Macroeconomics 1

Solutions to problem set 1

1. Please revise the definition of GDP: stress that goods + services are produced **domestically** and **within the period** of interest.

   a) True, it is a service.

   b) True it was produced within the period.

   c) False, the castle was produced in the past. The transaction is just a portfolio reallocation. Part of the stock of wealth is reallocated from physical capital (real estate) to money. Stress the difference between stocks (e.g. wealth) and flows (e.g. income). Emphasize that a porfolio reallocation does not create any new purchasing power, just reallocates existing one across assets.

   d) False, not produced domestically.

2. Please draw the circular flow diagram and explain why the two sides always coincide in value. Stress the accounting convention concerning the treatment of inventories (and the storable vs non-storable items distinction).

   Note that in the first table capital income is profits (revenues minus wages and cost of raw materials). In the second table, jewelry is the only final good (silver is an intermediate good). In the third table, mining uses no intermediate input. So its value added coincides with the full value of its product. Jewelry uses 300(K) £ of silver as an intermediate input. So its value added is only 700.

   Income side

	Mining	Jewelry	Total
Labour income	200(*)	250(*)	450
Capital income	100(*)	450(*)	550
Total	300	700	1000

   Output side (production of final goods)

	Mining	Jewelry	Total
Value of final goods	0(*)	1000(*)	1000

   Output side (value added)

	Mining	Jewelry	Total
Value added	300(*)	700(*)	1000

3. Please explain aggregation problem (cannot sum apples and oranges). Everything needs to be reduced to a common unit of account. That's why we need to use prices to aggregate. Define nominal (current prices) and real (base year prices) GDP. Conduct the analysis in general terms rather than giving them a number initially (put the numbers on the board just at the end of the exercise).

   Stress that nominal and real GDP coincide (trivially by definition) in the base year.

   Note that the quantity of apples in 1998 Q_a^{98} is zero. So the ratio between real GDP at 1998 prices is given by

   $$\frac{P_a^{98}Q_a^{99} + P_c^{98}Q_c^{99}}{P_c^{98}Q_c^{98}} = \frac{P_a^{98}}{P_c^{98}}\frac{Q_a^{99}}{Q_c^{99}} + \frac{Q_c^{99}}{Q_c^{98}}. \tag{1}$$

The ratio when real GDP is measured in 99 prices is

$$\frac{P_a^{99}Q_a^{99} + P_c^{99}Q_c^{99}}{P_c^{99}Q_c^{98}} = \frac{P_a^{99}}{P_c^{99}}\frac{Q_a^{99}}{Q_c^{99}} + \frac{Q_c^{99}}{Q_c^{98}}. \tag{2}$$

So the change in **real** purchasing prices depens on **relative** prices in the base year. This is undesirable.

a) What is nominal GDP in 1998? **90,000** And in 1999? **100,020**

b) Using 1998 as the base year (i.e. using 1998 prices) what is real GDP in 1998? **90,000** And in 1999? **75,040**

What is the ratio between real GDP in 1999 and 1998? **75,040/90,000**

c) Using 1999 as the base year (i.e. using 1999 prices) what is real GDP in 1998? **120,000** And in 1999? **100,020/120,000**

What is the ratio between real GDP in 1999 and 1998? _____

The two numbers differ for the reason discussed above (relative prices were different).

4. Suppose Toyota buys BMW German plants. The take-over has no effect on the quantity of car produced at the plants.

   What is the effect of the acquisition on the following variables in subsequent years (choose between *up*, *down* and *unchanged*)?

   a) German GDP **unchanged** the cars are still produced domestically

   b) German GNP **falls** the profits now accrue to Japanese shareholders who are not resident in Germany.

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Solutions to problem set 2

Stress that all components of GDP are **flows of goods and services;** i.e. neither transfers nor portfolio reallocation.

1. C will increase if individuals

   a) true

   b) false, portfolio reallocation

   c) true, it is an increase in transfers to private agents. It increases disposable income and induces them to buy more **goods and services**

2. I will fall if

   a) false, portfolio reallocation

   b) false, no increase in goods + services produced

   c) false, see a)

   d) false, it will increase

3. Please write down the goods market equilibrium condition. Stress that it requires **desired** expenditure Z to equal production. So it is a situation in which there is no undesired accumulation of inventories. This is what makes it an **equilibrium condition** rather than an **accounting identity.** The circular flow identity implies that production equals **actual** expenditure (that is expenditure including any undesired accumulation of inventories). It is an identity because it always holds (not only at equilibrium).

   Write down the system

   $$Z = C + I + G \tag{3}$$
   $$Y = Z \tag{4}$$

   Stress that it is a system of two equations in two unknowns (Please stress over and over that we always need as many equations and endogenous variables). So, it is determined. Rederive the Keynesian cross.

   a) Write down the goods market equilibrium condition? $\mathbf{Y = C + I + G}$. What is the value of equilibrium output? **800**

   b) Suppose the government increases spending by 100. In the new equilibrium, what are the values of:

      i) income? **1200**

      ii) demand? **1200**

      iii) consumption? **925**

4. If taxes increase with income, disposable income responds less than one to one to changes in gross income. This is because taxes fall in recessions (when Y is low) and increase in booms. So, consumption and equilibrium output fluctuate less in response to shocks that affect equilibrium income.

   a) Write down the expression for equilibrium output. $Y = \frac{1}{1-c_1(1-t)}\bar{Z}$ with $\bar{Z} = \bar{C} - c\bar{T} + \bar{I} + \bar{G}$.

   b) The Keynesian multiplier is $\frac{1}{1-c_1(1-t)}$. With respect to the case discussed in the lecture (constant taxes), does the economy respond more or less to a change in autonomous spending? It responds less. The Keynesian multiplier gives the change in equilibrium output with respect to a change in autonomous spending $\bar{Z}$.

$$\left.\frac{\Delta Y}{\Delta \bar{Z}}\right|_{\text{proportional tax}} = \frac{1}{1-c_1(1-t)} < \frac{1}{1-c_1} = \left.\frac{\Delta Y}{\Delta \bar{Z}}\right|_{\text{lump-sum tax}} \tag{5}$$

   The Keynesian multiplier is smaller with proportional taxes (for the reason mentioned above). That is why direct taxes (which in the real world are usually progressive) are called and automatic stabilizer.

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Solutions to problem set 3

1. Use the IS curve equation to show that with investment dependent on the interest rate, the Keynesian multiplier now gives the horizontal shift in the IS curve. Conduct the analysis both using the equation and graphically.

   a) True, think of it as a change in c_0. Show that it is an IS curve shift.

   b) false, it is a movement *along* a given IS curve.

   c) True, same as a).

   d) false, it is a portfolio reallocation and does not affect goods market equilibrium.

2. To save time, just set to zero the relevant coefficients in your previous derivation of the IS curve. With $I = a$ and $C = c_0$ it is

$$Y = C + I + \bar{G} = c_0 + a + \bar{G}. \tag{6}$$

   a) False. IS curve definition: locus of output/interest rate combinations for which the goods market is in equilibrium. This is the case for *any* level of the interest rate and output given by equation (6) above. So (6) *is* an IS curve.

   b) True.

   c) False it is vertical.

   d) True, equilibrium income is independent from the interest rate.

3. Please derive labour market equilibrium. Explain that equation 1 (the price setting equation) comes from profit maximization (marginal revenue=marginal cost), identifying MC and reminding students that unless there is perfect competition the price level is set as a mark up over marginal revenue and cost. Justify equation 2 (the wage setting curve) stressing that workers wage claims are likely to be lower when unemployment is higher and when outside sources of income (e.g. unemployment benefits) are lower. Stress that the model assumes flexible wages and prices and correct expectations for both workers and firms (long-run assumptions). Derive equilibrium both graphically in the $(W/P, u)$ space and algebraically. Stress that we have two equations and three endogenous variables. Yet, since two of them enter only as a ratio (the real wage) we can determine the real wage and the unemployment rate. Emphasize that the only variables that affect equilibrium are the price mark up μ and z. Use the production function to derive the long run labour market equilibrium locus $Y = \bar{Y}\left(\mu, \bar{z}, \bar{L}\right)$ in the (Y, i) space.

   a) $W/P = 1/(1+\mu) = 1/1.05$, $Y = N = 895$ and $u = 10.5\%$.

   b) Show graphically how the price setting curve shifts down (explain the intuition, firms want to make higher profits so the real wage has to fall) and how the equilibrium real wage falls and u goes up as workers are willing to work at the lower real wage only if the cost of being unemployed (negatively related to u) increases. Show how the MRLE locus shifts left.

i) The real wage decreases

ii) Output decreases

iii) The unemployment rate increases

c) Suppose that $\bar{z}$ falls to 0.05. Show that the wage setting curve shifts down as workers wage demands are lower. The real wage is unaffected since it is determined by the price mark up, but now more workers are willing to work at that wage and the unemployment rate falls.

i) The real wage is unchanged

ii) Output increases

iii) The unemployment rate decreases

4. In the long run labour market equilibrium determines the real wage. So if the nominal wage halves prices have to halve to keep the real wage unchanged (given that firms want to keep a constant mark up of prices over costs). Stress why nominal variables do not matter (no money illusion: workers are interested in the real purchasing power of their wage and firms in the mark up).

a) false

b) false

c) false

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Solution to problem set 4

1. Here the interest rate is the endogenous variable that clears the money market. Draw the demand and supply for **nominal money** in the interest-nominal M space. Note that nominal money demand is $M^d = PYL(i)$. Show which shock shifts which curve and discuss how the interest rate moves to reestablish equilibrium.

   a) True, the interest rate rises to reduce money demand until equilibrium is reestablished.

   b) True, it reduces nominal money demand at any level of i. Given that the nominal money supply is unchanged, i has to rise to bring money demand back to its original level.

   c) False, it increases nominal income hence nominal money demand. i has to rise to keep nominal money demand in line with the unchanged supply.

   d) False, it reduces it. It follows from either b) or c).

2. Derive the LM curve as the combinations of output and interest rate levels such that the money market is in equilibrium for a given price level (FYOI: this last qualifier is there to ensure that the LM curve shifts with changes in the price level even in the medium run).

   a) True, M increases. The LM shifts right as the equilibrium interest rate has to fall at any level of output to bring nominal money demand in line with the higher supply.

   b) Suppose money demand takes the form $M^d = PY(a - i)$ where a is a positive parameter. The shock can be represented by an increase in a. At unchanged Y money demand is higher. Since the nominal money supply is given the interest rate has to increase to bring money demand back in line with supply. Hence, LM shifts up.

      At this point answer d) before c).

   d) This is a movement along a given LM curve.

   c) This is tricky. It depends on whether the change in nominal income is due to a change in real income at unchanged prices (same as e)) or if prices change. Only in the latter case the LM shifts.

3. Stress that which variable/s clears the money market depends on the model. For example, in the long run we have seen that output and the interest rate are determined on the labour and goods market. Hence, they cannot adjust to clear the money market. So, prices have to do the job. Note that if you draw nominal money demand and supply in the interest-nominal M space, now the change in the price level shifts the M^d curve until it intersect the money supply curve at the exogenously given i. Show which shock shifts which curve and discuss how the price level moves to reestablish equilibrium.

a) Falls, the price level has to fall to reduce the nominal demand for money and reestablish equilibrium.

b) True, the fall in real income reduces money demand. The price level has to rise to keep demand in line with the unchanged supply.

c) False, it increases it. Now equilibrium has to take place at a higher level of the exogenous interest rate. At this higher i if prices are unchanged nominal money demand is below supply. Hence the price level has to rise to increase money demand.

d) False, nominal income is an endogenous variable (since it depends on P that is endogenous). So, for given interest rate and nominal money supply nominal income is fully pinned down to the level that ensures that the money market clears and cannot change. Any fall in real income will be offset by an incrase in P.

4. Now the interest rate is fixed at the level desired by the central bank. In order to keep the interest rate fixed, the central bank has to supply any amount of money that the public demands at that interest rate. That is, as output and money demand change, the central bank adjusts the supply of money to demand. This means that it loses control of the money supply. As in a standard demand/supply framework if you control the supply of one commodity the price adjusts to clear the market, but if you want to fix the price then you have to adjust supply in response to any change in demand at the fixed price. The LM curve is then horizontal at the target interest rate.

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Solution to problem set 5

Stress that we are talking long run equilibrium here. Just remind them that in the long run labour market equilibrium fully determines the unemployment rate, employment and the level of output; i.e. the LRLE locus is vertical. Since now output is determined on factor markets it cannot respond to demand. Viceversa it is demand which has to adjust to equal production and maintain goods market equilibrium. Derive the general equilibrium of this economy in the output interest rate space. Shift in the IS curve can only affect the interest rate and the composition of aggregate demand but not its level. The price level has to adjust (LM has to shift) to ensure that the money market clears.

Derive the AD curve from the IS and LM. Explain it denotes equilibrium on **both** the goods and money market in the (Y, P) space.

1. The price setting curve shifts down, hence equilibrium unemployment increase and equilibrium output falls.

   In the (Y, i) space the LRLE curve shifts to the left, the IS curve is unchanged. In the (Y, P) space the MRAS shifts left and the AD curve is unaffected.

   a) False. Disposable income falls.

   b) True. As the marginal propensity to consume is smaller than 1, consumption falls less than output. So, investment also has to fall to reestablish goods market equilibrium.

   c) False. The interest rate has to rise for equilibrium investment to fall.

   d) True, the price level increases, for real balances to fall in line with lower real money demand.

2. In the (Y, i) space the IS curve shifts left, the LRLE curve is unchanged. In the (Y, P) space the AD curve shifts left and the LRAS curve is unaffected.

   a) False. Output is determined on the labour market.

   b) False, it increases by 100. Investment is the only component of expenditure that can change to reestablish goods market equilibrium.

   c) True, this is the only way that investment can increase by 100.

   d) True, the price level falls, for real balances to increase in line with higher real money demand.

3. In the (Y, i) space the IS curve shifts right, the LRLE curve is unchanged. In the (Y, P) space the AD curve shifts right and the LRAS curve is unaffected.

   a) False. Unchanged.

   b) False. As the equilibrium interest rate goes up. Remind them of the equivalence between goods market equilibrium and equilibrium on the market for loanable funds.

c) True.

d) False, the price level increases, for real balances to fall in line with lower real money demand.

4. The government increases government expenditure G by 200. If the consumption function is given by

$$C = 100 + 0.7(Y - \bar{T}) \tag{7}$$

and the investment function is the same as in equation 1.

Curves shift as in the previous question. Discuss that a given amount of expenditure can be financed through taxes or debt. The latter way is more expansionary (i.e. we are assuming Ricardian equivalence does not hold) at given interest rate, so it requires a bigger fall in investment to keep the goods market in equilibrium.

In both cases the long run equilibrium level of output cannot change as it is determined on the labour market. So total aggregate demand cannot change.

a) $\Delta\bar{G} = 200$, $\Delta\bar{T} = 0$.

   i) $\Delta G = 200$, $\Delta C = 0$. So we require $\Delta I = -200$ which calls for $\Delta i = 0.2$ (a bigger increase in the the long run equilibrium interest rate)

   ii) the change in the long run equilibrium level of consumption $\Delta C = 0$

   iii) the change in the long run equilibrium level of aggregate saving $\Delta S = \Delta S_G = \Delta I = -200$.

b) $\Delta\bar{G} = \Delta\bar{T} = 200$

   i) $\Delta G = 200$, $\Delta C = -140$. So we require $\Delta I = -60$ which calls for $\Delta i = 0.06$ (an increase in the the long run equilibrium interest rate)

   ii) the change in the long run equilibrium level of consumption $\Delta C = -140$

   iii) the change in the long run equilibrium level of aggregate saving $\Delta S = S_p = \Delta I = -60$. Government saving is unaffected (balanced budget), but since a balanced budget fiscal expansion

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Solutions to problem set 6

Spot test held.

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Solution to problem set 7

Stress that we are talking long run equilibrium here.

Please write down the system of equations that describes general equilibrium (IS, LM and LRLE). Show the corresponding graphical devices (AD and LRAS) in the output/price space. Emphasize (by deriving it graphically) that the aggregate demand curve describes equilibrium on *both* the goods *and* money markets (it is in fact a reduced form of the IS and LM). For each change discuss which curve shifts in response to the shock in each graph and then derive the process to adjustment to the new equilibrium. Emphasize that demand cannot affect output (determined on the labour market in the long run). Fiscal policy can affect the composition of demand and the interest rate, but monetary policy only nominal variables (P and the nominal wage W).

1. If the government reduces expenditure. The IS and AD shift left (why? explain the economic intuition).

    a) False, nothing happens on the labour market.

    b) True.

    c) False, as demand falls but output not the interest rate has to fall for investment to rise.

    d) False, as the interest rate falls, real money demand (measured in units of output) increases. The price level has fall to increase the real supply of money and reestablish money market equilibrium.

2. If consumers want to save less. Model it as a rise in c_0. The IS and AD curves shift rightt. The equilibrium interest rate and price rise.

    a) False, exactly because output (and disposable income) is the same but the level of consumption is higher, saving falls.

    b) False, with higher consumption investment has to fall to keep total desired expenditure unchanged. In fact, the interest rate rises to achieve this.

    c) False, see point b).

    d) False, this is just the reverse of point d) in question 1 above.

3. For any level of Y, r the demand for real balances $L = YL(r)$ must fall. If you take a simple form for $L(r) = a - r$ this is a fall in the intercept a. This is shift to the right in the LM and AD curves (at unchanged P and r, Y has to increase for the real money demand to stay in line with supply). In equilibrium Y and r cannot change. So, equilibrium real money demand is lower. The price level increases to produce the necessary fall in real balances. Hence, the LM curve shifts all the way back to its original position.

    a) False, the price level adjusts to generate the necessary increase in *real* balances.

    b) False, determined on the goods and labour markets alone.

c) False, it will increase.

d) False, determined on the labour market alone.

4. Consider an economy in which the long run equilibrium level of output is given by $\bar{Y} = 2000$ and in which the IS and LM loci

$$IS \; Y = 2200 - 1000r \tag{8}$$

$$LM \; \frac{\bar{M}}{P} = Y\,(1 - r) \tag{9}$$

describe goods and asset markets equilibrium.

(a) If the nominal money supply is $\bar{M} = 800$ what are the equilibrium values of output 2000, the interest rate 0.2 and the price level 0.5.

(b) Please use the graphs derived above shifting the relevant curves and deriving the new equilibrium graphically. The nominal money supply increases by 50%. With Y and r unchanged the real demand for money is unchanged and so has to be the real money supply in equilibrium. So, the only change is a 50% increase in the price level which leaves real balances unchanged.

If the nominal money supply increases to $\bar{M} = 1200$ what are the new equilibrium values of output 2000, the interest rate 0.2 and the price level 0.75.

Macroeconomics 1

Solutions to problem set 8

1. Quickly derive the LRAS from labour market equilibrium and remind students why the SRAS is horizontal (firms are off the PS curve, they are not maximizing profits in the short run, but still making positive profits) and how it shifts over time as firms adjust their price towards the long run value.

   a) An exogenous increase in the price level shifts the LRAS (*false, independent from price*) and the SRAS (*true it shifts it up.*)

   b) An increase in the price mark up shifts the LRAS *true, it shifts left. If firms pay a lower real wage unemployment has to go up to convince workers to accept it.* and the SRAS *false, not on impact.*

   c) An increase in the minimum wage shifts the LRAS and the SRAS (*can be modelled as an increase in $\bar{z}$. Same as b). Now the reason why employment has to fall is to reconcile workers wage demands with firms' willingness to pay*).

   d) An increase in the nominal wage shifts the LRAS (*false it has no effect*) and the SRAS(*false firms supply any amount of output at $\bar{P}$ independently from W.*)

In what follows assume that before the shock all markets are both in short run and long run equilibrium. The questions ask you to derive the new short run equilibrium after the shock.

Write down the short run general equilibrium equations in both sets of axes. The SRAS-AD diagram shows the equilibrium price level. Stress that with $\bar{P}$, the labour market determines P and the IS and LM curves (together with P determined on the labour market) determine output and the real interest rate. Keep always the LRLE, LRAS loci on the graphs just as a reference.

2. IS and AD shift right. The interest rate increases but also equilibrium output. Crowding out of investment is only partial contrary to long run. The economic intuition is the following. The higher demand for consumption increases output through the multiplier. Firms produce more and employ more workers (nominal and real wages increase). The increase in output raises real money demand, the interest rate has to increase to reestablish money market equilibrium.

   a) The short run equilibrium level of output increases. True.

   b) The short run equilibrium interest rate will fall. False, it increases.

   c) The short run equilibrium level of investment increases. False, it falls.

   d) The short run equilibrium price level will increase. True.

3. If the central bank increases the supply of base money. The interest rate falls to clear the money market, which increases output through higher investment. Firms increase production in response to the increase in demand driving nominal wages and prices up.

a) The short run equilibrium level of output increases. True.

b) The short run equilibrium interest rate will fall. True.

c) The short run equilibrium level of investment increases. True.

d) The short run equilibrium price level will increase. True.

4. If the government reduces government expenditure. This is just the opposite of the fall in saving above. So everything we said about it applies (reversing the direction of the changes).

   a) The short run equilibrium level of output increases. False.

   b) The short run equilibrium interest rate will fall. True.

   c) The short run equilibrium level of investment increases. True.

   d) The short run equilibrium price level will increase. False.

5. If the government reduces government expenditure by the same amount as in question 4 and reduces taxes by an equal amount. A balanced-budget reduction in expenditure is still (though less) contractionary. Show students that the change in the autonomous component of expenditure is s maller.

   a) False, it false but by less than in question 4.

   b) The short run equilibrium interest rate falls by less than in question 4.

   c) The short run equilibrium price level falls by less than in question 4.

Macroeconomics 1
Solutions to problem set 9

Please write down the short run general equilibrium equations in both sets of axes. Keep always the LRLE, LRAS loci on the graphs just as a reference.

1. Fischer equation implies that $i = r + \pi^e$. So changes in inflationary expectations shift the LM curve alone in the output/*real* interest rate space. LM shifts down (money demand falls at unchanged r as i increases). So at unchanged real interest rate and prices output needs to increase to reestablish money market equilibrium. AD shifts right. **Do the long run first.**

   a) Real interest rate decreases. Prices are unchanged. So the LM curve does not shift all the way back and the real interest rate has to fall to clear the money market. The fall in the real interest rate boosts investment and output.

   b) Real interest rate is unaffected as neither the IS nor the MRLE have been affected (classical dichotomy holds and expected inflation is a nominal variable). The LM curve shifts all the way back. The nominal interest rate increases one for one. Output is unchanged and the price level needs to increase to bring the supply of real balances in line with lower demand. Note the crucial role of price adjustment to clear the money market without changes in the real interest rate.

2. IS and AD shift left. The interest rate falls but also equilibrium output. So unlike in the long run, the net effect on private and aggregate saving and investment is ambiguous. This is called the paradox of thrift (attempts by agents to save more may actually result in lower investment and saving in the short run). The economic intuition is the following. The lower demand for consumption reduces output through the multiplier. Firms produce less and employ less workers. The fall in output reduces money demand and the interest rate. The net effect on investment, hence on aggregate saving, is ambiguous. Stress that the ambiguity is not there if investment is independent of output as we have assumed throughout the course or in the long run when equilibrium output does not change.

   a) The short run equilibrium level of output increases. False.

   b) The short run equilibrium interest rate will fall. True.

   c) The short run equilibrium level of investment increases. Uncertain as both output and the interest rate fall.

   d) The short run equilibrium price level will increase. False, unchanged.

3. For investment to fall at unchanged output level the interest rate has to increase. So the necessary policy mix is one which increases the interest rate and leaves output unchanged. This requires an expansionary fiscal policy, which increases the interest rate but in the short run increases output, coupled with a contractionary monetary policy to keep output at its long run equilibrium level. The IS curve shifts right and the LM curve left in such a way that it intersects the new IS curve where the

latter crosses the MRLE. Since output is unchanged, the AD curve does not shift and the price level is unchanged both in the short and long run.

a) Expansionary fiscal and monetary policy. False, it would boost output in the short run.

b) Contractionary fiscal policy and expansionary monetary policy. False

c) None of the above. True

4. Please derive the money supply multiplier $mm = M/H$ using the definition of $Cu = cM$, $D = (1-c)M$ and $R = \theta D$. We can write $H = CU + R = cM + \theta(1-c)M$. $mm = 1/(c + \theta(1-c)) = 1/\theta$ given that $c = 0$ by assumption. So, all H takes the form of reserves and all notes and coins are owned by banks (which is trivial given that private agents do not hold any currency).

   Money supply multiplier in this economy? $mm = 1/\theta = 1/0.25 = 4$. If the supply of base money is £100, what is the supply of M_1? $M = mm \cdot H = 4 \cdot 100 = 400$. In equilibrium, who holds notes and coins in this economy? Banks.