Practice Problems on Money and Monetary Policy

1- Define money. How does the economist’s use of this term differ from its everyday meaning?

Money is the economist’s term for assets that can be used in making payments, such as cash and checking accounts. In everyday speech, people often use the term “money” to refer to their income or wealth, but in economics money means only those assets that are widely used and accepted as payment.

2- Who determines the nation’s money supply? Explain how the money supply could be expanded or reduced in an economy in which all money is in the form of currency.

The size of the nation’s money supply is determined by its central bank; in the United States, the central bank is the Federal Reserve System. If all money is in form of currency, the money supply can be expanded if the central bank takes newly minted currency and uses it to buy financial assets from the public or directly from the government itself. To reduce the money supply, the central bank can sell financial assets to the public or the government, taking currency out of circulation.

3- Define velocity. Discuss the role of velocity in the quantity theory of money.

Velocity is a measure of how often money “turns over” in a period. It is equal to nominal GDP divided by the nominal money supply. The quantity theory of money assumes that velocity is constant, which implies that real money demand is proportional to real income and is unaffected by the real interest rate.

4- Why is the equilibrium in the asset market described by the condition that real money supply equal real money demand?

Equilibrium in the asset market is described by the condition that real money supply equals real money demand because when supply equals demand for money, demand must also equal supply for non-monetary assets.

5- What is the relationship between the price level and the nominal money supply? What is the relationship between inflation and the growth rate of the nominal money supply.

In equilibrium, the price level is proportional to the nominal money supply: in particular it equals the nominal money supply divided by real money demand. Similarly, the
inflation rate is equal to the growth rate of the nominal money supply minus the growth rate of real money demand.

6- How would an increase in the expected inflation rate affect interest rates?

Factors that could increase the public’s expected rate of inflation include a rise in money growth or a decline in income growth. With no effect on the real interest rate, the increase in expected inflation would increase the nominal interest rate.

7- Assume that the quantity theory of money holds and that velocity is constant at 5. Output is fixed at its full-employment value of 10,000, and the price level is 2.

a- Determine the real demand for money and the nominal demand for money.

From the equation $MV = PY$, we get $M / P = Y / V$. At equilibrium, $M^d = M$, so $M^d / P = Y / V = 10,000 / 5 = 2000$. $M^d = P \times (M^d / P) = 2 \times 2000 = 4000$.

b- In this same economy the government fixes the nominal money supply at 5000. With output fixed at its full-employment level and with the assumption that prices are flexible, what will be the new price level? What happens to the price level if the nominal money supply rises to 6000?

From the equation $MV = PY$, $P = MV / Y$.

When $M = 5000$, $P = (5000 \times 5) / 10,000 = 2.5$.

When $M = 6000$, $P = (6000 \times 5) / 10,000 = 3$.

8- Suppose that the real money demand function is

$$L(Y, r + \pi^e) = (0.01 Y) / (r + \pi^e)$$

where $Y$ is real output, $r$ is the real interest rate, and $\pi^e$ is the expected rate of inflation. Real output is constant over time at $Y = 150$. The real interest is fixed in the goods market at $r = 0.05$ per year.

a- Suppose that the nominal money supply is growing at the rate of 10% per year and that this growth rate is expected to persist forever. Currently, the nominal money supply is $M = 300$. What are the values of the real money supply and the current price level? (Hint: What is the value of the expected inflation rate that enters the money demand function?)

$$\pi^e = \Delta M / M = 10\% \cdot i = r + \pi^e = 15\%. \quad M / P = L = 0.01 \times 150 / 0.15 = 10. \quad P = = 300 / 10 = 30.$$ 

b- Suppose that the nominal money supply is $M = 300$. The central bank announces that from now on the nominal money supply will grow at the rate of 5% per year. If
everyone believes this announcement, and if all markets are in equilibrium, what are
the values of the real money supply and the current price level? Explain the effects on
the real money supply and the current price level of a slowdown in the rate of money
growth.

\[ \pi^c = \Delta M/M = 5\% \quad i = r + \pi^c = 10\%. \quad M/P = L = 0.01 \times 150 / 0.10 = 15 \quad P = = 300 / 15 = 20. \] The slowdown in money growth reduces expected inflation, increasing real
money demand, thus lowering the price level.

9- The prisoner-of-war camp described by Radford (Box 7.1) periodically received large
shipments of cigarettes from the Red Cross or other sources.

a- How did cigarette shipments affect the price level (the prices of goods in terms of
cigarettes) in the POW camp?

New cigarettes mean an increase in the money supply. With higher nominal money
supply and no change in real money demand, the equilibrium price level must rise.

b- (More difficult) On some occasions the prisoners knew in advance when the
cigarette shipments were to arrive. What happened to the demand for cigarettes
money and price level in the camp in the days just before an anticipated shipment?

If people anticipate prices rising when the new cigarettes arrive, they will hold less
money so that they will not lose purchasing power when prices go up. But if their real
money demand is reduced, with the same nominal money supply the equilibrium
price level must rise. The result is that when prices are anticipated to rise in the
future, people may take actions that cause prices to rise immediately.

10- Define monetary base. What is the relationship between the monetary base and the
money supply in an all-currency economy?

The monetary base, or high-powered money, consists of the liabilities of the central
bank that are usable as money. In an all-currency economy, the money supply equals
the monetary base.

11- Define money multiplier. What is the value of the money multiplier in a system of
100% reserve banking? What is the value of the money multiplier in a system of
fractional reserve banking, if all money is held in the form of deposits? Why is the money
multiplier higher under fractional reserve banking than under 100% reserve banking?

The money multiplier is the number of dollars of the money supply that can be
created for each dollar of monetary base. In particular

\[ \frac{M1}{MB} = \frac{CU/DEP + 1}{CU/DEP + RES/DEP} = \frac{cu + 1}{cu + res} > 1 \]
In a system of 100% reserve banking, the reserve deposit ratio is one and the money multiplier is one. Under fractional reserve banking, with all money held as deposits, the money multiplier is the reciprocal of the reserve-deposit ratio. The multiplier is higher under fractional reserve banking, because banks hold only part of the monetary base as reserve and create money in the form of deposits with their excess reserves. Under 100% reserve banking, deposits simply substitute for the currency that is held by banks as reserves—no new money is created by banks. So the money multiplier is higher under fractional reserve banking, in which banks create money, than under 100% reserve banking, in which banks do not create money.

12- Discuss how actions of the public and banks can cause the money multiplier to rise or fall. Does the fact that the public and banks can affect the money multiplier imply that the central bank cannot control the money supply? Why or why not?

Changes in the desire by the public for holding currency affect the currency-deposit ratio, thus changing the money multiplier. Similarly, changes in banks’ desire to hold reserves affect the reserve-deposit ratio, thus changing the money multiplier. Increases in either the currency-deposit ratio or the reserve-deposit ratio reduce the money multiplier. But these effects do not mean that the central bank cannot control the money supply, because changes in the money multiplier can be offset by changes in the monetary base to leave the money supply unchanged.

13- How would each of the following affect the U.S. money supply? Explain.

a- Banks decide to hold more excess reserves (Excess reserves are reserves over and above what banks are legally required to hold against deposits).

The increase in banks’ reserve-deposit ratio reduces the money multiplier, causing the money supply to decline.

b- People withdraw cash from their bank accounts for Christmas shopping.

The increased holding of cash raises the currency-deposit ratio, reducing the money multiplier and causing the money supply to decline.

c- The introduction of automatic teller machines, which allow people to withdraw cash from the bank as needed, makes deposits relatively more convenient.

The availability of ATMs means people hold less cash and more deposits, reducing the currency-deposit ratio. This causes the money multiplier to increase, which causes the money supply to increase.
14- What is the effect on the monetary base of an open-market purchase of U.S. Treasury securities? What is the effect on the money supply?

An open-market purchase increases the monetary base. The increase in the monetary base leads to an increase in the money supply through the multiple expansion of loans and deposits.

15- Who determines monetary policy in the United States? What role does the President play?

Monetary policy in the United States is determined by the Federal Reserve System. The president appoints the seven members of the Board of Governors of the Federal Reserve System, including the chairman, but otherwise has no direct influence on monetary policy.

16- Besides open-market operations, what other means does the Federal Reserve have for controlling the money supply? Explain how these alternative methods work.

Other means of controlling the money supply include:

1. Reserve requirements. An increase in reserve requirements forces banks to hold more reserves, increasing the reserve-deposit ratio, thus reducing the money multiplier. With a lower money multiplier the money supply is reduced for a given size of the monetary base.
2. Discount window lending. A reduction in discount window lending, which may be caused by the Fed increasing the discount rate or by the Fed refusing to lend, causes a reduction in banks’ reserves, decreasing the monetary base. Also, a higher discount rate may lead banks to choose a higher reserve-deposit ratio, so the money multiplier declines. Both effects reduce the money supply.

17- How would each of the following affect the U.S. money supply? Explain.

a- The Federal Reserve sells gold to the public.

The sale of gold to the public has the same effect as an open-market sale of government securities-it reduces the monetary base, thus causing the money supply to decline.

b- The Federal government sells $20 billion of new government bonds to the Federal Reserve. The proceeds of sale are used to pay government employees.

When the Fed monetizes the government debt, the monetary base increases, so the money supply increases.

c- The Federal Reserve sells some of its government securities in Tokyo for yen.
When the Fed sells securities in exchange for yen, there is no change in the U.S. monetary base or in the U.S. money supply. The Fed has simply changed the composition of its assets.

18- Suppose that the central bank strictly followed a rule of keeping the real interest rate at 3% per year. That rate happens to be the real interest rate consistent with the economy’s initial general equilibrium. Assume that the economy is hit by money demand shocks only. Under the central bank’s rule, how will the money supply respond to money demand shocks?

If the Fed targets the real interest rate, then money demand shocks are offset by changes in the money supply. To see this, look at the figure below. Initially, real money supply is given by the $MS^1$ line, while money demand is given by the curve $L^1 (Y_1)$, where $Y_1$ is the current level of output. Suppose a money demand shock increases money demand for a given level of output; then the money demand curve shifts to $L^2 (Y_1)$. This tends to increase the real interest rate. When the Fed sees the rise in the real interest rate, it increases the money supply in response to reduce the real interest rate back to its targeted level of 3%. It is successful in doing so if it increases the real money supply to $MS^2$.

![Graph showing money supply and demand curves](image_url)

19- Suppose the Federal Reserve pursues a policy of lowering the real short-term interest rate.

a. How does the Federal Reserve attempt to lower the real interest rate (provide an explanation in terms of the liquidity effect, as discussed in class, of monetary policy)?

The Federal reserve will have to do repeated monetary injections to keep the real interest rate low. After a while this policy will become anticipated and lead to higher expected and realized inflation. This implies that current interest rates will rise and anticipated future interest rates will also rise.
b) Suppose the Federal Reserve attempted to maintain a low real interest rate for a sustained period of time. What would happen to the term structure of interest rates (provide an explanation in terms of the expectations hypothesis).

The expectations hypothesis says that the current n period interest rate, \( y^{(n)}(t) = \) average of the expected one period interest rates between now and \( t+n \). As the short-term interest rates are expected to sharply rise the yield curve will be sharply upward sloping.

20- Monetary Policy. Suppose real interest rate is constant and expected inflation rises. What will happen to the current level of prices in the economy if the Central Bank does not alter its supply of money?

A rise in expected inflation will lead to higher prices today. A rise in expected inflation makes holding money less attractive, and hence economic agents switch away from money to other assets. A rise in expected inflation raises nominal interest rates and leads to higher current prices and lower real money balances. That is, real balances, which have to fall, do so via a rise in prices.

21- Suppose thieves hijack a truckload of old bank notes on the way to the incinerator. The old currency is worth $1 billion. Who, if anyone, loses if the thieves get away with the cash?

If the thieves get away with the cash everybody holding cash would loose. The reason being that if they get away, there will be more money in the economy and eventually prices will rise. Then, those holding money would loose. Also holders of nominal bonds would loose, as inflation will increase unexpectedly. Same for all those who have nominal claims (creditors with nominal contracts, for example).

22- Rich people tend to hold more money than poor people; so is the inflation tax fair?

While rich people tend to hold more money than poor people in absolute terms, relative to their wealth, they tend to hold less than poor people.

23- In the United States of Albion expected inflation is 5% and the real interest rate is 2%.

a. What is the nominal interest rate?

b. If inflation turns out to be 10% instead, what is the ex-post real interest rate? Who gains and who loses from this error in forecasting inflation?

c. Recalculate your answers for a. and b. for net interest rates when tax rate is 50%. 

a. The nominal rate is approximately equal to the real rate (2%) plus expected inflation (5%) which is 7%. A more accurate formula is \((1 + \text{nominal rate}) = (1 + \text{expected inflation}) \times (1 + \text{real rate})\). This generates a nominal rate of 0.071, or 7.1%:

b. If actual inflation turns out to be 10% the ex-post real rate will be 7\% - 10\% = -3\%. The gainers are those who borrowed at a nominal rate of 7\% because the higher than expected inflation has eroded the real value of the debt below what was considered likely. The losers are those with savings paying 7\% when inflation is at 10\% and whose real savings have fallen by about 3\%.

c. If the after tax real rate needs to be 2\% when expected inflation is 5\% and the tax rate is 50\% we need the nominal rate, r, to satisfy the equation:
\[
r \times (1 - 0.5) - 5\% = 2\%
\]
which implies \(r = 14\%\).

If inflation turns out to be 10\% the after tax, ex-post real rate is once again 5\% lower at about -3\%. If the nominal rate were to rise enough to compensate for high inflation the rate would need to rise to 24\% with a 50\% tax rate.

24- Main Street Bank sets its loans on the basis of a 5\% reserve requirement and has $100 million cash in its vaults.

a. What is the amount of loans the bank can make?

b. If the bank has made $50 million of loans to real estate firms, and is required to keep a 50\% reserve requirement against such loans, how does this change your answer?

a. With a 5\% reserve requirement and $100 million in the vaults the bank would be able to sustain total lending of $2000 million, so that the 5\% reserve requirement on that stock of lending would be $100 million.

b. Assume that real estate loans are considered unusually risky, and that other loans continue to require a 5\% reserve requirement. The bank will have a reserve requirement of $25 million on the $50 million of real estate loans. This leaves $75 million in cash in the vaults. That amount is equal to the reserve requirement on non-real estate lending of $1500. Thus overall lending would be $1550 million. If all loans are to real estate companies the $100 of cash can only support lending of $200 million with a 50\% reserve requirement.

25- Let the demand for money in the economy be given by 150,000 – [inflation (\%)]. Calculate the amount of revenue raised through the inflation tax for inflation rates up to 50\% (a spreadsheet would help!). What inflation rate maximizes revenue?

Money demand is: 150,000 – (% inflation)³
Revenue raised by the inflation tax is: \( \text{inflation} \times (150,000 - (\% \text{ inflation})^3) \)

The following table shows revenue raised at various inflation rates:

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From the table it appears that an inflation rate of around 33% maximizes the inflation tax. We can get an exact answer by maximizing the value of the inflation tax with respect to inflation.

The inflation tax is: \( (\text{inflation}/100) \times (150,000 - (\% \text{ inflation})^3) \)

To maximize we take the first derivative with respect to inflation and set it to zero. This implies:

\( (1/100) \times (150,000 - 4 \times \text{inflation}^3) = 0 \)
which means inflation = \( (150,000/4)^{1/3} \)
solving this equation generates a revenue maximizing inflation rate of 33.47%.