Gross Domestic Product (Product Approach) is defined as the market value of final goods and services newly produced within a nation during a fixed period of time.

Market value: prices at which goods and services are sold
- (+): Allows adding of production of different goods and services
- (-): Some goods or services are not sold in formal markets, denoted **nonmarket goods and services**.

Newly produced: GDP only includes goods and services produced within current period.
Final: Goods and services are final if they are not intermediate. Goods and services are intermediate if they are used up in the production of others **in the same period they were produced**. **inventories** are a final good.

Gross National Product is defined as the market value of final goods and services newly produced *by domestic factors of production* during the current period.

NFP or **Net factor payments from abroad** is defined as the income paid to domestic factors of production by the rest of the world minus income paid to foreign factors of production by the domestic economy.

$$\text{GDP} = \text{GNP} - \text{NFP}$$

Income-Expenditure Identity: The **Gross Domestic Product** (Expenditure Approach) is defined as the total spending on final goods and services produced within a nation during a specified period of time.

$$Y = C + I + G + NX$$

Investment includes spending on
- fixed investment: spending on new capital goods
  - business fixed investment
  - residential investment
- inventory investment: spending on inventory holdings
  - including produced goods that are unsold

Government purchases of goods and services include expenditure by government for a currently produced good or service, foreign or domestic. Note that G excludes
- transfers
- interest payment on national debt

Government spending on fixed investments or inventory is counted under G, not I.

$$GNP = NNP + Depr + NFP$$
$$GDP = GNP + NFP$$

Private disposable income is the amount of income that the private sector has available to spend.

$$Y + NFP + TR + INT - T$$

Net government income is taxes paid by private sector, minus payments from government to the private sector

$$\text{net government income} = T - TR - INT$$

Private saving is defined as the difference of private disposable income and consumption

$$S_{pvt} = (Y + NFP - T + TR + INT) - C$$

Note that **investments** is not subtracted from private disposable income even though it constitutes private spending, because it *does not satisfy current needs*.

Government saving is defined as net government income, less goernment purchases of goods and services

$$S_{govt} = (T - TR - INT) - G$$

Government budget surplus is defined as government receipts less outlays

$$\begin{aligned}\text{budget surplus} &= T - (G + TR + INT) \\ &= S_{govt}\end{aligned}$$

Uses-of-saving identity The economy's private saving is used in 3 ways

$$S_{pvt} = I + (-S_{govt}) + CA$$

National Wealth is the total wealth of residents in a country, consisting of
- domestic physical assets, i.e. capital goods and land
- net foreign assets, comprising of
  - (+) foreign physical and financial assets
  - (-) foreign physical and financial liabilities

The **GDP deflator** is a price index that measures the overall level of prices of goods and services included in GDP.

$$\text{GDP deflator} = 100 \times \frac{\text{nominal GDP}}{\text{real GDP}}$$

The **Consumer Price Index**, or **CPI**, measures the prices of consumer goods, calculated as 100 times the current cost of a specific baset of consumer items divided by the cost of the same basket in the reference base period.

The CPI tends to overstate increases in cost of living because of
- improvements in quality of goods and services
- substition bias
  - CPI doesn't account for substitution away from the specified basket of goods

Inflation rate for a given period is defined as the percentage change in the price index in the same period.

$$\pi_{t+1} = \frac{P_{t+1} - P_t}{P_t} = \frac{\triangle P_{t+1}}{P_t}$$

The **real interest rate** on an asset is the rate at which the real value or purchasing power of the asset increases over time. The **nominal interest rate** on an asset is the rate at which the nominal value or purchasing power of the asset increases over time.

$$\begin{aligned}\text{real interes rate} &= \text{nominal interest rate} - \text{inflation} \\ &= i - \pi\end{aligned}$$

Expected real interest rate is the nominal interest rate minus expected rate of inflation.

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

The **Marginal product of capital** is the increase in output produced that results from a one-unit increase in capital stock.

$$MPK = \frac{\triangle Y}{\triangle K}$$

The **Marginal product of labor** is the increase in output produced that results from a one-unit increase in labor.

$$MPN = \frac{\triangle Y}{\triangle N}$$

The MPK and MPN
- are positive
- are decreasing in K / N, due to diminishing marginal product

Given a decrease in A,
- the marginal product decreases for every value of N
- the amount of output decreases for every value of N

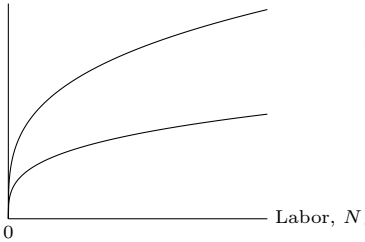


Fig - Decrease in A, holding K fixed

Note that

$$\begin{aligned}&A_2 < A_1 \\ \implies &Y_2 < Y_1 \\ \implies &MPN_2 < MPN_1\end{aligned}$$

Marginal revenue product of labor is the benefit of employing an additioinal worker in terms of the extra revenue produced.

$$MRPN = P \times MPN$$

The quantity of labor demanded is
- in nominal terms: equal to the $MRPN$
- in real terms: equal to MPN

Real wage refers to the wage measured in terms of units of output.

$$w = \frac{W}{P}$$

Note that firms will want to increase employment under the following condition, all 4 statements are equivalent

$$\begin{aligned}&MPN > w \\ \iff &MPN > \frac{W}{P} \\ \iff &P \times MPN > W \\ \iff &MPRN > W\end{aligned}$$

Vice versa for condition under which the firm will want to decrease employment

Factors that affect labor demand must change the amount of labor that firms want to employ *at any given level of the real wage*.
The labor demand increases in response to
- $A \uparrow$, productivity improvements / positive supply shock
- $K \uparrow$, increase in capital supply

The **substitution effect** refers to an increase in the opportunity cost of leisure causing workers to substitute away from leisure towards work.

Pure substitution effect: one-day rise in real wage, $NS \uparrow$.

The **income effect** refers to workers being better off and hence working less.

Pure income effect: changes in Z, e.g. winning the lottery, or higher expected future real wages, $NS \downarrow$

Income and **substition** effect work in opposite directions on labor supply.
An increase in real wages
- raises the marginal benefit of work, increases labor supply, by **substitution effect**
- increases workers' wealth, decreases labor supply, by **income effect**

The labor supply shifts left in response to
- increases in weath, $NS \downarrow$
- increases in expected future real wage, $NS \downarrow$
- decrease in working age population
- decrease in participation rate

Full-employment level of employment, $\bar{N}$ is defined as the equilibrium level of employment. The corresponding market-clearing real wage is $\bar{w}$.

Full-employment output, $\bar{Y}$, also called **potential output**, is the level of output that firms in the economy supply when wages and prices have fully adjusted.
$\bar{Y}$ is achieved when aggregate employment reaches its full-employment level, $\bar{N}$

$$\bar{Y} = AF\left(K, \bar{N}\right)$$

A decrease in A reduces $\bar{Y}$ in two ways
- $A \downarrow \rightarrow \bar{Y} \downarrow$ directly
- $A \downarrow \rightarrow MPN \downarrow \rightarrow ND \downarrow \rightarrow \bar{N} \downarrow \rightarrow \bar{Y} \downarrow$

Classification of individuals:
- E, employed, if person worked full-time or part-time during the past week
- U, unemployed, if person didn't work during the past week but looked for work in the past four weeks
- NLF, not in labor force, if the person didnt work and didn't look for work in the past 4 weeks
  - discouraged workers, people who become discouraged and move from U to NLF

$$\begin{aligned}\text{labor force} &= LF = E + U \\ \text{adult population} &= LF + NLF \\ \text{participation rate} &= \frac{LF}{LF + NLF} \\ \text{employment ratio} &= \frac{E}{LF + NLF}\end{aligned}$$

Sources of unemployment
- **frictional unemployment**: arises as workers search for suitable jobs and firms search for suitable workers
- **structural unemployment**: long-term and chronic unemployment that exists even when the economy is not in a recession
  - unskilled, low skilled workers
  - rellocation of labor from shrinking industries / depressed regions

The **natural rate of unemployment**, $\bar{u}$ is the rate of unemployment that prevails when output and employment are at the full-employment level.
The difference betwen actual unemployment and natural unemployment is **cyclical unemployment**

$$\text{cyclical unemployment} = u - \bar{u}$$

Okun's Law states that the gap between full-employment output and actual output increases by 2 percent for each percent increase in unemployment

$$\frac{\bar{Y} - Y}{\bar{Y}} = 2\left(u - \bar{u}\right)$$

Alternatively, the percentage change in real output is roughly 3 percent minus two times the change in unemployment

$$\frac{\triangle Y}{Y} = \frac{\triangle \bar{Y}}{\bar{Y}} - 2\triangle u$$

An individual's **Present Value of Lifetime Resources,** $PVLR$ is defined as

$$PVLR = a + y + \frac{y^f}{1 + r}$$

An individual's **Present Value of Lifetime Consumption,** $PVLC$ is defined as

$$PVLC = c + \frac{c^f}{1 + r}$$

An individual's **budget constraint** is given by

$$\begin{aligned}PVLC &= PVLR \\ c + \frac{c^f}{1 + r} &= (a + y) + \frac{y^f}{1 + r} \\ c^f &= (a + y - c)(1 + r) + y^f \\ &= \underbrace{(a + y)(1 + r) + y^f}_{intercept} \underbrace{-(1 + r)}_{slope} c\end{aligned}$$

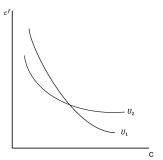
We can classify individuals as lending or borrowing
- lending, if $c < a + y \iff a + y - c > 0$
- borrowing if $c > a + y \iff a + y - c < 0$

We can classify individuals as saving or dissaving

- saving, if $y > c$
- dissaving, if $y < c$
  - borrowing, if $c > y + a \iff a + y - c < 0$

Dissaving $\neq$ Borrowing.

Slope of indifference curve

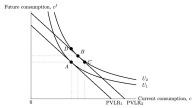


- U_1: **present-oriented**, steeper, values consumption today, require a lot of consumption to give up a unit of consumption today
- U_2: **future-oriented**, flatter, require a lot of consumption today to give up a unit of consumption tomorrow

Income effect occurs when
- $a \uparrow$
- $y \uparrow$
- $y^f \uparrow$

As a result
- $PVLR \uparrow$
- r unchanged

Income effect operates through $PVLR$ with unchanged r.



The **Riccardian Equivalence Proposition** states that tax cuts do not affect desired consumption or national saving because in the long run, because all government purchases must be paid for by taxes.

Riccardian Assumptions

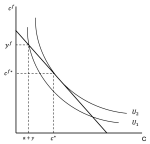
1. Assuming REP does not hold
   - People spend some and save some, i.e. *consumption smoothing*

   $$T \downarrow \implies c \uparrow, s \uparrow$$
2. Assuming REP holds and **there are borrowing constraints**
   - Borrowers facing constraints increase consumption,

   $$T \downarrow \implies c \uparrow, s \downarrow$$
3. Assuming REP holds and there are no borrowing constraints

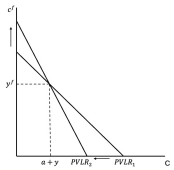
   $$T \downarrow \implies c, s \text{ constant}$$

One time tax rebate, assuming REP with borrowing constraints



If
- $a + \tilde{y} < c^*$ increase c by the full amount of the tax rebate
- $a + \tilde{y} > c^*$ increase c only up to c^*

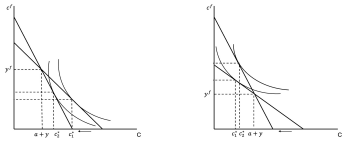
Effect of an increase in interest rate on budget constraint
- $PVLR \downarrow$: present value of future income decreases
- vertical intecept $\uparrow$: future value of present income and assets increases
- no-borrowing no-lending point remains the same
- c^*: depends



Effect of an increase in interest rate

Borrowers unequivocally consume less.
- Substitution effect: $r \uparrow \implies s \uparrow c \downarrow$
- Income effect: $r \uparrow \implies s \uparrow c \downarrow$

Lenders consumption uncertain
- Substitution effect: $r \uparrow \implies s \uparrow c \downarrow$
- Income effect: $r \uparrow \implies s \downarrow c \uparrow$



Summary of factors affecting consumption.

Change	ΔC	ΔS
$y \uparrow$	$c \uparrow$	$s \uparrow$
$a \uparrow$	$c \uparrow$	$s \downarrow$
$y^f \uparrow$	$c \uparrow$	$s \downarrow$
$r \uparrow$	$c \downarrow$	$s \uparrow$

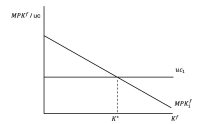
A firm's **desired capital stock** is the profit-maximizing amount of capital for the firm.

The profit-maximizing level of capital is achieved when the expected future marginal benefit, *expected future marignal product of capital*, MPK^f is equal to the expected future marginal cost, *user cost of capital*.

The **user cost of capital** is the expected real cost of a unit of capital for a specific period of time.

$$uc = (r + d)p_K$$

Desired Capital Stock



The **tax-adjusted user cost of capital** is the user cost of capital divided by $1+\tau$ where τ is the tax rate on firm revenues.

$$\frac{uc}{1-\tau} = \frac{(r+d)p_K}{1-\tau}$$

Gross investment is defined as the total purchase or construction of new capital goods.

Net investment is defined as the difference between gross investment and depreciation.

$$\underbrace{K_{t+1} - K_t}_{\text{net investment}} = \underbrace{I_t}_{\text{gross investment}} - \underbrace{dK_t}_{\text{depreciation}}$$

Summary of factors affecting goods-market equilibrium

Change	ΔC	ΔS
$A \downarrow$	$\downarrow$	$\downarrow$
$G \uparrow$	$\downarrow$ a little	$\downarrow$
Wealth $\uparrow$	$\uparrow$	$\downarrow$
$T \downarrow$	$\uparrow$ followed by $\downarrow$ a little	$\downarrow$
$\tau \downarrow$	$\downarrow$ a little	$\uparrow$ a little

(Current Account) The **current account** measures a country's trade in currently produced goods and services, along with unilateral transfers between countries.

$$CA = NX + NFP + NUT$$

Where
- NX: net exports of goods and services
- NFP: net income from abroad (primary income), approximated by NFP
- NUT: net unilateral transfers (secondary income)

CA is equal to the amount of funds that a country has available for net foreign lending

(Capital and financial account): The **capital and financial account** consists of
- capital account: unilateral transfers of assets
- financial account: transactions involving flow of assets

The following are equivalent
- CA surplus of \$10M
- KFA deficit of \$10M
- net **acquisition** of foreign assets of \$10M
- net foreign lending of \$10M
- net exports of \$10M, assuming $NFP = NUT = 0$

(Goods market equilibrium for an open economy) At goods market equilibrium, actual national saving and investment match their desired levels.

$$S^d = I^d + CA = I^d + (NX + NFP)$$

$$S^d = I^d + NX$$

This is equivalent to

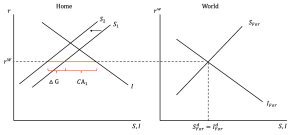
$$Y = C^d + I^d + G + NX$$

and

$$NX = Y - (C^d + I^d + G)$$

The last equation can be interpreted as: at goods market equilibrium, the amount of net exports equals total output less desired absoprtion (spending by domestic residents).
- output > absorption $\implies NX > 0$
- output < absorption $\implies NX < 0$

Change in G
- $G \uparrow \implies S = (Y - C - G \uparrow) \downarrow \implies NX \downarrow = CA \downarrow$



Eqm in large open economy

$$Y + Y_{For} = C^d + I^d + G + C^d_{For} + I^d_{For} + G_{For}$$

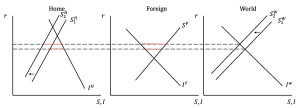
$$\underbrace{(Y - G^d - G)}_{S^d} + \underbrace{(Y_{For} - C^d_{For} - G_{For})}_{S^d_{For}} = I^d + I^d_{For}$$

$$\underbrace{(S^d - I^d)}_{CA} + \underbrace{(S^d_{For} - I^d_{For})}_{CA_{For}} = 0$$

Increase in government spending
- $G^H \uparrow \implies S^H = (\bar{Y}^H - C^H - G^H \uparrow) \downarrow$
- domestic savings curve shifts left
- world savings curve shifts left
  - world savings shifts by the manitude such that r^W brings NX^H and NX^F into equilibrium, i.e.

    $$NX^H = NX^F \iff CA^H = CA^F$$
- composition of GDP:

  $\underset{no\ change}{\bar{Y}^H} = \underset{a\ little}{C \downarrow} + I^H \downarrow + G^H \uparrow + NX^H \downarrow$



- N_t grows at fixed rate n
- economy is closed and $G = 0$, which implies output is either consumed or invested to grow capital stock, then

  $$C_t = Y_t - I_t$$
- S_t is proportional to current income for some fixed saving rate

  $$S_t = sY_t$$

The per-worker production function is

$$c_t = Af(k_t) - (n + d)k_t$$

At steady state, capital grows at n, hence

$$I_t = (n + d)K_t$$

Steady state consumption is therefore

$$C_t = Y_t - (n + d)K_t$$

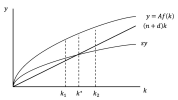
In per worker terms,

$$c_t = Af(k_t) - (n + d)k_t$$

Since national savings equal investment

$$S_t = sY_t = (n+d)K_t \implies fAf(k_t) = (n+d)k$$

At equilibrium,



(Money): Money refers to assets that are widely used and accepted as payment. Money has 3 functions
- medium of exchange
- store of value
- unit of account

(M1): The M1 monetary aggregate is the narrowest measure, consisting of
- currency
- travelers' check
- demand deposits
- other checkable deposits

(M2):
- M1
- Savings deposits
- Time deposits
- Money market mutual funds

(Money supply): Money supply is the amount of money available in an economy.
Central banks can control money supply through **open market operations**, and
- increase money supply by **buying financial assets**
- decrease money supply by **selling financial assets**

(Money demand): The demand for money is the quantity of monetary assets that people choose to hold in their portfolios.

$$M^d = PL(Y, i) = PL(Y, r+\pi^e) implies \frac{M^d}{p} =$$

where
- M^d is nominal aggregate money demand
- P is the price level
- Y is real income
- i is the nominal interest rate earned by **alternative, non-monetary assets**
- L is some function relating money demand to Y, r
- r is real interest rate
- π^e is expected inflation
- M^d/P is the real money demand

Factors affecting money demand
- price level

  - higher price level $\implies$ people need more dollars to conduct transactions $\implies$ people hold more money (proportional)
  -
- real income
  - higher real income $\implies$ more transactions $\implies$ more liquidity needed (less than proportionate)
- interest rates
  - increase in expected return on money $\implies$ more demand for money
  - increase in expected return on non-monetary assets $\implies$ less demand for money

Velocity of money: The velocity of money measures how often the money stock turns over each period

$$V = \frac{PY}{M} = \frac{\text{nominal GDP}}{\text{nominal money stock}}$$

(Quantity theory of money): The quantity theory of money says that real money demand is proportional to real income

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

Where k is some constant.

(Inflation): The inflation rate is the growth rate of the price level

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

At asset market equilibrium, rate of inflation equals growth rate of nominal money supply minus growth rate of real money demand.
This can be expressed as

$$\pi = \frac{\triangle P}{P} = \frac{\triangle M}{M} - \eta_Y \frac{\triangle Y}{Y} - \eta_i \frac{\triangle i}{i}$$

where

- i: nominal interest rate
- η_i: interest elasticity of money demand

Assuming that change in real income is the only source of change in money demand,

$$\pi = \frac{\triangle P}{P} = \frac{\triangle M}{M} - \eta_Y \frac{\triangle Y}{Y}$$

(Business cycle): The business cycle refers to the repeated sequence of economic expansion giving way to temporary decline followed by recovery.

Burns and Mitchell: "Business cycles are a type of fluctuation found in the aggregate economic activity of nations that organize their work mainly in business enterprises. A cycle consists of expansions occurring at about the same time in many economic activities, followed by similarly general recessions, contractions, and revivals which merge into the expansion phase of the next cycle; this sequence of changes is recurrent but not periodic; in duration business cycles vary from more than one year to ten or twelve years."
Note that

1. *Aggregate economic activity*: business cycles refers to fluctuations in aggregate economic activity, not a specific variable such as real GDP.
2. *Expansions and contractions*: business cycle are temporary deviations from economy's normal growth path. A cycle is measured from peak to peak or trough to trough
3. *Comovement*: expansions and contractions occur at about the same time in many economic activities across many economic variables
4. *Recurrent but not periodic*: not periodic i.e. does not occur at regular, predictable time intervals for predetermined period of time. recurrent i.e. standard pattern happens again and again
5. *persistence*: duration can vary greatly, but declines tend to be followed by more declines, growth tend to be followed by more growth

(Consumption function): The consumption function is

$$C = a + m(Y - T) = a + mY_d$$

Where

- $Y_d = Y - T$ is disposable income

(MPC): The marginal propensity to consume is

$$MPC = \frac{\triangle C}{\triangle Y}$$

In the above consumption function

$$MPC = \frac{\triangle C}{\triangle Y} = m$$

(MPC): The marginal propensity to save is

$$MPS = \frac{\triangle S}{\triangle Y} = 1 - MPC$$

In the above consumption function

$$MPS = \frac{\triangle S}{\triangle Y} = 1 - m$$

(Multiplier): the multiplier associated with an increase in a particular kind of **autonomous spending** is the short-run change in total output resulting from one-unit change in that type of spending.

$$multiplier = \frac{1}{MPS} = \frac{1}{1 - m}$$

Where a change in **autonomous spending** refers to change in spending not unrelated to change in GDP, examples include

- change in G
- change in I
- change in NX
- change in C **unrelated** to change Y (such as due to wealth or sentiment)

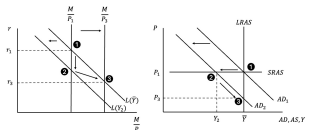
(Neutrality of money): Starting from $\bar{Y}$, an increase in M causes a proportional increase in P but no change ot real economic variables.

(Decrease in G, no monetary policy)
In the Short Run ((1) $\to$ (2))

$$G \downarrow \implies Y \downarrow \text{ with multiplier effects } \iff C \downarrow$$
$$\implies L(Y \downarrow) \downarrow \text{ i.e. money demand decreases}$$
$$\implies r \downarrow \text{ by money market eqm}$$
$$\implies I \uparrow \implies Y \uparrow$$

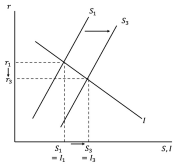
In the Long run ((2) $\to$ (3))

$$Y_2 < \bar{Y} \text{ i.e. excess supply}$$
$$\implies P \downarrow$$
$$\implies \frac{M}{P} \uparrow \text{ real money supply increases}$$
$$\implies r \downarrow$$
$$\implies I \uparrow$$
$$\implies Y \uparrow \text{ until } Y_3 = \bar{Y} \text{ by equilibrating mechanism in AD-AS}$$



This matches our conclusion from earlier

$$G \downarrow \implies S = (Y - C - G \downarrow) \uparrow \implies r \downarrow \implies S^d, I^d \uparrow \implies C \uparrow$$



Note the effect on C

- SR: $C \downarrow$ due to multiplier
- LR: $C \uparrow$ due to interest rate changes

(Decrease in G, with monetary policy)
If the Fed increases prevents a recession with expansionary monetary policy, then In the Short Run ((1) $\to$ (2)), **no change from above**

$$G \downarrow \implies Y \downarrow \text{ with multiplier effects } \iff C \downarrow$$
$$\implies L(Y \downarrow) \downarrow \text{ i.e. money demand decreases}$$
$$\implies r \downarrow \text{ by money market eqm}$$
$$\implies I \uparrow \implies Y \uparrow$$

From (2) $\to$ (3),

$$M \uparrow \implies \left(\frac{M \uparrow}{P}\right) \uparrow \implies r \downarrow \implies I \uparrow \implies Y \uparrow \text{ with multiplier}$$