Asset Markets, Money, and Prices

Econ 4021, Washington University in St. Louis

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February 2025

Introduction

- In previous lectures, we studied the labor and the goods market
- We now study the third core market, the **asset market**
- There are many types of assets
  1. **Real assets** such as gold and houses
  2. **Financial assets** such as bonds and stocks
- One very special financial asset that we will spend some time on is **money**

Introduction

This series of lectures:

1. Money
2. Portfolio Allocation and the Demand for Assets
3. The Demand for Money
4. Asset Market Equilibrium
5. Money Growth and Inflation

1. Money

What is Money?

- **Money** is any commodity that is widely used and accepted as a medium of economic exchange (i.e., a means of payment)
- Historically: shells, gold, silver, cigarettes
- Today: coins, paper money (currency), and digital money
- Functions of money:
  1. **Medium of exchange**: widely accepted as a means of paying for things. Barter is an extremely inefficient way of exchanging goods and services (double coincidence of wants) and hinders specialization.
  2. **Unit of account**: serves as the basic unit for measuring economic value of things, and simplifies the comparison of wages, incomes, etc. This function is disrupted in countries with high inflation.
  3. **Store of value**: serves as a way of holding and storing wealth, typically for short periods of time in positive interest rate environments.

Fiat Money

- The most common type of money in the world is **fiat money**
- Fiat money is intrinsically worthless: it only has value because the government says so
- "Fiat" is Latin for *let it be done*, in the sense of an order or decree
- The government has the monopoly over the creation of fiat money through an institution called a central bank
  - The Federal Reserve System is the central bank of the United States
- Alternative monetary systems include the silver standard and the gold standard, where money is backed by a precious metal
- These systems were problematic in many ways and were progressively abandoned throughout the 20th century

Measuring Money

- In practice, there are many financial assets that satisfy the definition of money
- For ex: you can get a debit card and checks associated with a money market mutual fund (MMMF) or savings account, and these assets pay a higher return than physical currency – are they money?
- For this reason there are several different measures of the quantity of money in the economy, known as **monetary aggregates**
- Monetary aggregates differ on how narrowly they define the concept of money
  1. M0
  2. Monetary Base (MB)
  3. M1
  4. M2
  5. M3

Monetary Aggregates: M0 and Monetary Base

- M0 is the narrowest definition of money and includes notes and coins in circulation (i.e., in the hands of the public)
- The **monetary base** consists of M0 plus bank reserves at the Federal Reserve
- The MB is the most direct measure of money that is created by the government through its central bank

$$MB = M0 + \text{reserves}$$

Monetary Aggregates: M1

- **M1** is the most common definition of "narrow money". It includes the monetary base plus traveler's checks and checking accounts
- This includes most things that we would normally call money
- In particular, it includes checking accounts at banks which are a very important medium of exchange: these are what you are using as money when you pay for something with a check or a debit card

Monetary Aggregates: M2

- **M2** includes all of M1 plus savings accounts (including MMDA), time deposits, and accounts at MMMFs
- Components of M2 that are not on M1 tend to be slightly less liquid
- There are often restrictions on the number of withdrawals that you can make from your savings account every month
- Contrary to M1, the components of M2 tend to compensate this lower liquidity by paying higher interest rates
- That is the main reason why households and firms hold MMMFs

Monetary Aggregates in the US

M1	**3691.8**
Currency	1564.8
Travelers' checks	1.8
Transaction accounts	2125.2
M2	**14,047.9**
Components of M1	3691.8
Savings deposits, including MMDAs	9194.2
Small-denomination time deposits	443.7
MMMFs (noninstitutional)	718.2

Note: Numbers may not add to totals shown owing to rounding. Source: Federal Reserve Statistical Release H.6, May 31, 2018. Data are not seasonally adjusted.

Money Supply

- The money supply is the amount of money available in the economy
- In fiat money systems, the money supply is controlled by the central bank
- Traditionally, the Fed changed the money supply via **open-market operations**
  - An open-market purchase is when the Fed creates money and purchases a financial asset, such as a bond
  - An open-market sale is when the Fed "destroys" money by selling a financial asset, thereby reducing the money supply
  - Monetary policy nowadays is more complicated than this - we will discuss this later in the course

Open-Market Operations

- They are called "open-market" because these transactions are made with the general public
- Alternatively, the Fed could also purchase assets from and/or sell assets to the government
  - Ex: purchase directly government bonds from the Treasury
  - This is called "debt monetization" or "monetary financing" and is equivalent to the government printing money to fund its expenditures
  - This is extremely dangerous and can lead to hyperinflation
  - It is a common practice in some emerging economies, but it is very rare and even forbidden by law in advanced economies such as the US
  - More on this later!

Application: is Bitcoin money?

1. Is it a medium of exchange?
   - **No**, because it is not widely accepted as a means of payment
   - Ex: Tesla accepted BTC between March and July 2021, having stopped due to the high volatility and low liquidity of bitcoin
   - It could become a medium of exchange in countries with volatile currencies and high inflation
2. Is it a unit of account?
   - **No**, because it is not widely used to measure the economic value of things
   - No one compares their own salaries or countries' GDPs in terms of BTC
3. Is it a store of value?
   - This is possibly the function that crypto is better able to perform
   - Many people have invested their savings in crypto
   - However, most of this investment is speculative: crypto investors store their wealth in crypto because they expect it to *appreciate*
   - By definition, this means that its value is not stable

2. Portfolio Allocation and the Demand for Assets

Portfolio Allocation

- Portfolio allocation problem: how do people decide to invest their wealth among the many different assets that are available?
- The set of assets chosen by an investor is called a **portfolio**
- Investors care mainly about four characteristics of an asset when allocating their portfolio:
  1. Expected return
  2. Risk
  3. Liquidity
  4. Time to maturity

Expected Return

- The rate of return of an asset is the increase in value of that asset over a period of time
- What is the return of holding a stock?
  1. You purchase it for p_t at period t
  2. In period $t+1$, you receive a dividend d_{t+1} and sell it at price p_{t+1}
  3. The return is then

$$\text{return}_{t+1} = \frac{\text{price}_{t+1} + \text{dividend}_{t+1}}{\text{price}_t}$$

- Since the price of a bank account does not change (it is money), its return is equal to the interest rate

Expected Return

- Investors want to invest in assets with high rates of return
- But returns are uncertain ex-ante (at the time they make their portfolio allocations)
- So investors care about the **expected return**
- The expected return is the investor's best guess of what the return on an asset will be

Risk

- Often, the return on an asset turns out to be lower (or higher) than what the investor expected
- This is because the prices (and dividends) of many assets depend on many factors that are outside of the control of the investor
  - Ex: you purchased a stock last month, but the market crashes unexpectedly
  - Ex: you purchased a bond issued by a tech company, but it was forced to pay a large fine to the government and went out of business, defaulting on its debt
- **Risk** measures the extent to which the realized return may differ from the expected return

Risk

- Investors prefer lower risk assets, as their realized returns are more likely to be in line with what they expected
- Riskier assets tend to have lower prices and thus have the potential to offer greater returns: this is called the **risk premium**
- Risk is often referred to as volatility

Liquidity

- Liquidity refers to the ease and quickness with which an asset can be converted into goods and services
- Money is the most liquid asset, as you can literally purchase goods and services with money
- A stock is less liquid: you cannot use a stock to buy lunch at the cafeteria, you have to convert it into money first
- Financial assets tend to be more liquid than real assets such as cars or houses, which can take a lot of time to sell
- Investors prefer assets that are more liquid as they are easier to convert into money

Time to Maturity

- Time to maturity (TTM) is the amount of time a financial asset takes to repay its principal value
- TTM is not relevant for stocks or most real assets, but is very important for bonds and other types of credit contracts
- A bond is a financial asset that may pay interest ("coupon") over a period of time and a principal payment at the end of its life
  - Ex: you buy a General Motors zero-coupon 3-year maturity bond for \$85 that promises a principal repayment of \$100 in 3 years

Time to Maturity and the Expectations Theory

- The **expectations theory of the term structure** states that investments with the same amount of risk should generate the same return, regardless of maturity
- The expectations theory predicts flat yield curves
  - The yield curve is the annual return on an investment, as a function of time to maturity
- For two investments with the same risk but with maturities $a > b$, the ETTS predicts

$$1 + r_a = (1 + r_b)^{a/b}$$

- Example: consider a 1-year bond with a return of 3%. An equivalently risky bond with 3-year maturity should have a total return of $(1 + 3\%)^3$
- The annual return should then be

$$1 + r_3 = [1 + (1 + 3\%)^3 - 1]^{1/3} = 3\%$$

The Term Premium

- In practice the ETTS rarely holds due to the **term premium**
- Assume you want to undertake a 2-year investment
  1. Plan A: buy a 2-year bond that pays 7% per year
  2. Plan B: buy a 1-year bond that pays 5% and then reinvest in another 1-year bond that pays 6%
- The return on Plan B is $(1 + 5\%) \times (1 + 6\%) - 1 = 5.5\%$, lower than the 7% of Plan A
- Plan A seems to be more profitable in terms of its expected return
- The two plans are risk-free, so why does Plan A generate a higher return?
- Plan A offers what is called a **term premium**
- Why is there a term premium?
  1. There may be a chance that you need the cash you invested one year from now, Plan B gives you that option while Plan A does not
  2. For that reason, Plan A is effectively riskier (even if the asset itself is now), and must compensate you for that risk in terms of its return

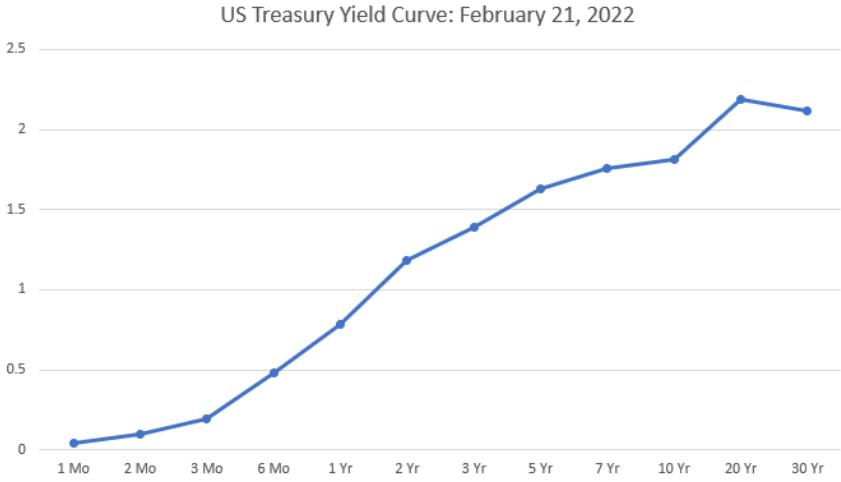
The Term Premium

- The ETTS predicts flat yield curves, while in practice they tend to be upward sloping
- The annualized return of longer-term investments tends to be larger than that of shorter ones
- The term premium is equal to the difference. For two investments with maturity $a > b$, the term premium is equal to

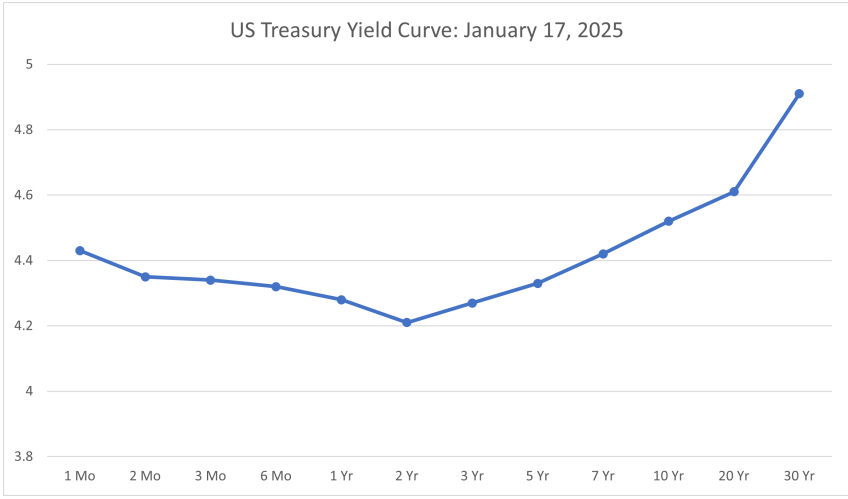
$$tp = r_a - r_b$$

where r_a, r_b are the annualized rates of return

US Treasury Yield Curve



US Treasury Yield Curve



In 2025, the term premium was **negative** at some maturities (i.e., 2 years)

Types of Assets

- Key asset characteristics: return, risk, liquidity, and time to maturity
- What are some of the most common assets and how do they differ in these characteristics?
  1. Money
  2. Bonds
  3. Stocks
  4. Housing
  5. Consumer durable goods

Types of Assets: Money

- **Return**: zero or negative. Due to inflation, money tends to lose value over time.
- **Risk**: money is very safe, and the only source of risk is uncertainty about inflation.
- **Liquidity**: cash is perfectly liquid by definition, some components of M2 may be less so (such as time deposits) but still fairly liquid
- **Time to maturity**: again, cash has zero time to maturity by definition. Some components of M2 have a positive but low TTM.

Types of Assets: Bonds

- Bonds are also called **fixed income securities** as they promise to pay specific amounts on specific dates
- Bonds are effectively loans to an entity that specify a schedule for the payment of interest (coupons) and principal
- Bonds may be issued by governments (i.e., US Treasury securities), corporations, and other organizations

Types of Assets: Bonds

- Bonds are subject to the risk of default (nonrepayment by the issuer). For this reason they are riskier than money but also offer a higher return. This risk tends to increase in recessions
- (US) Government bonds tend to be very liquid and safe, but also pay very low interest rates. Corporate bonds are less liquid and less safe, but yield higher returns
- The TTM of a bond is usually pre-specified, and it can range from a few weeks (commercial paper) to decades (the US government issues 30-year bonds)
- In the 1750's, the United Kingdom first issued perpetual bonds named "consols"

Types of Assets: Stocks

- Stocks represent ownership in a company, and yield non-guaranteed payments called **dividends**
- Companies generate profits in their operation, and these profits may be either reinvested in the business or paid to their owners as dividends
- Stock returns consist of dividend payments plus variations in the price of the stock

$$\text{return}_t = \frac{P_t + d_t}{P_{t-1}}$$

Types of Assets: Stocks

- Returns tend to fall during recessions, as stock prices fall and companies make fewer profits (and thus pay less dividends)
- Since stock prices fluctuate daily, stocks are relatively risky and may not be very liquid
- Common stock is a perpetual claim on company dividends, hence their TTM is infinite

Types of Assets: Housing

- Housing is the single most important asset that is owned for a majority of Americans
- Housing is in many ways a less liquid stock, whose return depends on price appreciation and a "dividend"

$$\text{return on housing}_t = \frac{P_t + d_t}{P_{t-1}}$$

- The "dividend" is the flow utility benefit of shelter, net of costs such as maintenance and taxes, which economists often call "housing services"
- Housing is illiquid because it can take months to sell a house, and selling it quickly may often involve substantial costs
- One factor that increases the liquidity of housing is the availability of home equity loans and lines of credit (HELOCs)

Types of Assets: Other

Durable Goods

- Automobiles, furniture, and appliances are other assets owned by most households
- They are similar to housing in that their return depends on price appreciation and a "dividend" that consists of the net utility provided by their services
- They are also relatively illiquid, as selling them quickly may be costly, and it is often hard to use them as collateral to obtain loans

Unincorporated Businesses

- People may own equity in businesses that do not issue tradable stock
- In this case, the return are the profits made by these "private" businesses
- Because these businesses do not issue stock, they are highly illiquid, but the price appreciation component of their return may be substantial (i.e. tech startups)

Household Assets in the US

	Amounts in trillions of dollars			Percentages of total assets		
	2006Q4	2009Q1	2017Q4	2006Q4	2009Q1	2017Q4
Real estate	25.0	18.9	27.8	31.3	27.3	24.3
Consumer durables	4.3	4.6	5.7	5.4	6.6	4.9
Currency and checkable deposits	0.2	0.3	1.0	0.3	0.4	0.9
Time, savings, and other deposits	6.6	7.9	10.4	8.3	11.5	9.1
Bonds	4.1	6.6	4.8	5.2	9.6	4.2
Stocks	14.1	7.4	26.6	17.6	10.7	23.2
Proprietors' investment in unincorporated businesses	8.9	6.9	11.6	11.2	10.1	10.1
Pension funds	14.3	14.0	23.2	17.9	20.2	20.3
Other assets	2.3	2.5	3.3	2.8	3.6	2.9
Total Assets	79.9	69.1	114.4	100.0	100.0	100.0

Note: Numbers may not add to totals owing to rounding. Source: Federal Reserve Financial Accounts of the United States, Statistical Release Z.1, March 8, 2018

Asset Demand

- People will trade-off return, risk, liquidity, and TTM when choosing their portfolio
- Additionally, people also like to **diversify** their portfolio, by investing in assets that have uncorrelated risks and returns
- By spreading their investments across different assets, investors can ensure that their overall return is less volatile
  - i.e. when some asset is yielding a low return, another yields a high return
  - Diversification occurs within and across asset classes
- The demand for each asset results from accounting for all these factors
- The sum of asset demands must equal total wealth

3. The Demand for Money

The Demand for Money

- The quantity of monetary assets that people want to hold in their portfolios
- The demand for money depends on expected return, risk, liquidity of money relative to other assets
- The **benefits** of holding money is that it is relatively safe and very liquid
- The **cost** of holding money is that it offers a low (usually negative) real return
- Government bonds are also very safe and offer a positive return (the interest rate), but are less liquid
- The demand for money results from trading off liquidity and the low return on money vs. that of comparably safe assets such as government bonds
- Main factors that affect the demand for money:
  1. Price level
  2. Real income
  3. Interest rates

Factors that affect the Demand for Money

There are three main factors that affect the demand for money

1. **The Price Level**, P: the higher the level of prices, the more money people need to conduct transactions

   - Everything else equal, the nominal demand for money is proportional to the price level

   - If things are ten times more expensive, then you need ten times the amount of money to buy them

Factors that affect the Demand for Money

2. **Real Income**, Y: consumption of goods and services is increasing in income, and so is the need for liquidity

   - Everything else equal, the demand for money is increasing in real income but not necessarily in a proportional way
   - This is due to decreasing marginal utility: a 1% increase in income typically leads to a less than 1% increase in consumption and hence a less than 1% increase in the need for liquidity
   - Wealthier people may also save their money more efficiently in non-money assets, while the less wealthy tend to save primarily in money

Factors that affect the Demand for Money

3. **Interest Rates**, i: government bonds tend to be as safe as money. They are less liquid, but pay a higher return. If interest rates rise, their return also rises and holding money becomes less attractive

   - Suppose your wealth is \$10,000. You have \$8,000 invested in govt bonds earning 8% interest and \$2,000 in cash. If interest rates rise to 10%, you may decide to take some of that cash and invest it in govt bonds.
   - Most interest rates on safe assets "move together", and we typically refer to one interest rate: the reference rate that is set directly or indirectly by the central bank
   - In the US, this is called the **Federal Funds Rate**, and is the interest rate on very short-term, very safe investments
   - In practice, some types of money earn an interest rate i^m, but it tends to lower than the one that is earned by nonmonetary assets and we often assume it is zero

The Money Demand Function

- We just saw that money demand is:
  1. Increasing on the price level (and proportional)
  2. Increasing on real income
  3. Decreasing on interest rates (of nonmonetary assets)
- This is all summarized in the money demand function

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

where L is the **real** money demand function

- We assume that

$$\frac{\partial L(Y,i)}{\partial Y} > 0, \quad \frac{\partial L(Y,i)}{\partial i} < 0$$

The Money Demand Function

- Recall that nominal interest rates are equal to real interest rates plus expected inflation

$$i = r + \pi^e$$

- This allows us to express real money demand as a function of the real interest rate

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

- This is also called the **demand for real balances**
- It is decreasing in both the real interest rate and expected inflation

Other Factors affecting Money Demand

1. **Wealth**: Similar to income, an increase in wealth means that more resources may be allocated to different assets, which tends to increase money demand
2. **Risk**: When other assets such as stocks become riskier, people may wish to rebalance their portfolios towards safer assets, such as money. Increased risk and volatility should therefore increase money demand. An exception is inflation risk, which causes people to move away from money.
3. **Liquidity of Alternative Assets**: as other assets become more liquid, people may choose to hold them instead of money. Financial innovation has led to the creation of MMMF's and to increased liquidity for assets such as housing (due to HELOCs), which may have decreased the demand for money.
4. **Payment Technologies**: Financial innovation through things like credit cards or Venmo has also reduced the need to use money for payments. Some societies such as Sweden and China are almost cashless nowadays, and so their demand for cash is close to zero.

Elasticities of Money Demand

- Economists are often interested in *how much* money demand changes if income or interest rates change

- The **elasticity of money demand** is the % change in money demand caused by a one percent change in some factor

$$\varepsilon_{M^d,x} = \frac{\partial M^d}{\partial x} \frac{x}{M^d}$$

- These elasticities have to be measured empirically, using data on money demand and changes in these factors

Elasticities of Money Demand

- The **income elasticity of money demand** has been measured to be around 2/3: positive, and less than one
  - A 3% increase in income leads to a $3\% \times 2/3 = 2\%$ increase in money demand
- The **interest elasticity of money demand** has been shown to be small and negative, -0.2, (as we would expect)
  - A 10% increase in interest rates leads to a $10\% \times (-0.2) = -2\%$ change in M^d
  - Note that if interest rates rise from 2% to 3%, this is a 1 percentage point increase, not a 1% increase
- The **price level elasticity of money demand** has been found to be equal to 1, which means that money demand is proportional to the price level

Velocity of Money

- **Velocity** is an important concept that measures how often the money stock "turns over" each period.

- Velocity is defined as nominal GDP (during that period) divided by the nominal stock of money

$$V = \frac{PY}{M}$$

- Think of it as the number of transactions undertaken in a given period divided by the amount of money that is available to undertake those transactions

Velocity: Textbook Example

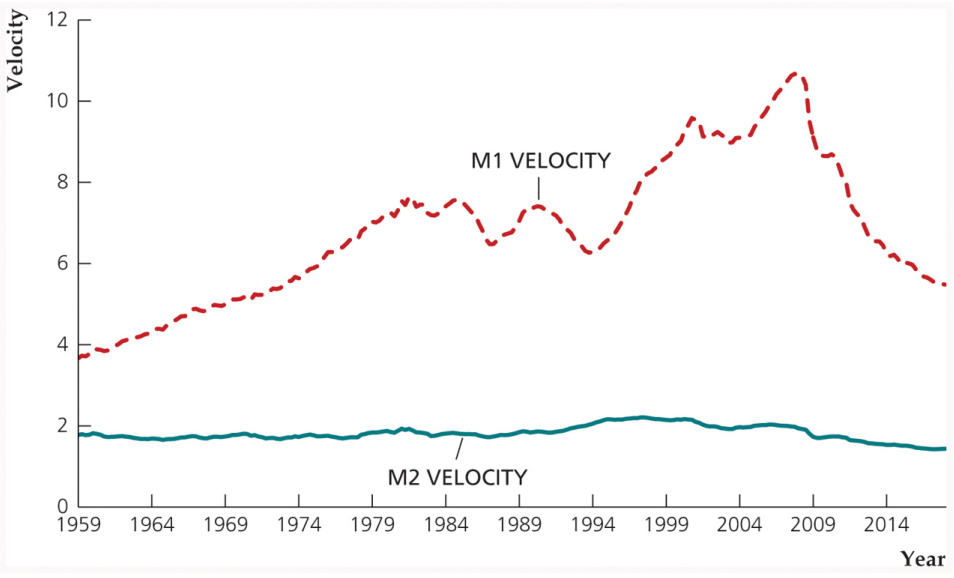
Assume that money supply is \$50, and the economy is populated by a farmer and a mechanic. During one year:

- Farmer spends \$50 on tractor repair from the mechanic
- Mechanic buys \$40 of corn from the farmer
- Mechanic spends \$10 on farm cats from the farmer

In this case, \$100 changed hands during that year. Velocity is

$$V = \frac{\$100}{\$50} = 2$$

Velocity of Money in the US



Quantity Theory of Money

- The concept of velocity originated in one of the earliest theories of money demand, known as the **Quantity Theory of Money** (QTM)
- The QTM asserts that real money demand is proportional to real income

$$\frac{M^d}{P} = kY$$

- Essentially, the QTM says that the real demand for money $L(Y, r + \pi^e)$ is simply equal to a constant k times real income Y
- The fundamental assumption of the QTM is that velocity is constant and equal to $1/k$, but this is a strong assumption:
  1. Velocity of M1 has fluctuated widely in the last 60 years
  2. Velocity of M2 is more stable, but not constant and affected by factors such as financial innovation and interest rates in alternative assets

4. Asset Market Equilibrium

Asset Market Equilibrium

- We have seen that asset demand depends on asset characteristics such as expected return, risk, liquidity, and time to maturity
- Additionally, the sum of all asset demands must equal wealth
- Asset supply is typically fixed at a given point in time, but it may change over time
  1. Central bank creates money
  2. Government issues bonds
  3. Companies issue new shares
- The asset market is in equilibrium when demand for a specific asset equals the supply of that asset

Asset Market Equilibrium: Aggregation

- Assume that we can aggregate all assets into two broad categories: money and nonmonetary assets
- Money includes assets that can be used as means of payment, such as currency and checking accounts. It pays interest rate i^m and supply is fixed at M
- Nonmonetary assets include all other assets: stocks, bonds, housing, etc. It pays interest rate $i = r + \pi^e$ and supply is fixed at NM
- This aggregation assumption implies that whenever the money market is in equilibrium, the market for nonmonetary assets is also in equilibrium
- This is an application of an important result in economics known as **Walras' Law**

Asset Market Equilibrium: Walras' Law

- Consider an individual investor i, whose demand for money and nonmonetary assets is constrained by their total wealth

$$m_i^d + nm_i^d = \omega_i$$

- This has to hold for everyone in the economy, $\forall i$, which means that we can sum both sides of the equation

$$\sum_{i=1}^{I}(m_i^d + nm_i^d) = \sum_{i=1}^{I}\omega_i$$

$$\sum_{i=1}^{I} m_i^d + \sum_{i=1}^{I} nm_i^d = \sum_{i=1}^{I}\omega_i$$

$$M^d + NM^d = W$$

- Where M^d, NM^d are the aggregate demands for money and NM assets, and W is aggregate nominal wealth

Asset Market Equilibrium: Walras' Law

- Because the only assets in this economy are money and NM assets, then aggregate nominal wealth must equal their supply

$$M^s + NM^s = W$$

- Combine the two conditions to obtain

$$M^d + NM^d - (M + NM^s) = W - W$$
$$(M^d - M^s) + (NM^d - NM^s) = 0$$

- $M^d - M^s$ is the excess demand for money, and $NM^d - NM^s$ is the excess demand for NM assets

Asset Market Equilibrium: Walras' Law

- The sum of the excess demands must equal zero
- So, if the demand for money is equal to the supply of money we have that $M^d = M^s$, which implies that

$$\begin{aligned}(M^d - M^s) + (NM^d - NM^s) &= 0 \\ (NM^d - NM^s) &= 0 \\ NM^d &= NM^s\end{aligned}$$

- Equilibrium in the money market implies equilibrium in the NM asset market
- Thus we only need to focus on studying one market equilibrium instead of two

Money Market Equilibrium

- The equilibrium condition in the money market is

$$\underbrace{\frac{M^s}{P}}_{\text{real supply of money}} = \underbrace{L(Y, r + \pi^e)}_{\text{real demand for money}}$$

- Depends on five variables: M^s, Y, r, π^e, P
  - M^s is determined by the central bank
  - Y is determined by equilibrium in the labor market and the production function
  - r is determined by the goods market equilibrium, given Y
  - π^e is treated as fixed/exogenous for now
- The only remaining free variable that adjusts to clear the money market is P
- The equilibrium price level is thus given by the relationship between the supply and the demand for money

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

Money Market Equilibrium

- Given Y, r, π^e, the price level is proportional to the money supply

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

- The factor of proportionality is the inverse of the real money demand, $\frac{1}{L(Y, r+\pi^e)}$
- When the central bank expands the money supply, the price level rises, everything else constant

5. Money Growth and Inflation

Money Growth and Inflation

- Equilibrium in the money market implies a close relationship between the growth rate of the money supply and the growth rate of the price level
- i.e. the inflation rate
- Write the equilibrium condition in logs

$$\log P_t = \log M_t^s - \log L(Y_t, r_t + \pi_t^e)$$

- Take first differences

$$\log P_{t+1} - \log P_t = \log M_{t+1}^s - \log M_t^s - \log L(Y_{t+1}, r_{t+1} + \pi_{t+1}^e) + \log L(Y_t, r_t + \pi_t^e)$$

- Using the fact that $\log(1 + g_x) \simeq g_x = \frac{\Delta X_{t+1}}{X_t}$, we get

$$\frac{\Delta P_{t+1}}{P_t} = \frac{\Delta M_{t+1}^s}{M_t^s} - \frac{\Delta L_{t+1}}{L_t}$$

Money Growth and Inflation

- The inflation rate is equal to the growth rate of nominal money supply minus the growth rate of real money demand
- An economy experiences inflation if money supply grows "too fast" relative to real money demand
- If real interest and inflation rates are roughly constant, we can write

$$\frac{\Delta L_{t+1}}{L_t} = \eta_Y \frac{\Delta Y_{t+1}}{Y_t}$$

where η_Y is the elasticity of money demand with respect to income

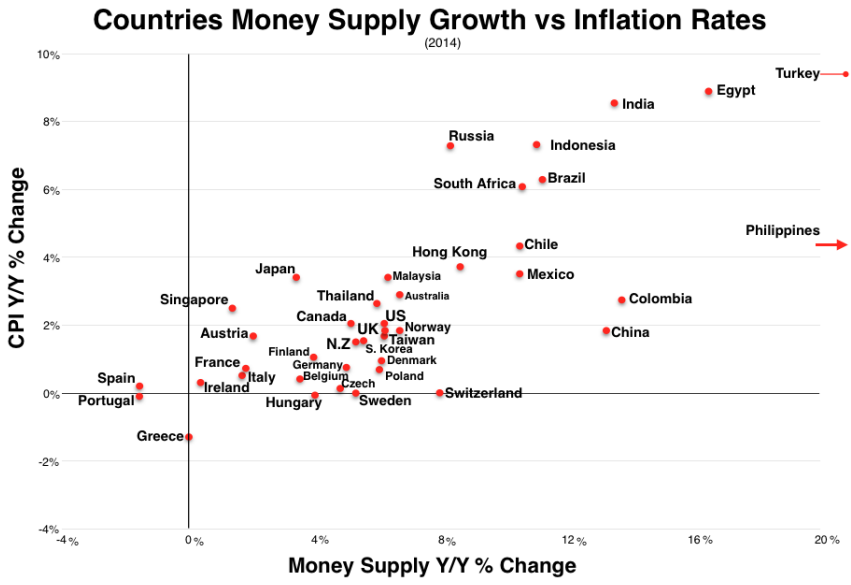
- Then, we can write the inflation rate as

$$\pi_t = \frac{\Delta P_{t+1}}{P_t} = \frac{\Delta M^s_{t+1}}{M^s_t} - \eta_Y \frac{\Delta Y_{t+1}}{Y_t}$$

- Example: $\Delta Y/Y = 3\%, \eta_Y = 2/3, \Delta M^s/M^s = 10\%$, then

$$\pi_t = 10\% - \frac{2}{3} \times 3\% = 8\%$$

Money Growth and Inflation



Inflation and the Nominal Interest Rate

- The nominal interest rate is equal to the real interest rate plus expected inflation

$$i = r + \pi^e$$

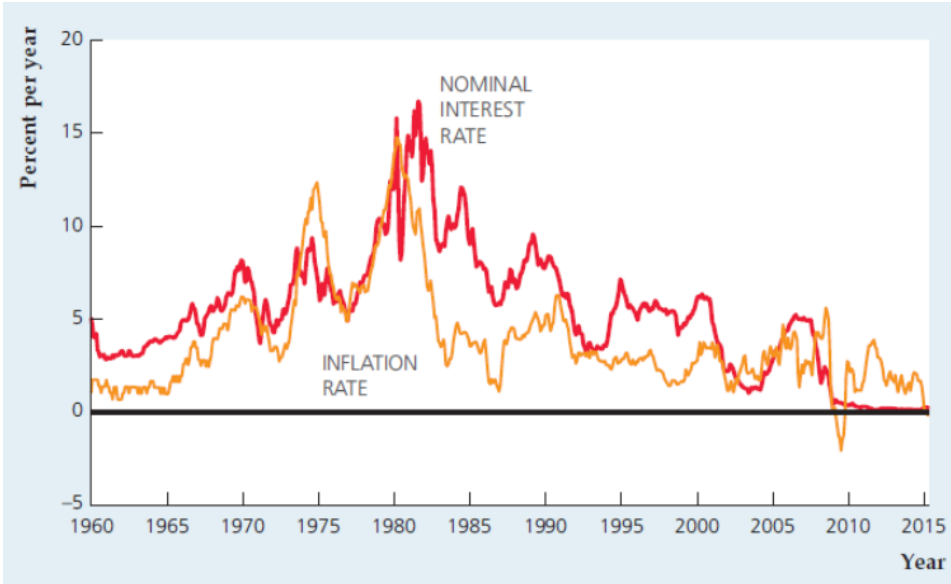
- π^e is not easy to observe
- But we know that

$$\pi_t = \frac{\Delta M^s_{t+1}}{M^s_t} - \eta_Y \frac{\Delta Y_{t+1}}{Y_t}$$

- Thus if the growth rates of money supply and output growth are expected not to change much, inflation won't change much either and $\pi^e = \pi$
- Additionally, if real interest rates are roughly constant then we should observe a close relationship between nominal rates and actual inflation

$$i = r + \pi$$

Inflation and the Nominal Interest Rate



Measuring Inflation Expectations

- In practice, how do we measure π^e? Two approaches:
  - Surveys, either of economists who specialize in forecasting macroeconomic variables (Survey of Professional Forecasters) or of the general public (University of Michigan Consumer Survey)
  - Financial market measures, such as the real return on TIPS
- TIPS (Treasury Inflation-Protected Securities) are US government bonds that guarantee a real return, as their nominal return varies with inflation
- No-arbitrage in asset markets implies that the real return of another government bond with the same maturity and liquidity must equal the real return on a TIPS bond (which is observable)

$$r_{bond} = i - \pi^e = r_{TIPS}$$

- We can then extract a measure of expected inflation as

$$\pi^e = i - r_{TIPS}$$

- This is called the **break-even inflation rate**

Measuring Inflation Expectations