

R10 Aggregate Output, Prices and Economic Growth

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1. Introduction

The previous few readings focused on microeconomics, which is the study of individual economic units such as individual households, firms, or markets. In this reading, we will start with the basics of macroeconomics, which is a study of aggregate behavior of households, firms and markets.

This reading covers:

- What is gross domestic product, and what are the related measures of domestic output and income.
- Short-run and long-run aggregate demand and supply curves.
- What causes shifts and movements along these curves.
- Factors that affect the equilibrium price and output.
- Sources and measures of economic growth.

2. Aggregate Output and Income

Aggregate output of an economy: It is the value of all goods and services produced during a period.

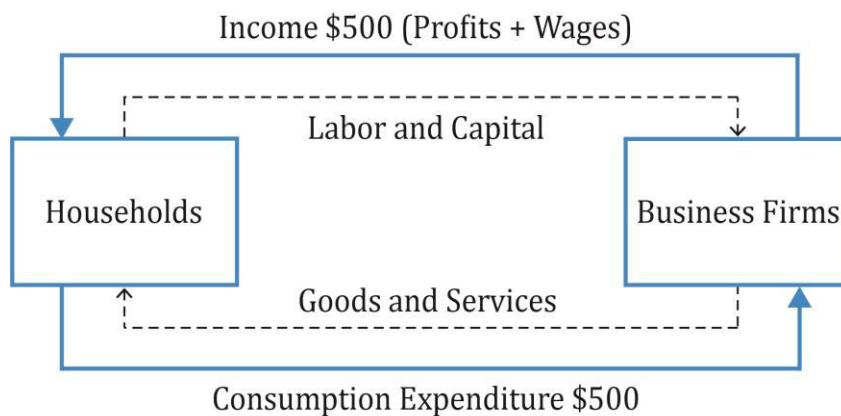
Aggregate income of an economy: It is the value of all the payments earned by the suppliers of the factors used in the production of goods and services. Payments are classified into four categories:

- Compensation of employees – for labor.
- Rent – for use of property.
- Interest - for lending funds.
- Profits – return earned for use of capital.

Operating surplus of Company = Rent + interest + profit

Operating surplus represents the return on all capital used by the business.

Aggregate expenditure: The total amount spent on goods and services produced in an economy during a given period. $\text{Aggregate Expenditure} = \text{Aggregate Output} = \text{Aggregate Income}$.



Let us take a simple economy, comprising households and business firms. Households provide labor and capital to the firms. Businesses, in turn, make payments to households to compensate them for labor. Households earn an income of \$500 towards labor and profits earned on the capital invested. This income can also be seen as the households' expenditure on firms. This shows the total output produced by the firms must equal aggregate income.

2.1. Gross Domestic Product

What is GDP?

There are two ways of defining GDP:

1. The market value of all final goods and services produced within an economy in a given period of time, or
2. The aggregate income earned by all households, all companies, and the government in a given period of time.

To ensure consistency across countries and across time, the following criteria are used:

- Only count goods and services produced during the measurement period.
- Count goods and services whose value can be determined by being sold in the market (goods and services included at imputed prices). Items that are excluded:
 - The value of labor for activities that are not used in production. Ex: commuting to work.
 - By-products that have no explicit value. Ex: air/water pollution
- Use market value of final goods and services. Final goods are goods that cannot be resold. Intermediate goods are goods that are resold to produce another good. The value of intermediate goods is included in the value of final goods. These are not included in GDP to avoid double counting. For example, a car is a final good, whereas several auto parts used in the car such as car tires, dashboard, steering wheel, and wipers are intermediate goods. The value of the car is included when calculating GDP and not that of the parts, or the steel used to make the car.

Calculating Gross Domestic Product

GDP can be calculated using the income approach or the expenditure approach.

The income approach computes GDP as the total income earned by households, businesses, and the government in a given period.

The expenditure approach computes GDP as the total amount spent on goods and services. Two methods are used to calculate the total amount spent:

- Sum-of-value-added method: Calculate GDP as the sum of the value added at each stage of production and distribution.
- Value-of-final-output method: Compute GDP as the sum of the value of all final goods and services produced during the period.

Let's take a simple example discussed in the curriculum.

- A farmer sells wheat to a miller for €0.15.
- The miller sells flour (after grinding wheat) to a baker for €0.46.
- The baker makes bread out of flour and sells to a retailer for €0.78.
- The retailer sells bread to the customers for €1.00.

The data associated with the example is presented in the table below:

Value of final products equals income created (in €)		
	Receipts at each stage	Value added
Receipts of farmer from miller	0.15	0.15
Receipts of miller from baker	0.46	0.31 (= 0.46 - 0.15)
Receipts of baker from retailer	0.78	0.32 (= 0.78 - 0.46)
Receipts of retailer from final buyer	1.00	0.22 (= 1.00 - 0.78)
Total	1.00	1.00

There are two ways to calculate the value of output:

- Value of the final product, bread, which is €1.00.
- Sum of value added at each stage, which is also equal to, €1.00.

Nominal and Real GDP

Nominal GDP measures the value of goods and services at their current prices.

Real GDP measures current-year output using prices from a base year. This eliminates the effect of inflation.

Example:

Consider a country that only produces cotton. In 2010, 1 million tons were produced at Rs100 per ton. In 2012, 1 million tons were produced at Rs120 per ton. What is the nominal and real GDP in 2012? Assume that 2010 is the base year.

Solution:

$$\text{Nominal GDP} = 120 * 1 \text{ million} = 120 \text{ million}$$

$$\text{Real GDP} = 1 \text{ million} * 100 = 100 \text{ million}$$

Inference:

As you can see, the output has not gone up. The nominal GDP is higher by 20% because of the inflation effect. To assess the exact change in output, it is judicious to use real GDP as it eliminates the price effect. Real GDP reflects the actual quantity of output available for consumption and investment.

GDP Deflator: used to measure inflation across all sectors of an economy such as consumer, business, government, exports, and imports. It is reported as a price index number that can be used to convert nominal GDP into real GDP by removing the effects of changes in prices.

$$\text{GDP Deflator} = \frac{\text{Nominal GDP}}{\text{Real GDP}} * 100$$

It can also be written as:

$$\text{GDP Deflator} = \frac{\text{Value of current year output at current year prices}}{\text{Value of current year output at base year prices}} * 100$$

Going back to the cotton example, using this formula, the GDP deflator for 2010 = $\frac{100}{100} * 100 = 100$. For 2012, GDP deflator for 2012 = $\frac{120}{100} * 100 = 120$. The GDP deflator indicates that the price has increased by 20% over the two years.

Example

Calculate the implicit GDP price deflator from 2009 to 2012 and the inflation rate for 2012 given the following data:

	2009	2010	2011	2012
GDP at market prices	100	110	118	125
Real GDP	90	92	94	95
Implicit GDP price deflator	$\frac{100}{90} * 100 = 111.11$	$\frac{110}{92} * 100 = 119.56$	$\frac{118}{94} * 100 = 125.53$	$\frac{125}{95} * 100 = 131.58$

Solution:

	2009	2010	2011	2012
Implicit GDP price deflator	$\frac{100}{90} * 100 = 111.11$	$\frac{110}{92} * 100 = 119.56$	$\frac{118}{94} * 100 = 125.53$	$\frac{125}{95} * 100 = 131.58$

$$\text{Inflation rate for 2012} = \frac{131.58}{125.53} - 1 = 0.048 = 4.8\%.$$

2.2. The Components of GDP

The following are the major components of GDP based on the expenditure approach:

- Consumer spending on final goods and services.
- Gross private domestic investment.
- Government spending on final goods and services for both current consumption and investment in capital goods.
- Net exports (exports – imports).

$$\text{GDP based on expenditure approach} = C + I + G + (X - M) = (C + G^C) + (I + G^I) + (X - M)$$

where:

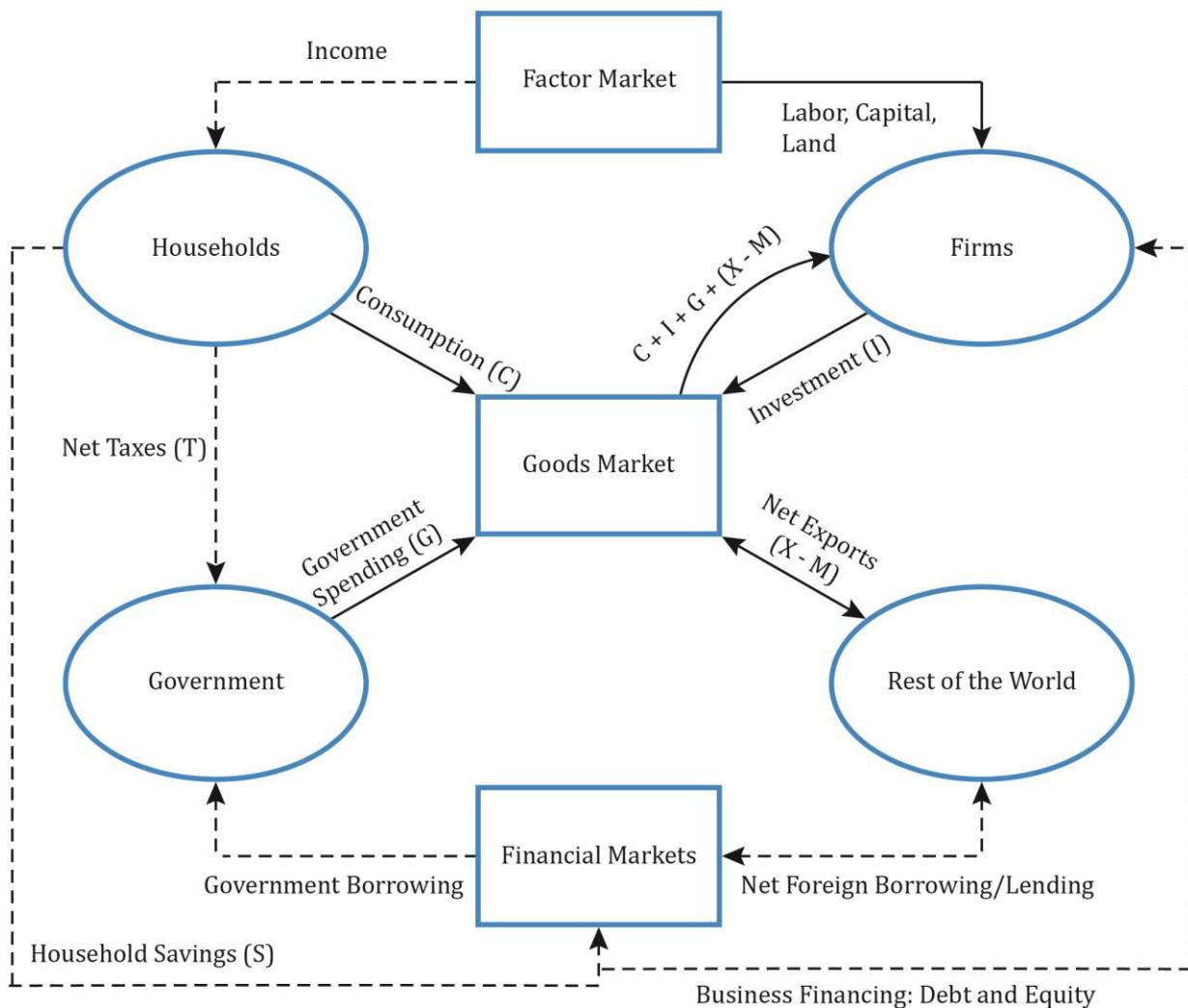
C = consumer spending on goods and services

I = gross private domestic investment

G = government spending on final goods and services for both current consumption and investment in capital goods = $G^C + G^I$

$$X - M = \text{net exports} = \text{exports} - \text{imports}$$

The following exhibit is reproduced from the curriculum (Exhibit 6):



Notation: flow of factor of production – solid lines.

Dashed lines – financial flows, including income and taxes.

Instructor's Note: The section on sectors of an economy in the curriculum is exhaustive. The important terms for each of the sectors are summarized below:

Sectors of an Economy	
The Household and Business Sectors (private sector)	
Consumption expenditure: C	Part of income that households pay to firms for consuming goods and services.
Saving: S	Part of income of households is saved. National savings equals savings by households, businesses, and government.

Investment: I	Refers to the purchase of new capital which includes plant, property, equipment, buildings and inventory. It does not include labor. It is financed by household savings and capital flows from the rest of the world.
Flow between the factor market	Labor, capital and land flow from households to firms. Income flows from firms to households as compensation for labor, interest, rent and profits. Income is spent in three ways: Consumption (C) Savings (S) part of which later goes to financial markets. Taxes (T)
Flow between financial market	Part of the savings from households flows to firms that need to raise capital. Firms raise money to invest in inventory and PPE (plants, property and equipment): (I)
Flow between goods market	Consumption expenditure flows to the business sector. Investment (I) from firms flows through goods back to firms.
The Government Sector	
Flow between households and businesses	Taxes (T): Government collects taxes from households and businesses. This is the government's revenue. Transfer payments: The government makes transfer payments to the unemployed, for health care, etc. This is not included in government expenditure (G) because this is a monetary transfer and nothing is received in return. Net taxes = T = taxes – transfer payments
Flow between goods market	Expenditure (G): Government purchases goods and services from businesses to build roads, schools, and other goods; spends on military, fire protection, security, and other services. This is denoted by G.
Fiscal deficit	If $G > T$, then the government has a fiscal deficit and must borrow from financial markets to fund its spending.
How government purchases (G) differs from government transfer payments?	Transfer payments are just a flow of money for social welfare. Whereas, G (expenditure) involves actual spending on goods or services.
The External Sector	
Exports: X	Value of goods and services sold to foreigners.
Imports: M	Portion of domestic consumption (C), government expenditure (G), and investment (I) spent on purchasing goods and services from the rest of the world.

Net exports	X-M
Trade deficit	If domestic saving is less than domestic investment plus government fiscal balance, then there is a deficit. It also means that the economy is spending more on imports than foreign countries are spending on domestic goods and services.

2.3. GDP, National Income, Personal Income, and Personal Disposable Income

There are two approaches to calculate GDP: expenditure approach and the income approach. Ideally, both the approaches should give the same estimate, but they differ because different data sources are used for each method. The numerical difference between the GDP using the expenditure approach and GDP using the income approach is accounted for as a statistical discrepancy.

$$\text{GDP based on expenditure approach} = C + I + G + (X - M) = (C + GC) + (I + GI) + (X - M)$$

$$\text{GDP based on Income Approach} = \text{GDP} = \text{Gross domestic income (GDI)} = \text{Net domestic income} + \text{Consumption of fixed capital (CFC)} + \text{Statistical discrepancy}$$

Gross domestic income is the income received by all factors of production which are used to produce final output:

Gross domestic income = Compensation of employees + Gross operating surplus + Gross mixed income + Taxes less subsidies on production + Taxes less subsidies on products and imports

where:

- Compensation of employees = wages and salaries including direct compensation in cash or in kind + employers' social contributions.
- Gross operating surplus represents corporate profits of businesses. Businesses includes private corporations, non-profit corporations, and government corporations.
- Gross mixed income = farm income + non-farm income (excluding rent) + rental income.

Consumption of fixed capital (CFC) is a measure of depreciation of the capital stock. It is the decrease in capital stock because of wear and tear during the production of goods and services. This is also the amount to be spent on replacing the depreciated stock and adding new capital stock. In other words, gross surplus is the sum of profit plus CFC.

Personal income measures the consumers' ability to make purchases.

Personal income = Compensation of employees + Net mixed income from unincorporated businesses + Net property income

HDI measures the amount of after-tax income that households have to spend on goods and

services or to save.

Household disposable income (HDI) = Household primary income - Net current transfers paid.

Household net saving = HDI - Household final consumption expenditures + Net change in pension entitlements.

Example

What is the GDP and Net domestic income given the following data for 2019?

Account Name	Amount
Consumption	300
Statistical discrepancy	10
CFC	30
Government spending on final goods and services for both current consumption and investment in capital goods i.e. $G^C + G^I = G$	76
Imports	34
Gross private domestic investment	80
Exports	30

Solution:

GDP for 2019 based on expenditure approach = $(C + G^C) + (I + G^I) + (X - M) = C + G + I + (X - M) = 300 + 76 + 80 + (30 - 34) = 452$

GDP based on Income Approach = GDP = Gross domestic income (GDI) = Net domestic income + Consumption of fixed capital (CFC) + Statistical discrepancy

Net domestic income for 2019 = GDP - CFC - Statistical discrepancy = $452 - 30 - 10 = 412$

2.4 Relationship among Saving, Investment, the Fiscal Balance and the Trade Balance

We saw in the previous section that aggregate expenditure = $C + I + G + (X - M)$

Aggregate income is the sum of consumption, saving, and taxes. Think of it as how your income gets spent. Aggregate Income = $C + S + T$

Since aggregate expenditure must equal aggregate income, we have the following relationship:

$$C + S + T = C + I + G + (X - M)$$

$$S + T = I + G + (X - M)$$

$$S = I + (G - T) + (X - M)$$

where:

$G - T$ = fiscal deficit, if Government expenditure (G) > Taxes collected (T).

$X - M$ is the trade deficit.

So, the above equation can also be rewritten as $(G - T) = (S - I) - (X - M)$

Or, $(S - I) = (G - T) + (X - M)$

Consumption spending

- It is primarily disposable income which is $GDP(Y) - \text{business savings} - \text{taxes}$. So, it can be expressed as a function of disposable income.
- Consumption spending = $C(Y - S_B - T)$.

Since S_B is insignificant, consumption spending = $C(Y - T)$

- Marginal propensity to consume (MPC): It is the portion of the additional unit of disposable income that an individual spends.
- Marginal propensity to save (MPS): It is the portion of the disposable income that is saved.
- MPS = 1 - MPC. If the marginal propensity to consume is 70% or 0.7, it means that for every \$1 increase in disposable income, 70¢ is spent. MPS in this case is 30%.
- Consumption increases with an increase in real income, decrease in taxes, or increase in disposable income.

Example

Given that the aggregate expenditure must equal aggregate output, how can we express a government's fiscal deficit in terms of private saving, investment, and net exports?

Solution:

$$(G - T) = (S - I) - (X - M)$$

Example

Because of a decline in housing costs, savings are up. Assume investment and the fiscal deficit are unchanged. What is the impact on net exports and capital outflows?

Solution:

$$S = I + (G - T) + (X - M)$$

It is given that I and $(G-T)$ are unchanged. If savings are up, then net exports must also increase.

When net exports increase, then it also leads to the economy investing in foreign assets or lending money to foreigners. So, when savings go up, capital outflows also increase.

3. Aggregate Demand and Aggregate Supply

Aggregate demand is the quantity of goods and services demanded by consumers (includes households, businesses, government, etc.) at any given price level.

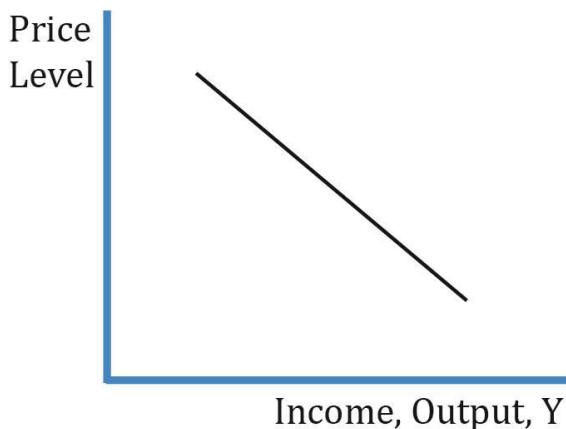
Aggregate supply is the amount of goods and services firms will produce in an economy (real GDP) at any given price level.

3.1. Aggregate Demand

The aggregate demand curve (AD) represents the combinations of aggregate income and the price level at which the following two conditions must be satisfied:

- Aggregate expenditure equals aggregate income.
- There must be equilibrium in the money market i.e., the available real money supply is willingly held by households and businesses.

The AD curve looks like an ordinary demand curve: quantity demanded increases as price levels decline.



The graph plots price level on the y-axis and aggregate income or real output on the x-axis.

The demand curve in microeconomics and the AD curve here are both negatively sloped. But there are some major differences as listed below:

- The demand curve in microeconomics maps the price of one good to the quantity demanded of that good. Ex: oranges. It is the demand curve for one market. Whereas, the AD curve in macroeconomics represents the average price level in an economy (of all the goods and services demanded) using an indicator such as GDP deflator.
- In microeconomics, we also assume that all other variables such as income and the price of related goods remain constant; and that only the price and quantity demanded of the good change. Whereas in macroeconomics, as we move along the AD curve, income also changes along with the output.

The downward slope of the aggregate demand curve arises as a result of three effects:

- **Wealth effect:** It is based on the concept of purchasing power of nominal wealth. Nominal wealth does not change, real wealth however fluctuates with the prices of goods and services. An increase in the price level decreases the quantity of goods and services that can be purchased with the fixed quantity of nominal wealth i.e., consumers become less wealthy and will demand fewer goods and services. The opposite is true when price levels decrease.
- **Interest rate effect:** An increase in price level increases the demand for money – we

will need more money to buy the same amount of goods and services. Since the supply of money is fixed, the price of money i.e., interest rate increases. Higher interest rates make borrowing expensive. Businesses make fewer investments when their borrowing costs are high. Consumers also purchase fewer big-ticket items such as automobiles or residential real estate. Thus, the demand for goods and services decreases. The opposite is true when price levels decrease.

- **Real exchange rate effect:** An increase in price levels increases the real exchange rate (i.e., the domestic currency appreciates). This makes domestic goods more expensive for foreigners, reducing exports. It also makes foreign goods less expensive for the country's residents, increasing imports. The overall impact is a decrease in demand of domestic goods and services. The opposite is true when price levels decrease.

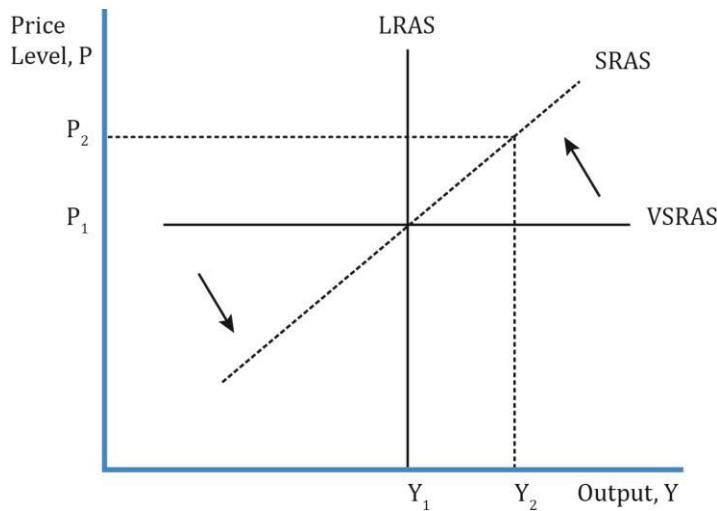
Why does real exchange rate increase when price levels increase?

When price levels increase, interest rates increase (as discussed above). Foreign investors are attracted by this higher interest rate and they make investments in domestic currency securities. This increases demand for the domestic currency in the foreign exchange market causes it to appreciate. Thus, the real exchange rate increases.

3.2. Aggregate Supply

Aggregate supply curve shows the relationship between domestic output and price level.

The graph below shows the long run, short run, and very short run AS curves (LRAS, SRAS, and VSRAS):



Interpretation of the graph:

- Plots real GDP on the x-axis (remember we had quantity in the microeconomics supply curve).
- Plots price level on the y-axis.

- Very short run: AS curve is almost flat. This is because companies increase or decrease output without changing prices.
- Short run: In the short run, firms consider the price level to decide how much to produce. AS curve is upward sloping – a decrease in the price level reduces the quantity of goods and services supplied. Some costs such as labor and capital are sticky (fixed) in the short run. So, when prices increase, businesses can increase output as it is more attractive (given the high selling prices).
- Long run: In the long run, the AS curve is vertical at a given level of output. We refer to this level of output as ‘potential GDP’ or ‘full-employment GDP’. Aggregate price has no effect on aggregate output because wages, prices and expectations adjust; firms do not decide how much to produce based on the price level. In the long run if prices are up, then costs such as wages also go up and in real terms, nothing has changed.
- In the very long run, there is a shift in the LRAS when costs of production change: labor, capital, natural resources, technological advance, etc. This is discussed in section 4.

There is a distinction in the terms short run and long run as used in micro- and macroeconomics.

- In microeconomics: in the short run, labor is variable, but capital is fixed.
- In macroeconomics: in the short run, wages or some costs are sticky i.e. they do not change. In the long run, all costs change.

Example

What is the relationship between wages and the slope of the SRAS curve?

Solution:

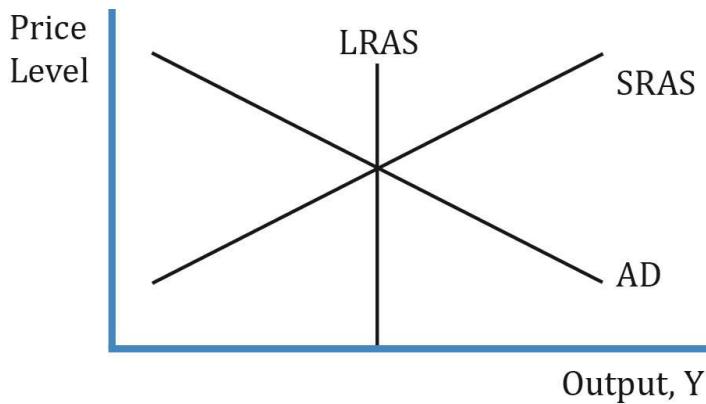
Consider two scenarios: when wages are sticky, and when wages are not sticky.

Wages are sticky: when prices increase, output increases substantially. The slope of SRAS is flatter.

Wages are not sticky: when prices increase, the output does not increase much. The slope of SRAS is steeper.

3.3. Shifts in the Aggregate Demand and Aggregate Supply Curves

The graph below shows LRAS, SRAS and AD curves. This section and the next are based on the interaction of these three curves.



Interpretation of the graph:

- The output level at the intersection of the three curves is called the long run equilibrium level of output or natural level of output.
- The output level is closely related to the level of employment. At the natural level of output, the economy is at the natural rate of unemployment.
- Full employment does not mean 100% employment. It means that there is a natural level of unemployment, which includes people who are in between jobs. The percentage of people who are in between jobs is equal to the percentage of vacancies.

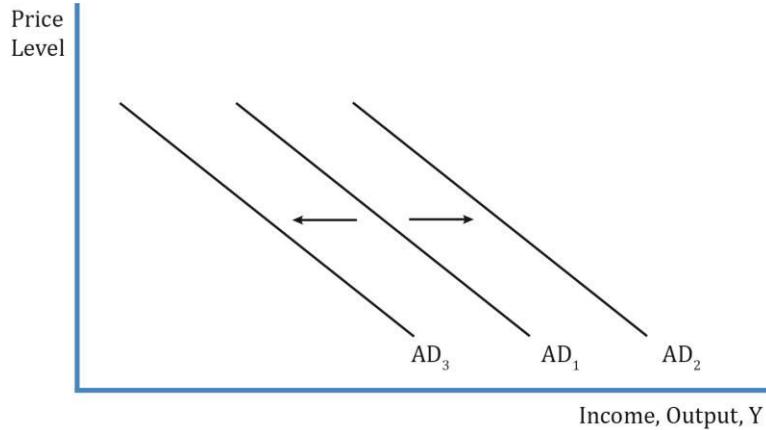
The objective of this section is to understand the interaction of the curves discussed above, what causes a shift in these curves, and to answer these important macroeconomic questions:

- What causes an economy to expand and contract?
- What causes changes in price level and unemployment?
- What determines an economy's rate of unsustainable growth?

Why are they important? Because GDP growth impacts corporate profits which, in turn, impacts stock prices.

Shifts in Aggregate Demand

In this section, we look at the factors that cause an aggregate demand curve to shift.



Shift in the Aggregate Demand Curve		
To determine shift in AD, use the equation $C + I + G + (X - M)$		
An Increase in the following factors	Shifts in the AD Curve	Reason
Stock prices	Right	Higher consumption. This is also called the wealth effect . Increase in stock prices → increase in household wealth → need to save decreases as future goals are met → more income spent on consumption → shift in the demand curve.
Housing prices	Right	Higher consumption. Wealth effect.
Consumer confidence	Right	Consumers confident about future & job security → spend more of their disposable income.
Business confidence	Right	Companies optimistic about future growth prospects → increase in investments.
Capacity utilization	Right	Increase in investment spending if companies are operating at near or full capacity.
Government spending	Right	Increase in government spending (fiscal policy).
Taxes	Left	Higher taxes → lower disposable income → lower consumption. Lower investment spending by businesses.
Bank reserves	Right	More money supply. Interest rates are low. Investment is higher. Higher income and higher expenditure. Consumers hold real money balances.
Exchange rate	Left	Domestic currency is stronger. Lower exports. Higher imports. Net exports are lower.
Global growth	Right	Faster economic growth in foreign markets → foreign consumers buy domestic products → exports are higher. Net exports are higher.

Note: Government spending and taxes are part of fiscal policy. Bank reserves and the exchange rate are part of monetary policy. These are covered in later readings.

A few other points related to AD curve:

- When the aggregate demand curve shifts to the right, in the very short run, output

goes up while the price level stays the same.

- In the long run, as wages and other costs adjust, the output is back to its initial equilibrium level.

Shifts in Aggregate Supply

In the AS curve, the price level is on the y-axis and output on the x-axis. The LRAS is a vertical line while the SRAS is a positively sloped curve. The factors in bold in the first column affect both the SRAS and the LRAS curve to shift, while the remaining factors affect only the SRAS curve.

Shift in the Aggregate Supply Curve			
An Increase in the following factors	Shifts SRAS	Shifts LRAS	Reason
Supply of labor	Right	Right	Increases resource base. Labor supply depends on the labor participation rate, growth of population, etc.
Supply of natural resources	Right	Right	Increases resource base.
Supply of human capital	Right	Right	Increases resource base. Improvement in quality of labor.
Supply of physical capital	Right	Right	More efficiency with better equipment → more output.
Productivity and technology	Right	Right	Higher productivity → higher efficiency and amount of output produced by workers in a given time. Decreases labor cost; higher profitability.
Nominal wages	Left	No impact	Largest component of a company's costs are wages. Higher wages → higher labor cost.
Input prices	Left	No impact	Increases cost of production.
Expectation of future prices	Right	No impact	Anticipating higher future prices → higher profitability.
Business taxes	Left	No impact	Increases cost of production.
Subsidy	Right	No impact	Lowers cost of production.
Exchange rate	Right	No impact	Lowers cost of production. Many countries import raw materials. Ex: Japan. If the domestic currency is stronger, then imports are cheaper.

The position of the LRAS curve is determined by the potential output of the economy.

Potential GDP measures the productive capacity of the economy and is the level of real GDP that can be produced at full employment.

3.4. Equilibrium GDP and Prices

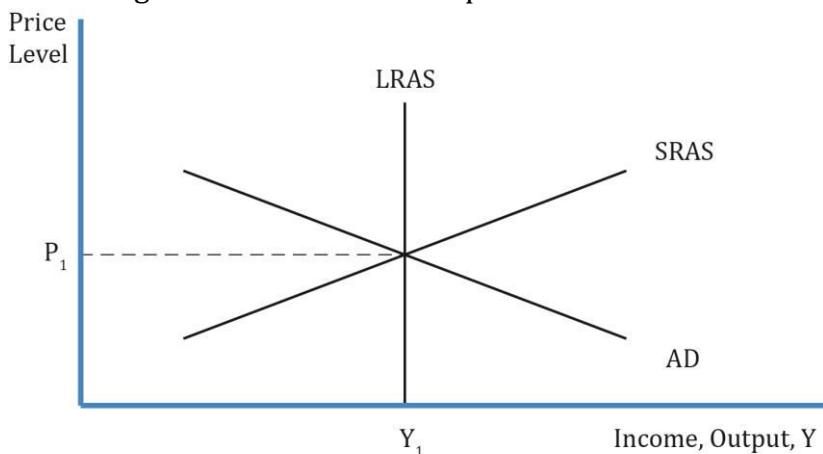
Short-run macroeconomic equilibrium may occur at a level above or below full employment; there are four possible types of macroeconomic equilibrium:

1. Long-run full employment.
2. Short-run full employment.
3. Short-run inflation gap.
4. Short-run stagflation.

The price level and output at the point where AD and SRAS curves intersect is called the short-run macroeconomic equilibrium. At this point, the aggregate quantity demanded = aggregate quantity supplied. Let us denote the real GDP at equilibrium as Y_1 . If we are to the left of this point, then the level of unemployment is higher than the natural level of employment.

Long-run macroeconomic equilibrium:

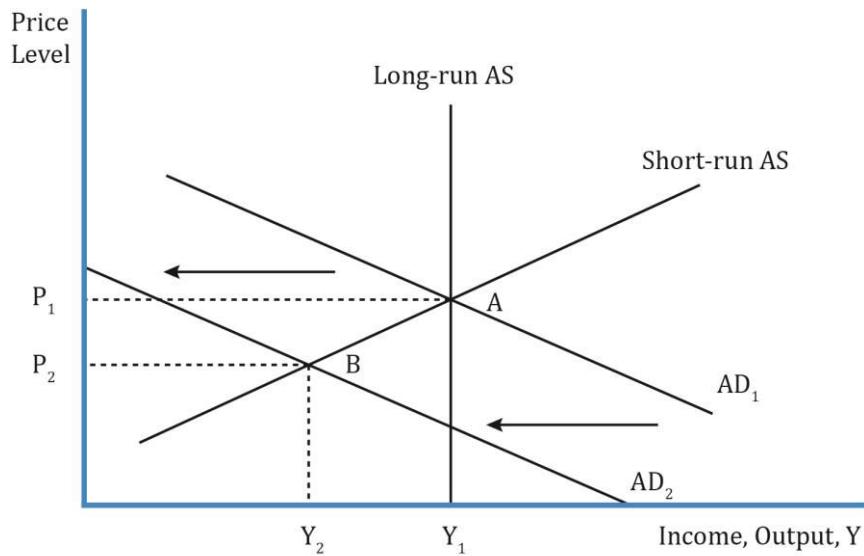
The graph below shows a long-run macroeconomic equilibrium.



- In the long run, the intersection of AD and SRAS curve occurs at a point on the LRAS curve; this point is the equilibrium point.
- At equilibrium, labor, and capital are fully employed. Unemployment is at its natural rate.
- In the long run, equilibrium GDP = potential GDP.

Recessionary gap:

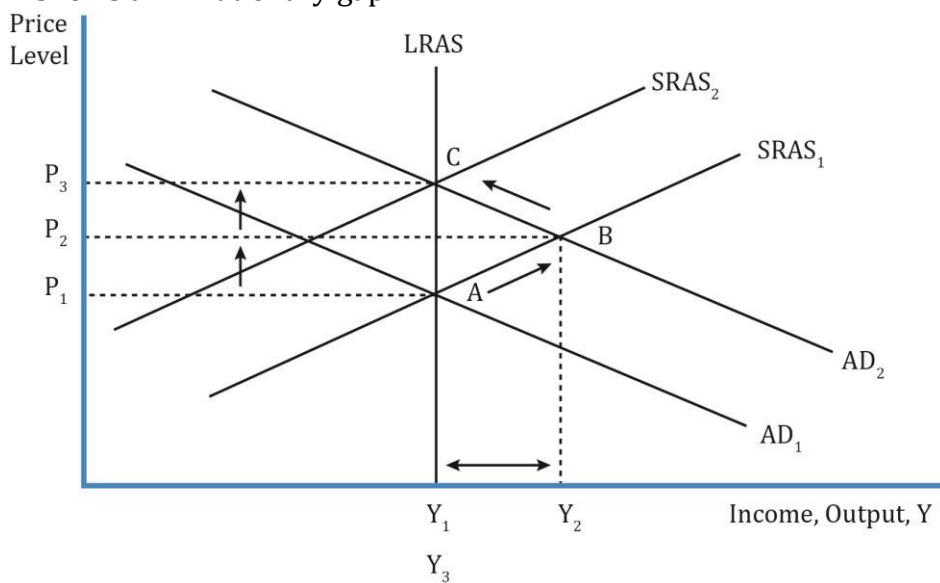
The graph below shows a recessionary gap.



- Assume for some reason, there is a leftward shift in the AD curve. It moves from AD_1 to AD_2 .
- This results in lower GDP and lower price levels.
- The corresponding short-run equilibrium real GDP has moved from Y_1 to Y_2 . The price level has come down from P_1 to P_2 . As demand has gone down, companies reduce workforce, which leads to unemployment going up. We are now below the natural level of unemployment. This difference ($Y_2 - Y_1$) is called the recessionary gap.
- Equilibrium GDP is below the potential GDP.
- The effects of a decline in AD are decline in corporate profits, commodity prices, interest rates, and demand for credit.

Inflationary gap:

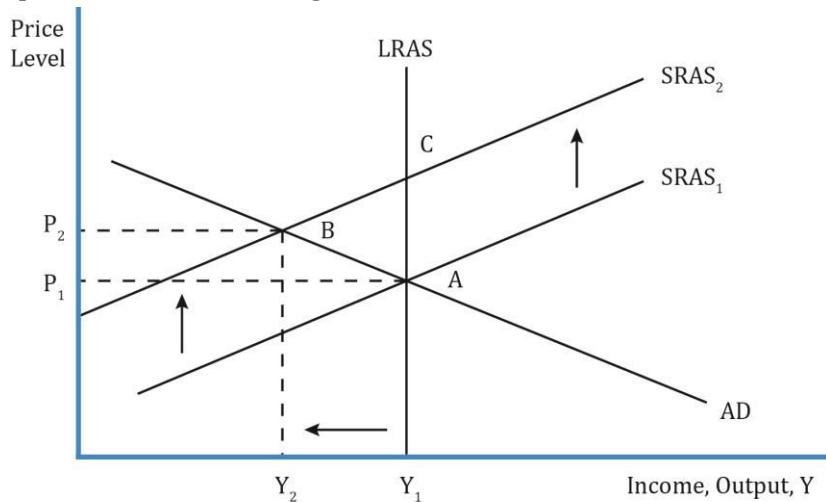
The graph below shows an inflationary gap.



- This happens if the aggregate demand curve shifts to the right.
- If the AD curve moves from AD_1 to AD_2 , then output increases from Y_1 to Y_2 . The price level moves from P_1 to P_2 . The short-run equilibrium moves to the left. This gap between Y_1 and Y_2 is called the inflationary gap because it drives inflation. The economy is over-utilizing its resources – workers are putting in more hours.
- At the new short-run equilibrium, GDP is above the potential GDP. As there is an upward pressure on prices, the company must pay higher wages and input prices to increase production.
- The economy cannot remain at Y_2 for long because people are working extra shifts and will demand higher wages. Eventual increase in prices will shift the SRAS to the left and the economy will return to potential GDP.
- The effects of an increase in AD includes increase in corporate profits, commodity prices, interest rates, and inflationary pressures.

Stagflation:

The graph below shows a stagflation scenario.



- SRAS curve shifts to the left.
- Output is down from Y_1 to Y_2 . Unemployment level is below the natural level of unemployment. Price levels go up. In short, there is high unemployment and increased inflation.
- Over time, reduced output will cause wages and input prices to decrease and shift SRAS to the right.

Example

The table below shows the effect of changes in AS and AD on real GDP. Fill the last two columns in the table below for different combinations of AD and AS in the first two columns.

Effect of changes in AD and/or AS			
Change in AS	Change in AD	Effect on Real GDP	Effect on Aggregate Price Level

	Increase		
	Decrease		
Increase			
Decrease			
Increase	Increase		
Decrease	Decrease		
Increase	Decrease		
Decrease	Increase		

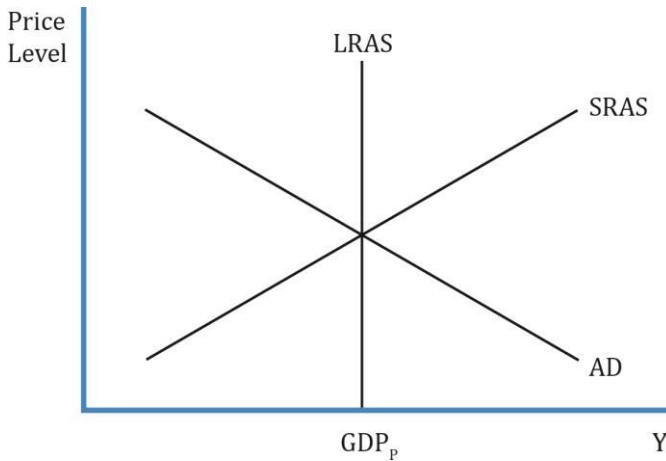
Solution:

Change in AS	Change in AD	Effect on Real GDP	Effect on Aggregate Price Level
	Increase	Increase. Lowers unemployment.	Increase
	Decrease	Decrease. Increases unemployment.	Decrease
Increase		Increase. Lowers unemployment.	Decrease
Decrease		Decrease. Increases unemployment.	Increase
Increase	Increase	Increase	Indeterminate
Decrease	Decrease	Decrease	Indeterminate
Increase	Decrease	Indeterminate	Decrease
Decrease	Increase	Indeterminate	Increase

4. Economic Growth and Sustainability

- Economic growth is measured as the annual percentage change in real GDP or the annual change in real per capita GDP. Growth in real GDP measures how the quantity of goods and services produced has increased from one year to the next.
- Per capita GDP is $\frac{\text{overall GDP}}{\text{size of the population}}$. It is a good measure as it tells us whether the standard of living is improving or not. For instance, if the GDP grew by 3% in a year and the population also grew by 3%, then there is no improvement in the standard of living. But if GDP grows at a higher rate than the population, then the per capita GDP would increase, and so would the potential standard of living.
- **Sustainable rate** of economic growth is the rate of increase in the economy's productive capacity or potential GDP. Any growth should be sustainable over the long term. A sudden, rapid increase in GDP is difficult to sustain as it leads to inflation, environmental damage, etc.

What is the difference between saying that there is a 4% change in real GDP and saying that there is a 4% change in potential GDP? As an investor, what will excite you more?



This is an economy in long-run equilibrium as the intersection of aggregate demand (AD) and short-run aggregate supply (SRAS) lies on the long-run aggregate supply curve (LRAS). Point GDP_P on the x-axis represents the potential GDP or productive capacity. The LRAS is shifting to the right, and the overall productive capacity of the economy is going up.

In contrast, if the real GDP increases by 4%, then it means the AD has increased, and the AD curve shifts up to the right. The corresponding GDP now is GDP_{real} . The equilibrium point has gone up in the short term and it is likely it will come back to a point on the LRAS. As an investor, we will be happy if the LRAS moves to the right as it means an increase in productive capacity.

4.1. The Production Function and Potential GDP

The **Solow growth model** is the starting point for analyzing the drivers of long-term growth in any economy. With this model, one can analyze why the growth in one country differs from another. This model is relevant in determining the factors that cause the LRAS curve to shift permanently to the right (increase in productive capacity of an economy).

According to the neo-classical model (also called the Solow growth model), productive capacity (potential GDP) increases for the following reasons:

1. Accumulation of factors of production such as capital, labor, and raw materials.
2. Discovery of new technologies that give production efficiency.

The Solow model builds on the Cobb-Douglas production function, which we have seen earlier in microeconomics, and adds capital accumulation to it. It is based on the assumption that capital accumulation in the long run fuels economic growth. The Solow model is based on a production function such as: $Y = A * F(L, K)$ which means the output is a function of labor and capital, and total factor productivity.

The Solow model uses four variables:

- Y is the level of aggregate output in the economy.
- A represents total factor productivity and is a measure of efficiency.
- L is the quantity of labor or the number of workers in the economy.

- K is the capital stock.

Recall that the production function is based on two assumptions:

- Constant returns to scale for two variables (capital and labor): If capital and labor inputs are increased by x percentage, then output also increases by x percentage. So, if all inputs are doubled, then the output doubles as well.
- Diminishing marginal productivity: At some point, the output from each additional input will decline. Consider a simple economy whose output is primarily agricultural products, and assume traditional methods, such as bullock carts, are used for farming.
 - If bullock carts are replaced with tractors, then the increase in capital causes output to increase rapidly.
 - With more capital per farmer, the economy produces more output per farmer.
 - But at some point, each additional unit of capital increases the output per farmer by less than the previous unit of capital; the increase in output is only marginal. This is diminishing marginal productivity.

Diminishing marginal productivity has two major implications on potential GDP:

1. Long-term sustainable growth cannot rely solely on capital deepening investment. Capital deepening is increasing the amount of capital per worker (labor). We just saw in the farming example, that increasing capital stock relative to labor will lead to diminishing returns. So, it is not sustainable to grow an economy by adding more and more capital in the long run.
2. But, adding more capital in developing countries leads to a substantially higher productivity (a higher rate of output) relative to developed countries. It implies that the growth rate of developing countries must exceed that of developed countries. Ex: think of investing USD 1 million on new farming techniques in India and the US in 2000. The spurt in output in India must have been much higher than that in the US. This also means that there should be a convergence of incomes between developed and developing countries over time.

Growth Accounting Equation

The following equation is the model developed by Solow to show the relationship between growth in potential output and growth in technology, capital, and labor.

$\text{Growth in potential GDP} = \text{growth in technology} + W_L(\text{growth in labor}) + W_C(\text{growth in capital})$

W_L and W_C are the relative share of labor and capital in the national income

$\text{Growth in per capita potential GDP} = \text{growth in technology} + W_C (\text{growth in } \frac{K}{L} \text{ ratio})$

Example: In a given economy, the growth in potential GDP is given by:

$2.0 + 0.7 (\text{growth in labor}) + 0.3 (\text{growth in capital})$

How should we interpret 2, 0.7, and 0.3?

Interpretation:

2.0: growth in technology.

0.7: relative share of labor in national income.

0.3: relative share of capital in national income.

In other words, if all else stays constant, a 1% growth in labor will result in 0.7% growth in potential GDP. Or, if all else stays constant, a 1% growth in capital will result in 0.3% growth in potential GDP.

4.2. Sources of Economic Growth

Increase in Labor Supply

Increase in labor supply leads to an increase in economic growth. Labor force is the number of people available for work from the working age population. This includes unemployed people who are looking for work.

Total hours worked = Labor force * average hours worked per worker

Increase in Human Capital

This is the quality of the workforce i.e. the skill and knowledge of the workers. Investment in education and on-the-job training improves human capital, which in turn causes the production function to shift upward, and improves productivity/standard of living/economic growth. The spillover effect is the effect of this investment in human capital on the people around.

Increase in Physical Capital

This refers to buildings, machinery, and equipment. If net investment is positive, then physical capital is growing. Countries with a higher rate of net investment have a higher GDP growth. Ex: China, India, and South Korea.

Investments in Technology

Spending on R&D leads to discoveries or technological improvements that make it possible to increase a firm's output with the same inputs. Ex: growth in IT; semiconductor industries. This is one factor that allows an economy to grow because other inputs (capital, labor) face diminishing marginal returns. The faster the growth in technological change, the greater the growth in productivity and GDP. TFP represents the amount by which an output increases due to improvements in the production process.

TFP Growth = Growth in potential GDP - [W_L(Growth in labor) + W_C(Growth in capital)]

Technology is the main factor that affects economic growth in developed countries.

Natural Resources: comprises renewable (can be replenished, such as trees and water) and non-renewable resources (coal and oil). Higher natural resources lead to higher growth.

Public infrastructure: Examples of public infrastructure include: roads, water systems,

mass transportation, airports, utilities etc. These investments create externalities which boost the production of private goods and services. The benefits derived from public infrastructure investments extend beyond the direct costs incurred in creating them.

Other factors driving growth: Other factors such as R&D and public education also produce positive externalities that can boost economic growth.

However, some factors such as pollution can produce negative externalities and limit economic growth. For example, carbon dioxide emissions usually rise with economic growth, the resultant climate change impose a cost on the global economy in terms of economic activity, food production, health and habitability.

Improvements in a country's legal and political environment can also improve economic growth.

4.3. Measures of Sustainable Growth

- It is not easy to measure sustainable GDP as it depends on growth of technological change, capital, labor, and natural resources. This is because there is no observed data on TFP or potential GDP and hence it must be estimated.
- Labor productivity is easier to measure. It is the amount of output produced by an average worker in one hour.

$$\text{Labor productivity} = \frac{\text{Real GDP}}{\text{Aggregate hours}}$$

$$\frac{Y}{L} = A * F(1, \frac{K}{L})$$

- An increase in any of the factors – capital; technology – improves productivity of the labor force.
- Level of labor productivity: Higher labor productivity means more goods and services per person. This, in turn, depends on the level of human and physical stock. The higher the accumulated capital, the higher the productivity.
- Growth rate of labor productivity: % increase in productivity over a year.
- Labor productivity can be used to estimate the rate of sustainable growth of the economy and differences in living standards.

Potential GDP can be expressed as:

$$\text{Potential GDP} = \text{Aggregate hours worked} * \text{Labor productivity}.$$

Converting the above equation in terms of growth rates we get:

$$\text{Potential growth rate} = \text{long-term growth rate of labor force} + \text{long-term labor productivity growth rate.}$$

Summary

LO.a: Calculate and explain gross domestic product (GDP) using expenditure and income approaches.

Gross domestic product refers to the market value of all final goods and services produced within a country over a specific time period - usually one year. Government transfers and goods/services without market value are not included.

The income approach computes GDP as the total income earned by households, businesses, and the government in the country during a time period.

The expenditure approach is based on calculating the total amount spent on goods and services.

LO.b: Compare the sum-of-value-added and value-of-final-output methods of calculating GDP.

The expenditure approach:

- Can be computed through the sum-of-value-added approach where GDP is calculated by summing the additions to value created at each stage of production and distribution.
- Can be computed through the value-of-final-output approach where GDP is calculated by summing the values of all final goods and services produced during the period.
- Can also be stated as: $GDP = (C + G^C) + (I + G^I) + (X - M)$

where:

C = consumer spending on goods and services

I = gross private domestic investment

G = government spending on final goods and services for both current consumption and investment in capital goods = $G^C + G^I$

X-M = net exports = exports - imports

LO.c: Compare nominal and real GDP, and calculate and interpret the GDP deflator.

Nominal GDP values goods and services at their current prices; Real GDP measures current-year output using prices from a base year. Real GDP eliminates the effect of inflation. The GDP deflator is a price index that can be used to convert nominal GDP into real GDP by removing the effects of changes in prices.

LO.d: Compare GDP, national income, personal income, and personal disposable income.

GDP based on Income Approach = GDP = Gross domestic income (GDI) = Net domestic income + Consumption of fixed capital (CFC) + Statistical discrepancy

Gross domestic income is the income received by all factors of production which are used to

produce final output.

Personal income is the pretax income received by households. Household disposable income (HDI) is the household primary income after deducting net current transfers paid.

Household net saving is HDI less household final consumption expenditures plus net change in pension entitlements.

LO.e: Explain the fundamental relationship among saving, investment, the fiscal balance, and the trade balance.

Simply put, aggregate income is the sum of consumption, expenditure, and taxes. Think of it as how your income gets spent. The relationship between saving, investment, fiscal balance, and trade balance is: $(S - I) = (G - T) + (X - M)$.

LO.f: Explain how the aggregate demand curve is generated.

The aggregate demand curve (AD) represents the combinations of aggregate income and the price level at which the following two conditions must be satisfied:

- Aggregate expenditure equals aggregate income.
- There must be equilibrium in the money market i.e., the available real money supply is willingly held by households and businesses.

The aggregate demand curve shows the negative relationship between GDP (real output demanded) and the price level (y -axis)

The downward slope of the aggregate demand curve arises as a result of three effects: wealth effect, interest rate effect, and real exchange rate effect.

LO.g: Explain the aggregate supply curve in the short run and in the long run.

The aggregate supply curve shows the positive relationship between GDP and the price level:

- In the very short run: input quantities are fixed and aggregate supply curve does not change.
- In the short run; input prices are fixed so businesses expand real output when output prices increase.
- In the long run: aggregate supply is perfectly inelastic (vertical) and represents the potential GDP – the full-employment level of economic output.

LO.h: Explain causes of movements along and shifts in aggregate demand and supply curves.

For a movement along the AD curve, the following two equilibrium conditions must hold:

- $(S - I) = (G - T) + (X - M)$; assuming no changes in trade and fiscal balance, changes in savings = changes in investment spending.
- Equilibrium in the money market: money supply = money demand.

Shifts in AD are caused by changes in household wealth, business and consumer expectations, capacity utilization, fiscal policy, monetary policy, currency exchange rates,

and global economic growth rates.

Shifts in the SRAS are caused by changes in input prices, expectations about the future, changes in business tax rates, changes in subsidies, and currency exchange rates. Shifts in the LRAS are caused by changes in labor supply, availability of natural resources, stock of physical capital, changes in productivity: technology.

LO.i: Describe how fluctuations in aggregate demand and aggregate supply cause short-run changes in the economy and the business cycle.

The price level and output at the point where AD and SRAS curves intersect is called the short-run macroeconomic equilibrium. At this point, the aggregate quantity demanded = aggregate quantity supplied.

LO.j: Distinguish among the following types of macroeconomic equilibria: long-run full employment, short-run recessionary gap, short-run inflationary gap, and short-run stagflation.

In the long run, the intersection of AD and SRAS curves occurs at a point on the LRAS curve; this point is the equilibrium point. At equilibrium, labor and capital are fully employed.

Recessionary gap refers to a situation where the real GDP (as determined by the intersection of AD and SRAS) is less than the potential GDP (as determined by the intersection of AD and LRAS). It results in a downward pressure on input prices, which causes an increase in SRAS back towards long-run equilibrium.

Inflationary gap refers to a situation where the real GDP (as determined by the intersection of AD and SRAS) is more than the potential GDP (as determined by the intersection of AD and LRAS). It results in an upward pressure on input prices, which causes a decrease in SRAS back towards long-run equilibrium.

Stagflation refers to simultaneous high inflation and weak economic growth which results from a sudden decrease in short-run aggregate supply.

LO.k: Explain how a short-run macroeconomic equilibrium may occur at a level above or below full employment.

Short-run macroeconomic equilibrium may occur at a level above or below full employment; there are four possible types of macroeconomic equilibrium, three of them are short-run:

1. Short-run full employment.
2. Short-run inflation gap.
3. Short-run stagflation.

LO.l: Analyze the effect of combined changes in aggregate supply and demand on the economy.

Change in AS	Change in AD	Effect on Real GDP	Effect on Aggregate Price Level
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	Increase	Increase. Lowers unemployment.	Increase
	Decrease	Decrease. Increases unemployment.	Decrease
Increase		Increase. Lowers unemployment.	Decrease
Decrease		Decrease. Increases unemployment.	Increase
Increase	Increase	Increase	Indeterminate
Decrease	Decrease	Decrease	Indeterminate
Increase	Decrease	Indeterminate	Decrease
Decrease	Increase	Indeterminate	Increase

LO.m: Describe sources, measurement, and sustainability of economic growth.

Following are the main sources of economic growth:

- Increase in labor supply.
- Increase in capital: physical capital and human capital.
- Increase in productivity: technology.
- Increases in natural resources
- Increases in public infrastructure

Economic growth is measured as the annual percentage change in real GDP or the annual change in real per capita GDP.

Sustainable rate of economic growth is the rate of increase in the economy's productive capacity or potential GDP.

LO.n: Describe the production function approach to analyzing the sources of economic growth.

The Solow growth model is the starting point for analyzing the drivers of long-term growth in any economy. With this model, one can analyze why the growth in one country differs from that in another. This model is relevant in determining the factors that cause the LRAS curve to shift permanently to the right (increase in productive capacity of an economy).

LO.o: Define and contrast input growth with growth of total factor productivity as components of economic growth.

An increase in any of the factors – capital, technology – improves productivity of the labor force. Higher labor productivity means more goods and services per person. This, in turn, depends on the level of human and physical stock. The higher the accumulated capital, the higher the productivity.

Total factor productivity represents the amount by which an output increases as a result of improvements in the production process.