ECN 106 Macroeconomics 1

Lecture 4

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Roadmap for this lecture

- What is money?
- The supply of money
- The demand for money
- Money (and financial) market equilibrium
- Mankiw Ch. 4-1, 4-4, 4-5, 4-8, 10-2

What have we learnt

Long run equilibrium.

- ▶ Labour mkt equilibrium determines the *real* wage, employment and output.
- ▶ Goods and labour mkt equilibrium determine the real interest rate and the composition of demand.
- ▶ Nominal variable (W and P) undetermined.

What determines nominal variables

Nominal variables:

- ▶ Inflation: *rate* of increase in the price *level P*.
- ▶ Price level (P): relative price of output in terms of money
- ▶ Nominal wage (W): relative price of labour in terms of money.

$\rightarrow$ We need to understand money and its effect on the economy.

What is money

- Money: stock of assets that can be readily to used to carry out transactions (and **extinguish the liability immediately**).
- Debit card (yes) vs credit card (no).
- Credit card transaction establishes a loan between the buyer and the credit card company. Does not extinguish the liability immediately.

Features of money:

1. Store of value (common to all assets)
2. Unit of account (or numeraire)
3. Medium of exchange (agents accept it in exchange for goods and services)

Money as a medium of exchange
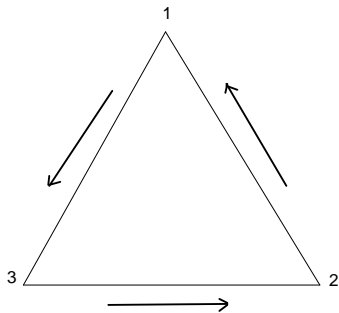
It allows trade in the absence of double coincidence of wants.

Commodity money vs fiat (unbacked) money I

- ▶ Historically, the first mediums of exchange were goods with alternative uses, hence intrinsic value (e.g. stones, shells, precious metals or stones): commodity money.

  - • Recent examples of commodity money: Gold Standard, cigarette money in POW camps.

- ▶ Commodity money is often inconvenient (difficult to verify, etc.). If a **reliable** agent (e.g. government) issues certificates redeemable against commodity money people may be willing to accept them.

- ▶ Eventually nobody may be interesting in reedeming and the commodity backing become irrelevant: fiat money.

Commodity money vs fiat money II

Difficult to explain how valueless *fiat* (unbacked) *money* (as opposed to commodity money) can become an accepted medium of exchange. Two possible equilibria:

1. As long as people expect it to be accepted as a medium of exchange, it will be accepted. The belief that money has value becomes self-fulfilling.

2. No money circulates because nobody expects it to be accepted in exchange.

The government can help the economy settle in the monetary equilibrium by decreeing that the money is *legal tender* - creditors are required to accept it in settlement for debts - and by standing ready to accept it in payment for taxes.

What constitutes money

- In simple economies, e.g. POW camp, often just one asset is used to carry out (and extinguish) transactions.
- In complex economies, many assets: currency (notes and coins), checking accounts, saving accounts, money mkt accounts, etc.
- Various definitions of money (different liquidity).
  - $M0$ (UK definition): notes and coins + banks' checkable deposits at CB.
    The UK definition coincides with H (monetary base).
  - $M1$: $M0$ + private checkable deposits
  - $M2$: $M1$ + saving deposits + money market funds

Who supplies money

I.e. who supplies (a) notes and coins and (b) deposits.

(a) The only agent that has the monopoly in supplying **notes and coins** is the government through the **Central Bank**. The Central Bank introduces notes and coins in the economy by buying goods, services or financial assets from the private sector and giving pieces of paper (fiat money) in exchange.

(b) Private banks supply **deposits**.

The Central Bank balance sheet

ASSETS	LIABILITIES
1. Bonds	4. Notes and coins:
2. Gold	a) held by the public (Cu)
3. Foreign currency	b) held by banks $\left.\vphantom{\begin{matrix}a\\b\\c\end{matrix}}\right\}(R)$
	5. Banks' deposits at CB
	6. Others + Net worth

- Monetary base $H = 4 + 5 = Cu + R$.
  <u>liabilities</u> of the Central Bank that can be used as 'money'.

- M: <u>assets</u> of private agents' that can be used as 'money'.

How does CB alter the money supply

- The central bank injects base money in the economy through **open market operations**; i.e. by buying (or selling) goverment bonds in exchange for pieces of paper (notes).

- Suppose CB wants to inject £100 into the economy. It prints £100 and uses them to buy government bonds from the private sector for the same amount.

- Assume only two assets: government bonds and money

$$W = B + H.$$

- Open market operation: $\Delta B + \Delta H = 0$.

The money supply without banks

CB			Public	
Assets	Liabil.		Assets	Liabil.
Bonds 100	100 Notes		Bonds -100	
			Notes 100	

$$M = Cu$$
$$Cu = H$$
$$M = H = 100$$

H vs M without banks

- In a world without banks the central bank controls the money supply perfectly, as it is the only agent which creates money.

- In the presence of banks, there is slippage as the central bank controls only how much base money it creates but not how much deposits private banks create.

- **Note:** for the time being we assume away banks (will deal with them towards end of course) $\rightarrow$ **the supply of money and base money coincide**.

Money demand: the cost of holding money

▶ The quantity of money demanded depends on the opportunity cost of holding it.

▶ In a world without banks money coincides with notes and coins. Holding £1 for one day, yields £1. The nominal (£tomorrow/£today - 1) rate of return is zero.

▶ Consider instead investing £1 in a bond which pays $£(1 + i)$ after one day. The asset is nominal (pays £tomorrow for £today); i.e. it too is exposed to changes in the purchasing power of money.

▶ By holding £1 in coins one foregoes the nominal return i. This is the opportunity cost of holding money (in a world without banks).

Real vs nominal interest rate

Consider instead a **real** asset; i.e. one paying $(1 + r)$ units of **output** tomorrow for one unit of **output** today.

- What is the nominal (monetary) rate of return of such asset? How much units of money today one obtains for each unit of money invested in the asset today.

- One unit of money today buys $1/P_t$ units of output today which yield $(1 + r)/P_t$ units of output tomorrow and

$$\frac{1 + r}{P_t} P_{t+1}^e$$

expected units of money tomorrow.

- P_{t+1}^e is the expectation, as of time t, of the price level at time $t + 1$. Tomorrow's price level is not known with certainty.

No arbitrage I

- Agents must be indifferent between investing in a "real" asset and in a "nominal" one.
- This requires

$$(1 + r_t) \frac{P_{t+1}^e}{P_t} = (1 + i_t)$$

which can be written as

$$(1 + r_t) \left(1 + \frac{P_{t+1}^e - P_t}{P_t}\right) = (1 + i_t)$$

No arbitrage II

- $\left(P_{t+1}^e - P_t\right)/P_t$ is just the expected percentage change in the price level between time t and $t+1$; i.e. the expected (as of time t) rate of inflation π_t^e between t and $t+1$.

- So we can write

$$(1 + r_t)(1 + \pi_t^e) = (1 + i_t)$$

or

$$1 + r_t + \pi_t^e + r_t\pi_t^e = 1 + i_t$$

which (for small r_t and π_{t+1}^e is approximately equivalent to

$$r_t + \pi_t^e \approx i_t \qquad \text{Fischer equation}$$

Ex post vs ex ante real interest rate

- At time $t+1$ the actual loss in the purchasing power of money is $\pi_t = (P_{t+1} - P_t)/P_t$, the <u>actual</u> rate of inflation which may differ from the expected one.

- It follows that the ex post real return on a nominal asset is

$$r_t^{\text{ex post}} = i_t - \pi_t = r_t + \pi_t^e - \pi_t$$

- For nominal assets the ex post real return differs from the ex ante one if inflation is different from its ex ante expected value.

- When nominal assets are involved unexpected inflation redistributes purchasing power from creditors to debtors.

Money demand: putting it all together

Private agents demand money because of its medium of exchange use.

1. The quantity of money that they desire to hold is thus an increasing function of the value of the cash transactions that they plan to carry out. These are likely to be related to the value of total transactions within the economy.

2. The quantity of money demand is also likely to be negatively related to the opportunity cost of money, the nominal interest rate.

3. The demand for money can thus be written as

$$M^d = PYL(\underset{-}{i})$$

Money market equilibrium

Assumptions:

1. The money supply is controlled by the central bank: $M^s = \bar{M}$.

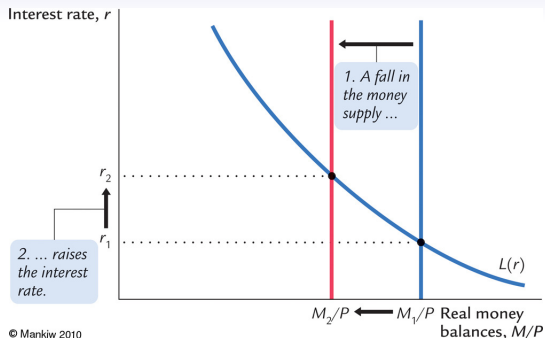2. Money demand is given by $M^d = PYL(i)$.

Equilibrium requires $M^s = M^d$ or

$$\bar{M} = PYL(i)$$

The same equilibrium condition can be expressed in units of output (real terms) as

$$\frac{\bar{M}}{P} = YL(i)$$

Money market equilibrium: M changes

Interest rate, r

1. A fall in the money supply ...

r_2

2. ... raises the interest rate.

r_1

$L(r)$

M_2/P ← M_1/P Real money balances, M/P

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- For given $\bar{M}, P, Y$ the interest rate adjusts to ensure that money demand equals money supply.
- A fall in the money supply, induces an increase in the nominal interest rate i so that money demand falls by the same amount.

Money market equilibrium: the LM curve

► If we keep $\bar{M}, P$ **constant,** let the level of real output vary and work out the money market clearing level of the interest rate, we obtain all the possible combinations of *nominal* interest rate and output values for which the money market is in equilibrium.
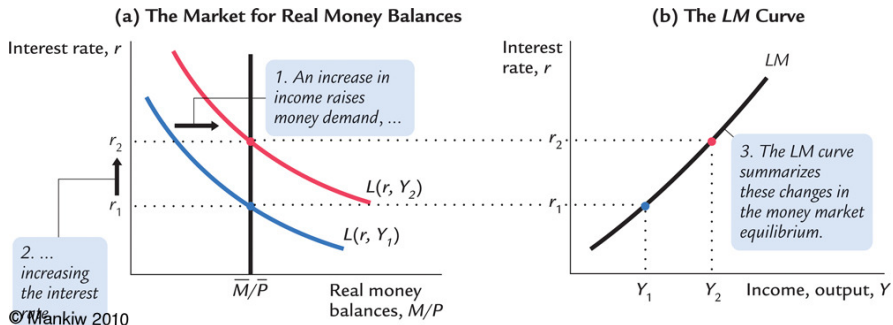
$$\frac{M}{P} = Y L(i)$$

► The locus of all such points is called the LM curve.

► Using Fisher equation we can write it as

$$\frac{M}{P} = Y L(r + \pi^e)$$

What does the LM curve represent?

LM curve: locus of output and interest rate combinations for which the money market is in equilibrium **for given** $\bar{M}, P, \pi^e$. To better understand it let us see how it is constructed.

(a) The Market for Real Money Balances

Interest rate, r

1. An increase in income raises money demand, ...

r_2

$L(r, Y_2)$

r_1

$L(r, Y_1)$

2. ... increasing the interest rate

$\bar{M}/\bar{P}$ Real money balances, M/P

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(b) The *LM* Curve

Interest rate, r

LM

r_2

3. The LM curve summarizes these changes in the money market equilibrium.

r_1

Y_1 Y_2 Income, output, Y

Money market eq. $\rightarrow$ bond market eq.

In a world with only two assets, money and bonds, equilibrium on one asset market implies equilibrium on the other. Intuition:

- Total private wealth has to equal the total supply of assets

$$W = B^s + \bar{M}$$

- It also has to equal the total demand for assets

$$W = B^d + M^d$$

- Money mkt equilibrium requires $M^d = M$. Hence it implies

$$B^d = W - M^d = W - M = B^s;$$

  i.e. bond market equilibrium.

- An example of Walras' law. If $n-1$ markets clear, so does the n-th market.