



Money market equilibrium

ECON 302, Intermediate Macroeconomics

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1. Introduction
2. Money Supply
3. Money demand
4. Money market equilibrium
5. Summary

Introduction

- So far we have analyzed real variables and relative prices.
- In this class we will analyze the nominal variables and its relationship with rest of the economy.
- For that we need to understand what is money, why do we want/need it and who supplies it.
- These are topics from ECON 345 and 445, so we will not go in too much depth

- At the end of this class you should know what is money and what variables affect its demand and supply.
- You should understand why the price of money is the nominal interest rate.
- You will be acquainted with some of the tools and mechanisms through which monetary policy is conducted. You will be expected to know how the conventional instruments work.
- The main goal of this lecture is to construct and understand the variables that affect the LM curve.

Most of the material in this class can be found in:

- [Abel et al. \(2018\)](#), Chapter 7 and 14)
- [Mankiw \(2009\)](#), Chapters 4 and 18)

I also recommend to take a look at the following articles:

- [McLeay et al. \(2014\)](#): non-technical article on how the money creation process works nowadays.
- [Bordo \(2007\)](#): 3 page long briefing on the history of central banks.
- [Powell \(2005\)](#): history of the Canadian dollar.

- What does it mean to have a lot of money?
- The value of our wealth is stored in different assets, a subset of such assets is money.
- Liquidity: speed at which an asset can be purchased or sold without causing a drastic change in its price.
- **Money**: assets that are widely used and accepted as payment and therefore readily to make transactions.
- Functions of money:
 - Medium of exchange
 - Unit of account
 - Store of value

- Barter is inefficient: double coincidence of wants.
- Money facilitates trade of goods and services: e.g., allows people to trade their labor for money, then use the money to buy goods and services in separate transactions.
- A commodity has intrinsic value. Accept it in a transaction seems somehow natural.
- But commodities can be bulky and inconvenient.
- A certificate or claim to the ownership of the commodity would help.
- If no one consumes the commodity, and use the certificates mostly for transactions, the intrinsic value becomes irrelevant.
- Fiat money has no intrinsic value, but is worth to hold because we all use it.

Figure 1: Canadian bank note, 1817



Figure 2: US 100 dollar bill, 1882



Figure 3: Canadian dollar, 1935



- History of money and banking are tightly intertwined.
- The banking business is to borrow and lend.
- Banks wrote claims which were paid on demand —paper money.
- Some of the deposits are lent by the bank to the public.
- What would happen if some borrowers do not pay back? How about the majority not paying back?
- What would happen if too many notes are printed and all of them arrive at the bank the same time?

"Trust grows at the speed of a coconut tree, and falls at the speed of a coconut"

- Money and banking requires a build up of trust/reputation.
- The value of a bank note would fade away in the case of bankruptcy.
- The rules of the banking system were born to minimize these problems.
- Nonetheless, even with good rules and good practices, there's still room for failure.
(Financial crises in the U.S. vs U.K in the XIX century)
- Central bank: the bank of the banks and the lender of last resort.

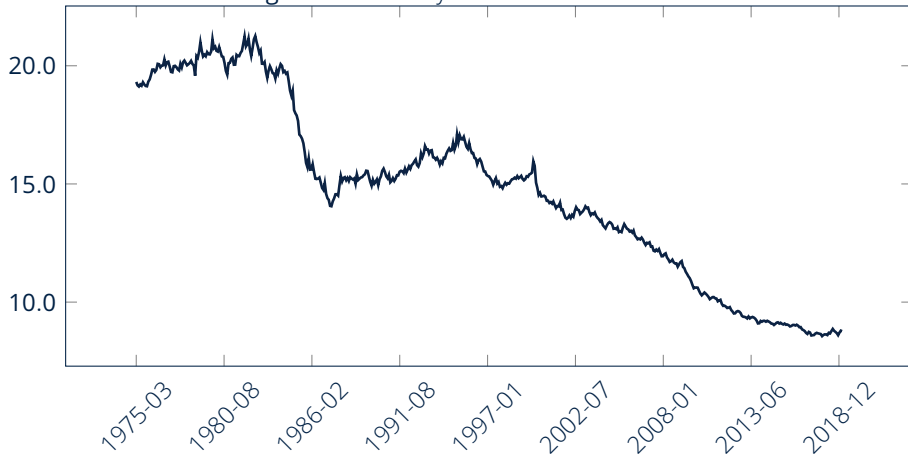
Although in most countries there is a monopoly on the supply of currency, there are other assets —usually supplied by the banking system— that fall in our definition of money. (do you have *money* in your checking account?)

- Distinguishing what is money from what is not is sometimes difficult. (financial innovation and technology)
- There is no single best measure of the money stock.
- Most central banks of the world keep track of M1 and M2.

Bank of Canada ([link](#)):

- M1+ (gross): Currency outside banks plus all chequable deposits held at chartered banks, trust and mortgage loan companies, credit unions and caisses populaires.
- M1++ (gross): M1+ (gross) plus all non-chequable deposits (other than fixed-term deposits) held at chartered banks, ...; less interbank deposits; plus continuity adjustments.
- M2 (gross): Currency outside banks plus bank personal deposits, bank non-personal demand and notice deposits; less interbank deposits; plus continuity adjustments.
- M3 (gross): M2 (gross) plus bank non-personal term deposits and foreign-currency deposits of residents; less interbank deposits; plus continuity adjustments.

Figure 4: Currency outside banks as % of M1+



Source: Bank of Canada, Selected monetary aggregates and their components

Money Supply

- We know that the central bank holds the monopoly of issuing currency.
- Define the monetary base as the total amount of dollars held by the public (C), plus the dollars held by banks as reserves (R). $B = C + R$
- For the purpose of this class consider money to be currency in circulation (C) plus deposits (D). (M1+)
- Assume banks have to hold a minimum proportion ν_d of their deposits as reserves. Would they hold more?
- Assume households like to hold a proportion ν_c of their money as currency.
- Note that B , ν_d , and ν_c are exogenous variables. Both B and ν_d are decided by the central bank.

- The supply of money is:

$$M^s = C + D$$

- The monetary base is :

$$B = C + R$$

- We would like to express the money supply as a function of the exogenous variables
- Note that $\frac{M^s}{B} = \frac{C/D+1}{C/D+R/D}$
- Substituting the definition of currency and reserves to deposit ratios, and rearranging we get

$$M^s = \underbrace{\frac{1 + \nu_c}{\nu_c + \nu_d}}_{\text{multiplier}} \times B \quad (1)$$

Money multiplier

In a fractional-reserve banking system, the supply of money corresponds to the monetary base multiplied by a factor (greater than one) that increases as less currency the household wants to hold, and the less reserves banks are required to have. This factor is called the money multiplier.

Money multiplier

- Assume the central bank prints \$ 100, and makes it available to the public.
- People don't like to keep cash in the pockets so they make a deposit in the bank.
 $\nu_c = 0$
- The bank lend \$80 and keep as reserves \$20. $\nu_d = 0.2$
- The \$80 borrowed by the public is used to make transactions. The counterpart in the transaction makes a deposit of \$80.
- The bank lends \$64 and keeps as reserves \$16 ...

Money multiplier (cont)

- At the end of the cycle, the amount of currency in circulation is 0 and deposits are:

$$D = 100 \times \left[1 + (1 - 0.2) + (1 - 0.2)^2 + \dots \right] = 100 \times \frac{1}{0.2}$$

- Therefore, the money supply in this economy is

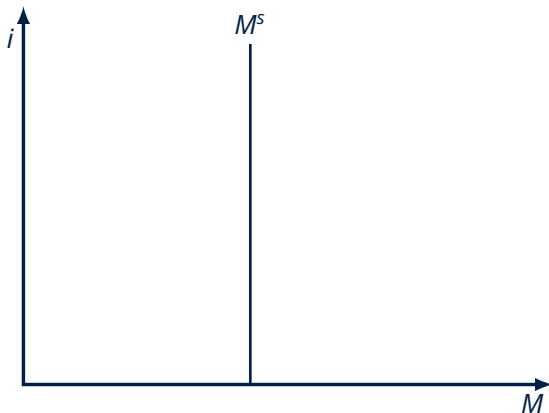
$$M^s = C + D = 0 + 500$$

- The money multiplier is 5

- Let's say that the central bank would like to increase the quantity of money supplied in the economy.
- How can this be done? helicopter drop!?
- Some of the typical instruments:
 - **Open market operations:** purchases and sales of government bonds. (to banks, not directly from the government!)
 - **Discount window rate:** banks interact with the central bank to meet reserve requirements or in case of emergencies.
 - **Reserves requirements:** impose on banks a minimum reserve–deposit ratio
- Unconventional instruments: quantitative easing.

- We will assume the supply of money given exogenously by the monetary authority

Figure 5: Money Supply



Money demand

- **Portfolio theories:** people hold many different assets, including money, bonds, stocks, houses, and consumer durable goods.
- **Transaction theories:** money is necessary to make transactions.
- Combining both imply that holding money and non-monetary assets requires to balance:
 - Expected Return
 - Risk
 - Liquidity
 - Time to maturity
- We will see a simple model where holding money is costly but necessary for transactions.

- Assume households want to spend Y smoothly during the period. To keep things simple assume prices don't change.
- Transactions are made using cash only. (money = cash)
- Each withdrawal of money costs f (e.g., fees)
- Alternative assets have a return of i (e.g., savings account or bonds)
- The household has to decide how many times it will withdraw money (N).

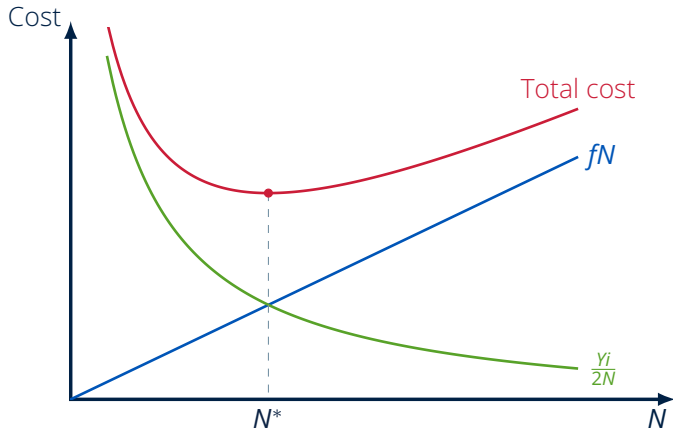
- If the household withdraws once ($N = 1$) the average cash holding is $Y/2$ (Y at the beginning and 0 at the end)
- If the household withdraws N times the average cash holding is $Y/(2N)$
- The total cost is the sum of the transaction fees plus the foregone interest:

$$\text{Total Cost} = N \times f + \frac{Y}{2N} \times i$$

- The first order condition of the previous equation with respect to N implies

$$N^* = \sqrt{\frac{Yi}{2f}}$$

Figure 6: Cost of withdraw



- With the optimal number of trips we can compute the money demand (average cash holding)

$$M^d = \sqrt{\frac{Yf}{2i}} \quad (2)$$

- This demand has two properties that are supported by the data
 1. The elasticity with respect income is positive.
 2. The elasticity with respect interest rates is negative.
- Note that the elasticities for income and interest rates are $1/2$ and $-1/2$, respectively. This is a strong prediction that empiric studies do not ratify.
- One hypothesis is that the parameters in the demand function are volatile. (This is very relevant at the time of choosing a monetary policy instrument: interest rates vs quantity of money)
- See [Goldfeld and Sichel \(1990\)](#) and [Poole \(1970\)](#) for further discussion on this topic.

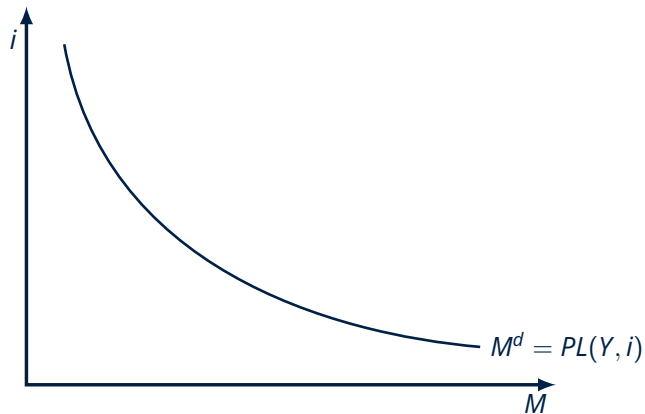
The model we just saw can give you an idea on how the money demand works. For the rest of the course we will continue with a general version of it, maintaining some of the properties and including prices.

$$M^d = P \times L(Y, i) \quad (3)$$

where

- M^d is the aggregate nominal money demand.
- P is the price level.
- Y is real income/output.
- i is the nominal interest rate.
- L is the demand for real money balances (Liquidity)
 - $\frac{\partial L}{\partial i} < 0$
 - $\frac{\partial L}{\partial Y} > 0$ with elasticity less than 1.

Figure 7: Money Demand



Money market equilibrium

- Equilibrium in the money market is reached when money supply equalizes money demand.

$$M^S = P \times L(Y, i)$$

- Recall that money and non-monetary assets (e.g., bonds) are related through the foregone interest when choosing money.
- The higher the price of a bond, the lower its yield.

Bond prices and yields

The return of a bond that costs **\$100** and will pay **\$110** at maturity is $\frac{110}{100} - 1 = 10\%$. If the price of the same bond jumps to \$104.7, its return fall to $\approx 5\%$

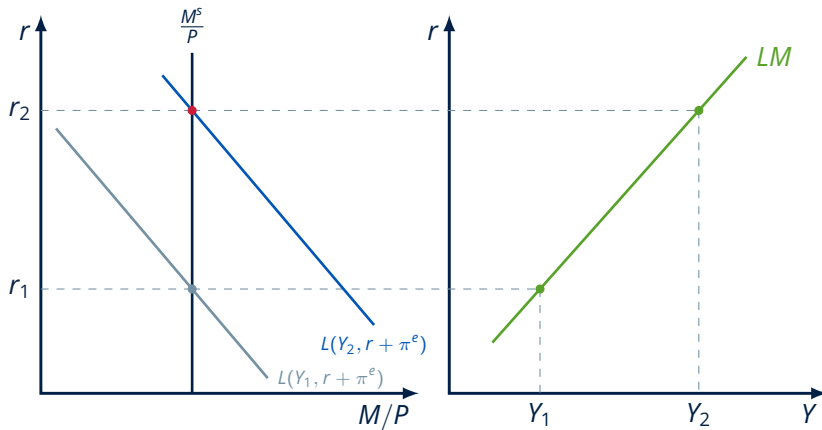
- How does the money market clear?
- Assume there is an excess of supply of money.
 - When there is too much money, the private sector's demand for non-monetary assets increase.
 - Higher demand for non-monetary assets implies higher price if the supply remains unchanged.
 - An increase in the price of the non-monetary asset implies a fall in the return/interest rate.
 - Lower return/interest rates increase the quantity of money demanded.
 - The excess supply gap closes.
- The exercise with excess demand is similar

- We can express the equilibrium in the money market in real terms. (Recall the Fisher equation $i = r + \pi^e$, where π^e is the expected inflation)
- The money market equilibrium implies

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

- Given a level money supply, prices and inflation expectation, the previous equation relates output to real interest rate.
- The LM curve — Liquidity and Money— is the combination of real interest rates and output in which the money market is in equilibrium.

Figure 8: Derivation of the LM curve



The LM in a linear world

- Assume a linear version of our demand for real money balances:

$$L(Y, r + \pi^e) = m_0 + m_1 Y - m_2(r + \pi^e)$$

- If the supply of money is M^s , the equilibrium in the money market implies:

$$LM : Y = \left[\frac{M^s}{m_1 P} + \frac{m_2}{m_1} \pi^e - \frac{m_0}{m_1} \right] + \frac{m_2}{m_1} r$$

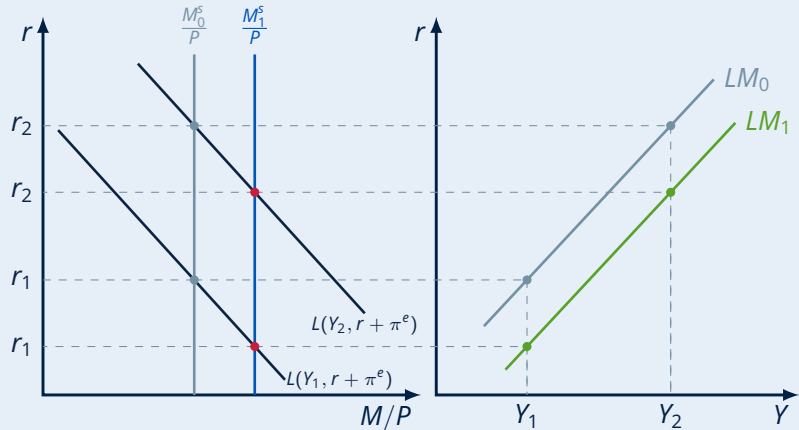
- The LM curve is positively sloped: higher interest rates are associated with higher output so the money market clears.
- The LM shifts right and down when:
 - Nominal money supply (M^s) increases.
 - Price level decreases.
 - Expected inflation increases.
- All changes in variables that affect either money supply or demand — apart from interest rates and output— will translate in a shift in the LM curve.

Monetary expansion

- Assume the monetary authority decides to increase the quantity of money in the economy.
- For this, the central bank needs to purchase bonds from the banking system (Open market operations)
- Since the demand for bonds is higher, the price of bonds increase.
- Higher price in bonds implies a lower return.
- If inflation expectations and price index are not affected, the real interest rate will be lower.
- This is true for all levels of output.
- Therefore, the LM curve shifts down/right

Monetary expansion

Figure 9: Increase in money supply



Summary

- Money is defined as assets that can be used for transactions.
- The functions of money are to be a medium of exchange, unit of account and store of value.
- There is no “best” measure of money.
- In “normal” times, the monetary authority creates and destroy money through open market operations, discount window, and reserve-to-deposits ratio requirements.
- The banking system multiplies the changes in the monetary base made by the central bank.
- These are changes in liquidity, not in wealth. (discuss)

- Reasons why we demand money: Portfolio and Transactions.
- Two of the functions of money are related to the previous point: medium of exchange and store of value.
- We can store value in money as we can do with other assets (e.g., bonds, stocks, etc).
- Nonetheless, money is usually dominated (there are alternatives with higher return and same risk)
- The alternative cost is the interest rate paid by assets with the same risk.
- We balance liquidity benefits of money with its cost: foregone interest.

- The LM curve correspond to all combinations of real interest rate and output in which the money market is in equilibrium.
- Other factors that affect the LM are: Price of the consumption goods, inflation expectations, and money demand shifters (e.g. financial innovation and technology)
- We have assumed that the monetary authority can predictably affect the LM. This is not necessary the case.
- A central bank might have troubles in controlling the money supply. e.g., if banks don't lend the money they get from the central bank (higher ν_d) the multiplier is smaller.
- The volatility in money demand is one of the reasons why central banks use overnight nominal interest rates as policy tool instead of the quantity of money.

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