy boost employment without putting pressure on the interest rate (and the foreign exchange rate)? Show how the government can engineer an appreciation of the currency without harming employment. Distinguish the two cases of fixed and flexible exchange rates.
- Explain why a small open economy with fixed exchange rates is extremely sensitive to shocks in world trade. Is it possible to use monetary or fiscal policy to counter the effects of world trade shocks?

Question 4

In the book we have developed a very simple model of the aggregate labour market. Suppose that we write this model as follows::

$$N^D = N^D(W/P, \bar{K}), \quad N_{W/P}^D = \frac{1}{F_{NN}} < 0, \quad N_{\bar{K}}^D = -\left(\frac{F_{NK}}{F_{NN}}\right) > 0, \quad (1)$$

$$W/P = g(N^S), \quad g_N > 0, \quad (2)$$

$$[N \equiv] \quad N^D = N^S, \quad (3)$$

where N^D is labour demand, W is the nominal wage, P is the price level, \bar{K} is the capital stock, N^S is labour supply, and N is equilibrium employment. We assume that the expected price is equal to the actual price ($P^e = P$) and that the labour market is in equilibrium. Answer the following questions about this model. Use graphical means as much as possible.

- (a) What do we assume implicitly in equation (1) about the income and substitution effects in labour supply? Explain intuitively how these effects operate.
- (b) Assume that the government introduces a so-called *payroll tax* (t_W), i.e. a tax levied on employers which is proportional to the firm's wage bill. The payroll tax is thus a tax on the use of labour by firms. This tax changes the definition of profit for the representative firm to: $\Pi \equiv PF(N, \bar{K}) - W(1 + t_W)N$. Explain the effect of the payroll tax on the demand for labour
- (c) Demonstrate the effects on employment (N) and the gross real wage (W/P) of the payroll tax. Who end up ultimately paying the payroll tax—the firms or the worker-households?
- (d) Introduce a value-added (consumption) tax (t_C) in the simple labour market model. Explain what happens to employment (N) and the gross real wage (W/P). Who ultimately pays the tax?

Question 5

A.C. Pigou was a colleague but not a big personal friend of Keynes. He refused to take the so-called *liquidity trap* seriously. He claimed (just like Blinder and Solow, to be studied in Chapter 2) that consumption also depends positively on real wealth (A , for "assets"), so that the economy can never find itself permanently in the "liquidity trap." Suppose that we write the consumption function as $C = C(Y - T, A)$ (with $0 < C_{Y-T} < 1$ and $C_A > 0$) and that wealth consists of real capital plus real money balances ($A = \bar{K} + M/P$). Explain that Pigou may well be right. Illustrate Pigou's argument graphically.

Question 6

Consider the Cobb-Douglas production function:

$$Y = F(N, \bar{K}) = N^\epsilon \bar{K}^{1-\epsilon}, \quad 0 < \epsilon < 1,$$

where Y is output, N is employment and \bar{K} is the capital stock. The capital stock is fixed in the short run.

- (a) Show that under perfect competition the parameter ϵ corresponds to the national income share of wages.

- (b) Derive the short-run labour demand and goods supply schedules, both in levels and in terms of relative changes.
- (c) What are the wage elasticities of labour demand and the supply of goods?

Question 7 ★

We can formulate the following classical macroeconomic model of a closed economy:

$$Y = C(Y - T) + I(R - \pi) + G, \quad 0 < C_{Y-T} < 1, \quad I_{R-\pi} < 0, \quad (1)$$

$$M/P = l(Y, R), \quad l_Y > 0, \quad l_R < 0 \quad (2)$$

$$N^D = N^D(W/P, \bar{K}), \quad (3)$$

$$W/P = g(N^S), \quad g_N > 0, \quad (4)$$

$$N^D = N^S [\equiv N], \quad (5)$$

$$Y = F(N, \bar{K}), \quad (6)$$

where Y is aggregate output, C is consumption, T is taxes, I is investment, R is the nominal interest rate, π is the anticipated inflation rate, G is government consumption, M is the money supply, P is the price level, N is labour, and W is the nominal wage. The endogenous variables are Y , P , N , R , and W . Exogenous are π , G , and \bar{K} . Technology features constant returns to scale.

- (a) Interpret the equations.
- (b) What are the effects of an adverse supply shock, proxied by a fall in the capital stock, on the price level, the real wage, employment and output.
- (c) Why do fiscal and monetary policy not affect employment and output?
- (d) What are the effects of a fiscal and a monetary expansion on the price level and the interest rate?
- (e) Can you think of classical channels by which demand-side policies do affect employment and output?