

**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.

$$GDP = GNP - NFP$$

**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 government purchases of goods and services

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

**Government budget surplus** is defined as government receipts less outlays

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

**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 basket 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
- substitution 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.

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

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.

$$\text{real interest rate} = \text{nominal interest rate} - \text{inflation} = i - \pi$$

**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.

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

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

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

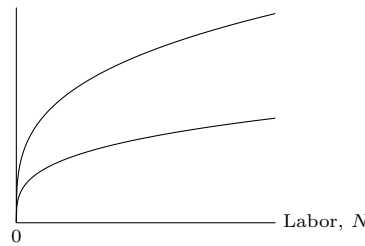
The  $MPK$  and  $MPN$

- 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  $N$

Output,  $Y$



**Fig - Decrease in  $A$ , holding  $K$  fixed**

Note that

$$A_2 < A_1$$

$$\Rightarrow Y_2 < Y_1$$

$$\Rightarrow MPN_2 < MPN_1$$

**Marginal revenue product of labor** is the benefit of employing an additional 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

$$MPN > w$$

$$\Leftrightarrow MPN > \frac{W}{P}$$

$$\Leftrightarrow P \times MPN > W$$

$$\Leftrightarrow MRPN > W$$

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 substitution 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 wealth,  $NS \downarrow$
- 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,  $\bar{N}$

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

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 didn't work and didn't look for work in the past 4 weeks
  - discouraged workers, people who become discouraged and move from  $U$  to  $NLF$

$$\text{labor force} = LF = E + U$$

$$\text{adult population} = LF + NLF$$

$$\text{participation rate} = \frac{LF}{LF + NLF}$$

$$\text{employment ratio} = \frac{E}{LF + NLF}$$

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
  - relocation 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 between 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

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

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

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

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

$$PVLC = PVLR$$

$$c + \frac{c^f}{1+r} = (a+y) + \frac{y^f}{1+r}$$

$$c^f = (a+y-c)(1+r) + y^f$$

$$= \underbrace{(a+y)(1+r)}_{\text{intercept}} + \underbrace{y^f - (1+r)c}_{\text{slope}}$$

We can classify individuals as lending or borrowing

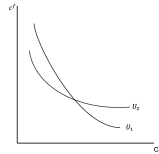
- lending, if  $c < a + y \Leftrightarrow a + y - c > 0$
- borrowing if  $c > a + y \Leftrightarrow a + y - c < 0$

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

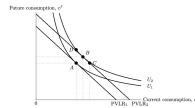
Income effect occurs when

- $a \uparrow$
- $y \uparrow$
- $y^f \uparrow$

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

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

$$T \downarrow \implies c \uparrow, s \uparrow$$

- Assuming REP holds and **there are borrowing constraints**

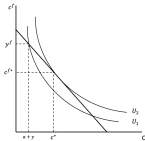
- Borrowers facing constraints increase consumption,

$$T \downarrow \implies c \uparrow, s \downarrow$$

- 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

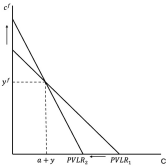


If

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

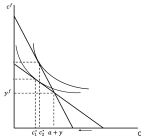
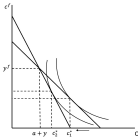
**Effect of an increase in interest rate on budget constraint**

- $PVLR \downarrow$ : 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 unequiv- Lenders consump-  
ocally consume less. tion uncertain

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



**Summary of factors affecting consumption.**

Change	$\Delta C$	$\Delta S$
$y \uparrow$	$c \uparrow$	$s \uparrow$
$a \uparrow$	$c \uparrow$	$s \downarrow$
$y^f \uparrow$	$c \uparrow$	$s \downarrow$
$r \uparrow$	$c \downarrow$	$s \uparrow$

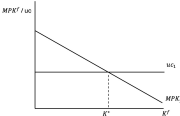
A firm's **desired capital stock** is the profit-maximizing amount of capital for the firm.

The profit-maximizing level of capital is achieved when the expected future marginal benefit, *expected future marginal 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  $\tau$  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	$\Delta C$	$\Delta S$
$A \downarrow$	$\downarrow$	$\downarrow$
$G \uparrow$	$\downarrow$ a little	$\downarrow$
Wealth $\uparrow$	$\uparrow$	$\downarrow$
$T \downarrow$	$\uparrow$ followed by $\downarrow$ a little	$\downarrow$
$\tau \downarrow$	$\downarrow$ a little	$\uparrow$ a little