12. Macroeconomics

Symbol	Meaning
Y	Real GDP / Output / Total Income
C	Consumption
I	Investment
G	Government Spending
NX	Net Exports (Exports−Imports)
T	Taxes
S	National Saving (Y−C−G)
K	Capital Stock
L	Labor Force
W	Nominal Wage
W/P	Real Wage
R	Nominal Rental Rate of Capital
R/P	Real Rental Rate of Capital
P	Price Level (GDP Deflator or CPI)
r	Real Interest Rate
i	Nominal Interest Rate
M	Money Supply
V	Velocity of Money
π	Inflation Rate
$E\pi$	Expected Inflation Rate
e	Nominal Exchange Rate
ε	Real Exchange Rate
s	Job Separation Rate
f	Job Finding Rate
u	Unemployment Rate (U/L)

Part 1

Gross Domestic Product (GDP)

Gross Domestic Product (GDP)

Two definitions:

- Total **expenditure** on **domestically produced final goods and services**
- Total **income** earned by **domestically located factors of production**

GDP Measurement Equivalence

$$\text{GDP} = \text{Total Expenditure} = \text{Total Income}$$

because every dollar spent by a buyer is a dollar of income for a seller.

It does **not** measure well-being or prosperity.

$$\begin{aligned} \text{GDP} &= \text{value of final goods produced (total output)} \\ &= \text{sum of value added at all stages of production} \\ &= \text{total income} \\ &= \text{total expenditures} \end{aligned}$$

Expenditure Components of GDP

- C = Consumption
- I = Investment
- G = Government Purchases
- NX = Net Exports (Exports - Imports)

∑ **GDP Expenditure Formula**

$$\boxed{\underbrace{Y}_{\text{value of total output}} = \underbrace{C + I + G + NX}_{\text{total expenditure}}}$$

The net exports represents the spending on domestically produced goods by foreigners minus the spending on foreign produced goods by domestic residents.

Gross National Product (GNP)

Gross National Product (GNP)

Total income earned by the nation's factors of production, *regardless of where located*.

Gross Domestic Product (GDP)

Total income earned by **domestically located** factors of production, *regardless of nationality*.

∑ **GNP and GDP Relationship**

$$\boxed{\text{GP} - \text{GDP} = \text{factor payments } \textbf{from} \text{ abroad} - \text{factor payments } \textbf{to} \text{ abroad}}$$

Nominal vs. Real GDP

GDP is the value of all final goods and services produced

Nominal GDP

Measures GDP using **current prices**.

Real GDP

Measures GDP using the **prices of a base year**.

$$RGDP_t = \sum_i P_i^{\text{base}} Q_{it}$$

GDP Deflator

Inflation rate

The percentage increase in the overall level of prices.

One **measure of price level** is the **GDP deflator**.

∑ GDP Deflator

$$\boxed{\text{GDP Deflator} = 100 \cdot \frac{\text{ominal GDP}}{\text{Real GDP}}\%}$$

We can deconstruct the GDP deflator to see that it is a **weighed average of prices**.
The weight on each price reflects that good's relative importance in GDP.
Weights change over time.

$$GDP\ \text{Deflator}_t = \frac{NGDP_t}{RGDP_t} = \frac{\sum_i P_{it} Q_{it}}{RGDP_t} = \sum_i \left(\frac{Q_{it}}{RGDP_t} \right) P_{it}$$

Consumer Price Index (CPI)

Consumer Price Index (CPI)

A measure of the overall level of prices tracking changes in the typical household's cost of living.

∑ Consumer Price Index (CPI)

$$\boxed{\text{CPI} = 100 \cdot \frac{\text{Cost of basket in that month}}{\text{Cost of basket in base period}}}$$

We can once again deconstruct the CPI to see that it is a **weighed average of prices**.
The weight on each price reflects that good's relative importance in the CPI's basket.
Weights are **fixed over time.**

$$CPI_t = \frac{E_t}{E_b} = \frac{\sum_i P_{it} Q_i^{\text{base}}}{E_b} = \sum_i \left(\frac{Q_i^{\text{base}}}{E_b} \right) P_{it}$$

Categories of Population

- **Employed**
- **Unemployed**
  - Not employed
  - But looking for work
- **Labor Force**
  - Employed + Unemployed
  - Amount of labor available for producing goods and services
- **Not in Labor Force**
  - Not employed
  - Not looking for work

∑ Unemployment Rate

Percentage of labor force (employed + unemployed) that is unemployed.

$$\text{Unemployment Rate} = 100 \cdot \frac{\text{umber of Unemployed}}{\text{Labor Force}}$$

∑ Labor Force Participation Rate

Fraction of the adult population that "participates" in the labor force (working or looking for work).

$$\text{Labor Force Participation Rate} = 100 \cdot \frac{\text{Labor Force}}{\text{Adult Population}}$$

Unemployment Types

1. **Structural Unemployment**
   - Mismatch between skills of workers and requirements of jobs
   - *e.g.* AI replacing human jobs
2. **Frictional Unemployment**
   - Time it takes to match workers with jobs
3. **Cyclical Unemployment**
   - Caused by economic downturns

Natural Rate of Unemployment

Natural Rate of Unemployment

The average rate of unemployment around which the economy fluctuates.

Rule

- In a **recession**, actual unemployment rate $>$ natural rate
- In a **booming economy**, actual unemployment rate $<$ natural rate

Notation:

Notation

- E = # of employed workers
- U = # of unemployed workers
- $L = E + U$ = # of workers in the labor force
- U/L = unemployment rate
- s = **rate of job separation** = fraction of employed workers who lose or leave their jobs
- f = **rate of job finding** = fraction of unemployed workers who find jobs

Assumptions

1. L is exogenously fixed
2. During any given month, s and f are constant

∑ **Steady-State Unemployment Rate**

There is a **steady state** if

$$\boxed{\underbrace{s \cdot E}_{\text{of employed people who lose or leave their obs}} = \underbrace{f \cdot U}_{\text{of unemployed people who find obs}}}$$

∑ **"Equilibrium" Unemployment Rate**

$$\boxed{\text{natural rate of unemployment} = \frac{U}{L} = \frac{s}{s+f}}$$

Policy: reduce s or increase f to reduce natural rate of unemployment.

Small closed economy model

Assumptions:

- closed economoy
- market-clearing model:
  - **supply = demand**
  - same for **employment market**
- supply side:
  - factor markets (supply, demand, price)
  - determination of output/income
- demand side:
  - determinants of consumption C, investment I, government spending G
- equilibrium:
  - goods market
  - loanable funds market

Notation

- K = capital
- L = labor

∑ **Production Function**

How much output Y the economy can produce from K units of capital and L units of labor

$$\boxed{Y = F(K, L)}$$

- Reflects the economy's level of technology
- Exhibits **constant returns to scale**:

Constant Returns to Scale

If we double inputs, output doubles

$$\boxed{F(2K, 2L) = 2F(K, L)}$$

Assumptions:

- technology is fixed (no technological progress)
- the economy's supplies of capital and labor are fixed:

$$K = K$$

and

$$L = L$$

∑ Output with Fixed Inputs

The output is determined by the fixed factor supplies and the fixed state of technology:

$$\boxed{Y = F(K, L)}$$

Distribution of National Income

Determined by factor prices

Factor Price

The price per unit firms pay for factors of production.

- Wage = price of labor L
- Rental rate = price of capital K = opportunity cost of renting

Notation

- W = **nominal** wage
- R = **nominal** rental rate of capital
- P = price of output

Measuring units of outputs:

∑ Real Wage and Real Rental Rate

$$\boxed{\mathbf{eal}\ \mathrm{Wage} = \frac{W}{P} \quad , \quad \mathbf{eal}\ \mathrm{Rental\ Rate} = \frac{R}{P}}$$

Supply Side

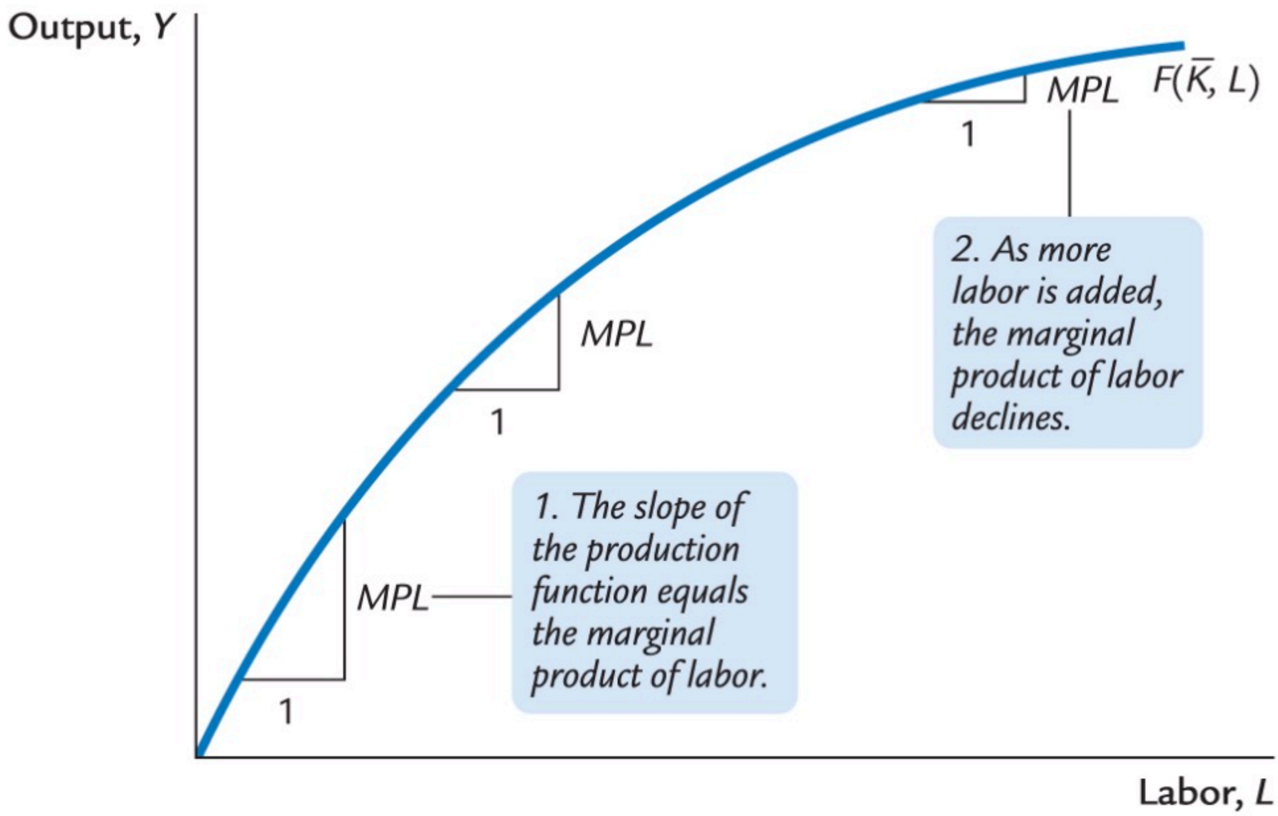
Assume that markets are competitive. Each firm takes W, R and P as given.

A firm hires each unit of labor L at cost W/P if that cost W/P does not exceed the benefit (marginal product of labor) of hiring that unit of labor.

∑ Marginal Product of Labor (MPL)

The increase in output from an additional unit of labor, holding the amount of capital fixed:

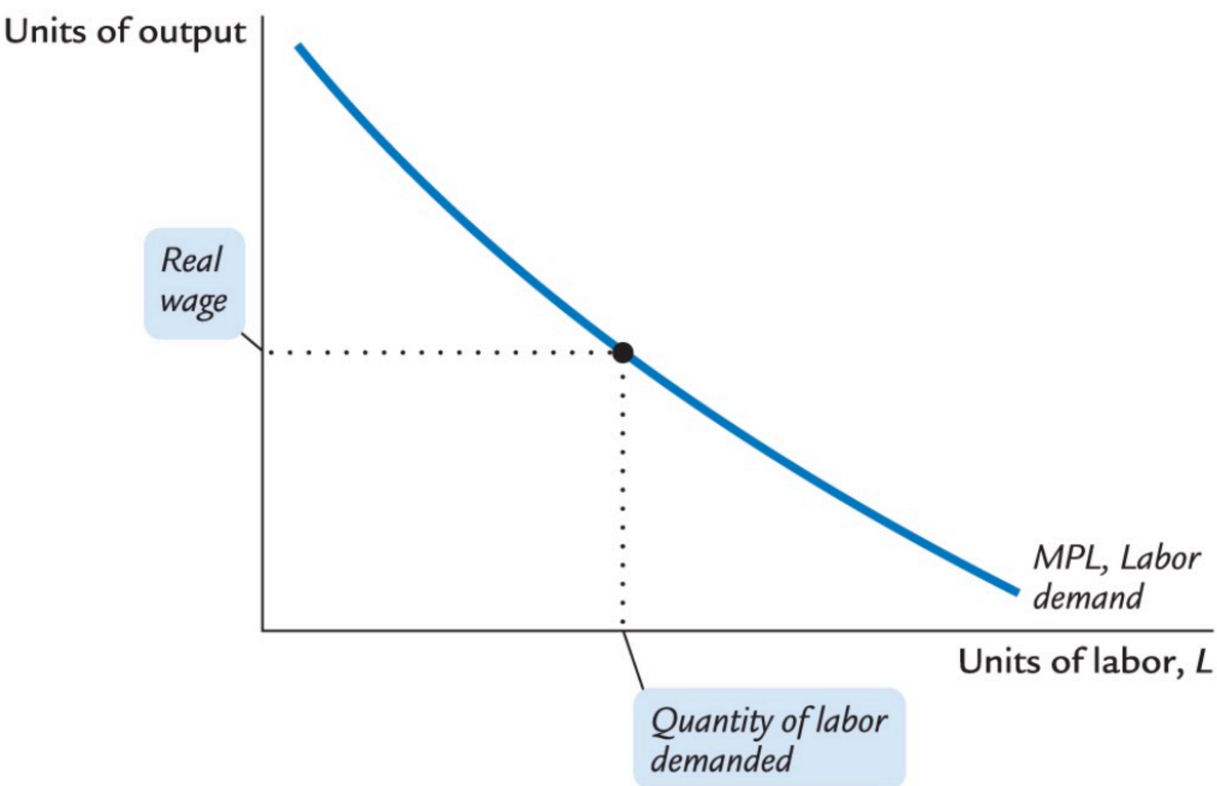
$$\boxed{MPL = \frac{\partial F(K, L)}{\partial L}}$$



Hiring unit of labor

Firm hires unit of labor L at cost of **real** wage if it doesn't exceed the MPL

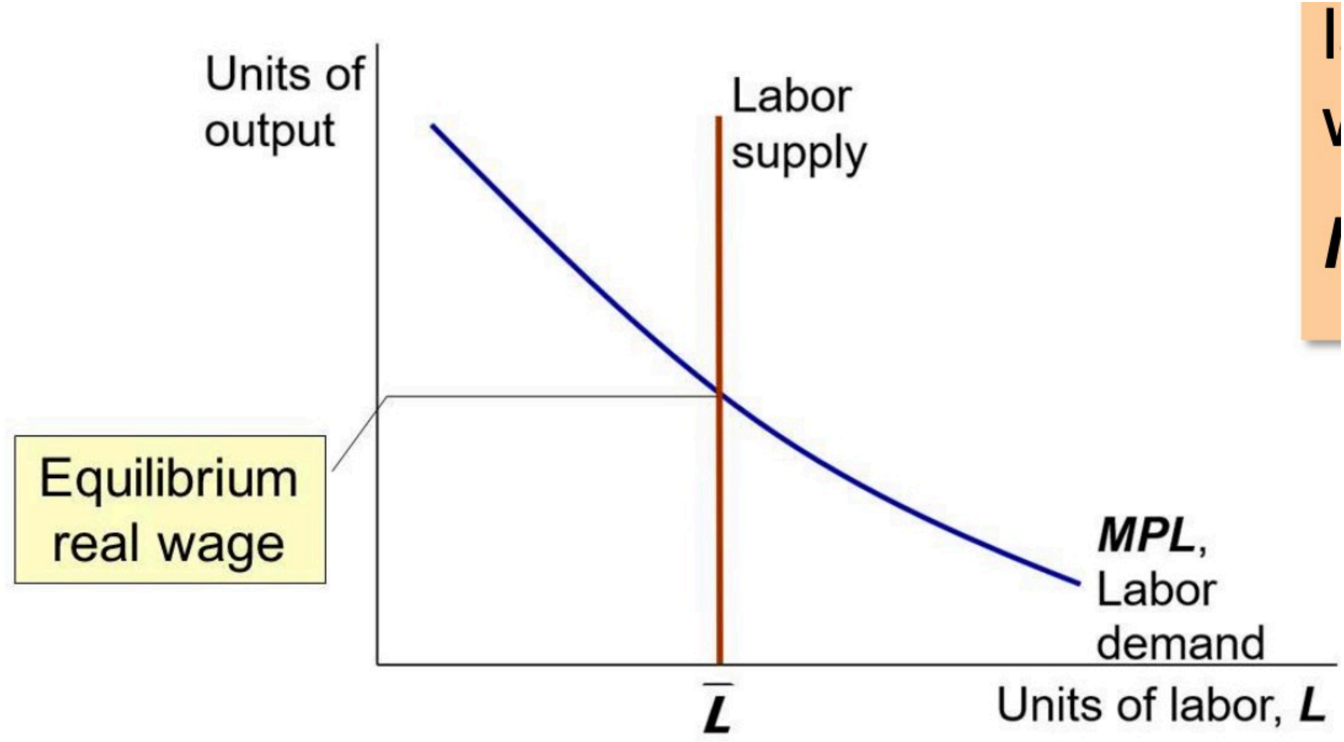
$$\boxed{\frac{W}{P} \leq MPL}$$



Equilibrium real wage

The real wage adjust to equate labor demand with supply:

$$\boxed{\frac{W}{P} = MPL}$$



Equilibrium Real Rental Rate

The real rental rate adjusts to equate demand for capital with supply:

$$\boxed{\frac{R}{P} = MPK}$$

∑ Distribution of Income between Labor and Capital

If the production function $Y = F(K, L)$ has **constant returns to scale**, then the total output is exactly exhausted when **each factor is paid its marginal product**

$$\boxed{\underbrace{Y}_{\text{ational Income}} = \underbrace{MPL \cdot L}_{\text{Labor Income}} + \underbrace{MPK \cdot K}_{\text{Capital Income}}}$$

In a Cobb-Douglas production function, the shares of labor and capital income are constant.

∑ **Cobb-Douglas Production Function**

$$\boxed{Y = AK^{\alpha}L^{\beta}}$$

In this case, the marginal products are:

$$MPL = \beta AK^{\alpha}L^{\beta-1} = \beta \cdot Y \cdot L^{-1}$$

and

$$MPK = \alpha AK^{\alpha-1}L^{\beta} = \alpha \cdot Y \cdot K^{-1}$$

If $\alpha + \beta = 1$, then the production function exhibits **constant returns to scale.**
In this case, each factor is paid its marginal product

$$Y = MPL \cdot L + MPK \cdot K = \beta Y + \alpha Y$$

and the **shares of labor (β) and capital income (α) are constant**:

$$\boxed{\text{labor income} = MPL \cdot L = \beta Y} \quad \boxed{\text{capital income} = MPK \cdot K = \alpha Y}$$

Demand Side

Determinants of C, I, and G?

∑ **Disposable Income**

Disposable income is total income minus total taxes T:

$$\boxed{\text{Disposable Income} = Y - T}$$

∑ **Consumption Function**

Consumption depends positively on disposable income:

$$\boxed{C = C(Y - T)}$$

∑ **Marginal Propensity to Consume (MPC)**

The change in consumption C when disposable income $Y - T$ increases by one dollar:

$$MPC = \frac{\Delta C}{\Delta(Y - T)}$$

∑ **Investment Function**

The investment functino $I = I(r)$ depends **negatively on the** real** interest rate r.

I depends **negatively** on r because higher r raises the cost of borrowing to finance investment spending.

Real Interest Rate r

The **real interest rate** r is the **nominal** interest rate adjusted for inflation.

$$r = i - \pi$$

- the cost of borrowing
- the **opportunity cost of using one's own funds to finance investment spending**

Government Spending

G = government spending on goods and services.

We assume that government spending G and total taxes T are **exogenous**:

$$G = G \qquad T = T$$

Market for Goods and Services

∑ Aggregate Demand

$$\boxed{C(Y - T) + I(r) + G}$$

∑ Aggregate Supply

$$\boxed{Y = F(K, L)}$$

The **real interest rate** r adjust to equate demand and supply in the goods market.

Goods Market Equilibrium

$$\boxed{Y = C(Y - T) + I(r) + G}$$

Loanable Funds

Loanable Funds

Funds available to finance investment spending.

What about supply of LF (= loanable funds)

∑ Households: private saving

$$\boxed{\text{Private Saving} = (Y - T) - C}$$

∑ Government: public saving

$$\boxed{\text{Public Saving} = T - G}$$

Public Saving Budget Surplus/Deficit

- $T > G$: **budget surplus** = $T - G$ = public saving
- $T < G$: **budget deficit** = $G - T$. Public saving is negative.
- $T = G$: **balanced budget**. Public saving is zero.

∑ National Saving

$$\begin{aligned} \boxed{\text{ational Saving } S} &= \boxed{\text{Private Saving} + \text{Public Saving}} \\ &= (Y - T) - C + (T - G) \\ &= Y - C - G \end{aligned}$$

When is there equilibrium in a CLOSED economy?

There is equilibrium in the loanable funds market when national saving equals investment:

$$\boxed{S = I(r)}$$

Loanable Funds Market Equilibrium

Because $S = I(r)$ and $S = Y - C - G$, we have that $Y - C - G = I(r)$, which is the same as the goods market equilibrium condition.

$$\boxed{\text{E in LF market} \iff \text{E in goods market}}$$

Money

Money supply

Money supply M = quantity of money available in the economy.

Money policy

Monetary policy = the control over the money supply
Conducted by the country's **central bank**

To control the money supply, the central bank uses **open-market operations**: the purchase and sale of government bonds.

Currency

Currency C = paper bills and coins in the hands of the public.

∑ Formula

The money supply M equals the sum of currency C and demand (checking account) deposits D:

$$\boxed{M = C + D}$$

The total Money Supply (M) is the sum of currency and demand deposits.

- C, **Currency**: The **physical money** (e.g., notes and coins) held by the non-bank public.
- D, **Demand Deposits**: Funds held in **bank accounts** that can be **accessed "on demand"** (i.e., immediately and without notice).

Checking Accounts is a common term for demand deposits, allowing funds to be withdrawn via checks, debit cards, or electronic transfers.

Reserves

Reserves

Reserves R = portion of deposits that banks have to lend.

A bank's liabilities (= what it owes) include deposits D.
A bank's assets (= what it owns) include reserves R and outstanding loans L.

Two types of reserve banking:

- **100-percent-reserve banking**: banks keep all deposits as reserves
- **Fractional-reserve banking**: banks keep only a fraction of deposits as reserves

Reserve Ratio

Reserve ratio rr = fraction of deposits that banks hold as reserves.

∑ Total money supply

$$\text{Total money supply} = \text{Initial deposit} \times \frac{1}{rr}$$

Exogenous Variables

Exogenous means determined outside the model.

∑ Monetary Base

$$\text{Monetary Base} \boxed{B = C + R}$$

Where C = currency in circulation and R = bank reserves.
Controlled by the central bank.

∑ Reserve-deposit ratio

$$\text{Reserve-deposit ratio} \boxed{rr = \frac{R}{D}}$$

depends on regulatios and bank policies.

∑ Currency-deposit ratio

$$\text{Currency-deposit ratio} \boxed{cr = \frac{C}{D}}$$

depends on preferences of households.

∑ Money Multiplier

Money multiplier , the increase in the money supply M resulting from a one-dollar increase in the monetary base B (= $C + R$):

$$\boxed{= \frac{1 + cr}{rr + cr}}$$

∑ Money supply in terms of base

$$\boxed{M = \cdot B}$$

If monetary base $B = C + R$ increases changes by ΔB, then money supply M changes by $\Delta M = \cdot \Delta B$.

Part 2

NGDP vs RGDP

∑ **Nominal GDP**

$$\boxed{NGDP = P \cdot Y}$$

∑ **Real GDP**

$$\boxed{RGDP = Y}$$

Velocity of Money

- V = velocity of money
- T = **value of all transactions**
- M = money supply

∑ **Velocity of Money**

$$\boxed{V = \frac{T}{M}}$$

If we use nominal GDP $NGDP$ as a proxy for value of all transactions T, then

∑ **Velocity of Money (using NGDP)**

$$\boxed{V = \frac{P \cdot Y}{M}}$$

where

- P = price of output (GDP deflator)
- Y = quantity of output (real GDP)
- $P \cdot Y$ = nominal GDP

∑ **NGDP**

$$\boxed{NGDP = P \cdot Y = \text{GDP deflator} \times \text{real GDP}}$$

Thus, we have that $M \cdot V = \boxed{T = P \cdot Y}$.

∑ **Quantity Equation**

$$\boxed{M \cdot V = P \cdot Y}$$

This is an **identity**: it holds by definition of the variables.
It says that the money supply times the velocity of money equals nominal GDP, which is the GDP deflator times real GDP.

∑ **Money Balance**

M/P = real money balances = purchasing power of the money supply.
Measure the purchasing power of the stock of money.

$$\boxed{\text{real money balance } = \frac{M}{P}}$$

∑ **Money Demand Function**

$$\boxed{(M/P)^d = k \cdot Y}$$

where k = **how much money people wish to hold for each dollar of income**.

NOTE: this is **not** M/P to some power, but rather the **demand for real money balances, denoted as** $(M/P)^d$.
This says that for a given level of real income Y, the quantity of real money balances demanded is proportional to Y.

∑ **Connection between velocity and money demand**

$$\boxed{k = \frac{1}{V}}$$

When people hold lots of money relative to their incomes (k is large), money changes hands infrequently (V is small).
$\Rightarrow$ money demand parameter k and velocity of money V are opposite sides of the same coin.

Quantity Theory of Money

Starts with Quantity Equation $M \cdot V = P \cdot Y$.
Assume that **velocity V is constant** and exogenous: $V = \bar{V}$.

∑ **Quantity Theory of Money Equation**

$$\boxed{M \cdot \bar{V} = P \cdot Y}$$

- Money supply M determines nominal GDP $P \cdot Y$.
- Real GDP Y is determined by factors of production and technology (supply side).
- The price level $\boxed{P = NGDP/RGDP}$ **adjusts to ensure that the quantity equation holds**.

Example Scenario

Imagine an economy produces **100 apples** (Real GDP is fixed at 100).

1. **Scenario A:** The Money Supply is **\$100**. The price per apple is **\$1.00**. (Nominal GDP = \$100).
2. **Scenario B:** The government doubles the Money Supply to **\$200**.
   - Real GDP is still **100 apples** (printing money didn't grow more apple trees).
   - Nominal GDP is now **\$200**.
   - Therefore, the Price must rise to **\$2.00** per apple.

The growth rate of a product equals the sum of the growth rates of its factors:

Money Growth Rate

$$\text{money growth rate} = \frac{\Delta M}{M}$$

∑ **Growth Rate Form of Quantity Theory of Money**

$$\boxed{\frac{\Delta M}{M} + \frac{\Delta \bar{V}}{\bar{V}} = \frac{\Delta P}{P} + \frac{\Delta Y}{Y}}$$

Because the quantity theory of money assumes that velocity V is constant, its growth rate is zero: $\Delta V / V = 0$.
Thus, we have

∑ Simplified Growth Rate Form of Quantity Theory of Money

If V is **constant** (V) - as assumed by the quantity theory of money, then $\Delta V / V = 0$ and

$$\boxed{\frac{\Delta M}{M} = \frac{\Delta P}{P} + \frac{\Delta Y}{Y}}$$

∑ Real Money Balance

$$\text{real money balance } = \frac{M}{P}$$

∑ Change in Real Money Balance

$$\frac{\Delta(M/P)}{M/P} = \frac{\Delta M}{M} - \frac{\Delta P}{P}$$

or equivalently

$$\boxed{\%\Delta \text{ real money balance } = \%\Delta M - \%\Delta P}$$

∑ (Actual) Inflation Rate

$$\text{Inflation Rate} = \frac{\Delta P}{P} = \boxed{\pi = \frac{\Delta M}{M} - \frac{\Delta Y}{Y}}$$

Normal economic growth requires a certain amount of money supply growth to facilitate the growth in transactions
$T \quad P \cdot Y = RGDP$.
Money growth in excess of this amount leads to inflation.

Rule

The quantity theory predicts a one-for-one relationship between changes in the money growth rate $\Delta M / M$ and changes in the inflation rate π.

Interest rates

Nominal Interest Rate

The **nominal interest rate** i is the interest rate that the **bank pays**.

Real Interest Rate

The **real interest rate** r is the **nominal interest rate adjusted for inflation**.
It is the increase in your purchasing power from saving.

∑ Real Interest Rate adjusted for Inflation

$$\text{real interest rate } \boxed{r = i - \pi}, \qquad (i = \text{nominal interest rate}, \pi = \text{inflation rate})$$

∑ **Fisher Equation**

$$\boxed{i = r + \pi}$$

Fisher Effect

We saw earlier that $S = I$ in the loanable funds market (where I = investment) and that this determines the real interest rate r.
Hence, an increase in the inflation rate π causes an equal increase in the nominal interest rate i.
This one-for-one adjustment of the nominal interest rate to the inflation rate is called the **Fisher effect**.

Actual Inflation rate

$$\text{actual inflation rate } = \boxed{\pi = \frac{\Delta P}{P}}$$

Not known until **after it has occurred.**

Expected Inflation Rate

$$\text{expected inflation rate } = E\pi$$

The inflation rate that people **expect** to occur.

This leads to two definitions of the real interest rate:

∑ **Ex-ante Real Interest Rate**

$$\textbf{ex-ante} \text{ real interest rate } = \boxed{i - E\pi}$$

This is the real interest rate that people expect at the time they buy a bond or take out a loan.

∑ **Ex-post Real Interest Rate**

$$\textbf{ex-post} \text{ real interest rate } = \boxed{i - \pi}$$

This is the real interest rate actually realized.

Money Demand Function

∑ **Money Demand Function**

$$\boxed{(M/P)^d = L(i, Y)}$$

where

- L = money demand function because money is *L*iquid asset
- $(M/P)^d$ = real money demand, which depends
- negatively on i = nominal interest rate = opportunity cost of holding money
- positively on Y = RGDP, because higher Y increases spending on goods and services

Let's use the **ex-ante real interest rate** instead of the nominal interest rate:

∑ Money Demand Function

$$\boxed{(M/P)^d = L(i, Y) = L(r + E\pi, Y)}$$

Equilibrium in the Money Market

Money Market Equilibrium

$$\boxed{\frac{M}{P} = L(r + E\pi, Y)}$$

Where LHS = supply of real money balances
and RHS = real money demand

- M = exogenous (controlled by central bank)
- r = adjusts to ensure $S = I$
- $Y \to Y = F(K, L)$

Price P adjusts to ensure $\frac{M}{P} = L(i, Y)$.
A change in M leads to a proportional change in P, just like in the quantity theory of money.

The Classical Dichotomy

A dichotomy is a division into two parts.

Real variables

Measured in **physical units**: quantities and relative prices, e.g.

- quantity of output Y
- *real* wage = output earned per hour of work
- *real* interest rate r = output earned in the future by lending one unit of output today

Nominal variables

Measured in **money units**, e.g.

- *nominal* wage = dollars paid per hour of work
- *nominal* interest rate i = dollars paid in the future by borrowing one dollar today
- price level P = number of dollars needed to buy a representative basket of goods

Classical Dichotomy

The theoretical separation of **real** and **nominal** variables, which implies
nominal variables do not affect real variables.

Neutrality of Money

Idea that **changes in the money supply do not affect real variables**.

In the real world, money is approximately neutral in the long run.

Open Economy Model

- We now allow trade.

- A "small" economy like Denmark cannot affect world prices or interest rates.
- $\text{Spending } \neq \text{output } Y$
- $\text{Saving } S \neq \text{investment } I$
- The domestic interest rate is determined by the world interest rate: $r = r^*$.

∑ Open Economy GDP Identity

$$\boxed{Y = C + I + G + NX}$$

or

$$\boxed{NX = Y - (C + I + G) = X - IM}$$

Where

- NX = net exports = exports - imports
- Y = output
- $(C + I + G)$ = domestic spending
  - C = consumption
  - I = investment
  - G = government spending

∑ Net Exports

$$\boxed{\text{trade balance} = NX = X - IM}$$

where

- X = exports
- IM = imports

Trade Surplus

- output > spending
- exports X > imports IM
- size of trade surplus:

$$\boxed{\text{trade surplus} = NX = NC}$$

Trade Deficit

- output < spending
- imports IM > exports X
- size of trade deficit =

$$\boxed{\text{trade deficit} = -NX = -NC}$$

$\sum$ **Net capital outflow**

Net outflow of loanable funds = net purchases of foreign assets by the country's purchases of foreign assets minus foreign purchases of domestic assets.

$$\boxed{NC = S - I}$$

Where

- NC = net capital outflow
- S = national saving
- I = investment

Country = net LENDER

A country is a **net lender** if

$$S > I \quad \iff \quad NC > 0 \quad \iff \quad NX > 0 \quad \iff \quad \text{positive net capital outflow}$$

Country = net BORROWER

A country is a **net borrower** if

$$S < I \quad \iff \quad NC < 0 \quad \iff \quad NX < 0 \quad \iff \quad \text{negative net capital outflow}$$

Trade balance = Net Capital Outflow

$\sum$ **Formula**

$$NX = (Y - C - G) - I = S - I, \qquad \text{since} \quad \boxed{S = Y - C - G}$$

and

$$NX = X - IM, \qquad NC = S - I, \qquad \implies \boxed{NX = NC = S - I}$$

Rule

A country with a trade deficit ($NX < 0$) is a **net borrower** ($S < I$)

If we save more than we invest domestically ($S > I$), we lend the excess to foreigners (net lender, $NC > 0$).
If we invest more than we save domestically ($S < I$), we borrow the difference from foreigners (net borrower, $NC < 0$).

Exchange Rates

Nominal Exchange Rate e

The **nominal exchange rate** e is the relative price of domestic currency in terms of a foreign currency.

Real Exchange Rate ε

The **real exchange rate** ε is the relative price of domestic goods in terms of foreign goods.

Net Exports Function

∑ Net Exports Function

$$\boxed{\text{trade balance} = NX = NX(\varepsilon)}$$

World Interest Rate

The **world interest rate** r^* is the real interest rate that prevails in the world economy.

The accounting identity says that $NX = S - I = NC$.
We saw how $S - I$ is determined:

- S depends on domestic factors (output Y, fiscal policy variables (G = government spending, T = taxes))
- I is determined by the world interest rate r^*.

∑ How ε is determined

$$\boxed{NX(\varepsilon) = S - I(r^*)}$$

Determinants of the Nominal Exchange Rate e

Start with the expression for the real exchange rate ε:

∑ Real Exchange Rate

$$\boxed{\varepsilon = \frac{e \cdot P}{P^*}}$$

Solve for e to get

∑ Nominal Exchange Rate

$$\boxed{e = \varepsilon \cdot \frac{P^*}{P}}$$

Where

- ε = real exchange rate
- P = domestic price level
- P^* = foreign price level

Where

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

We can rewrite $e = \varepsilon \cdot \frac{P^*}{P}$ as

$$\frac{\Delta e}{e} = \frac{\Delta \varepsilon}{\varepsilon} + \frac{\Delta P^*}{P^*} - \frac{\Delta P}{P} = \frac{\Delta \varepsilon}{\varepsilon} + \pi^* - \pi$$

∑ Formula

$$\%\Delta e = \%\Delta \varepsilon + \pi^* - \pi$$