BIEM/BIEF

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BLAB

HANDOUTS

MACROECONOMICS

-FIRST PARTIAL-

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This handout is written by students with no intention of replacing official university materials.

It is a useful tool for studying the subject, but it does not guarantee preparation that is as exhaustive and complete for passing the exam as the material recommended by the University.

The content may contain errors and has not been reviewed or approved by professors in any way. It should be used only as supplementary support, always alongside the official sources and materials indicated in the exam syllabus.

Chapter 2 – A Tour of the Book

Type	Lecture
Date	@5 February 2026
Reviewed	☑

Reference: Lectures 1 & 2 (05/02/2026 – 06/02/2026) and Chapter 2 Textbook (Sections 2.1, 2.2, 2.3, 2.5)

Note: Section 2.4 (Okun's law and Phillips curve) and the Appendix are skipped as per lecture instructions.

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1. 📦 Aggregate Output – GDP

GDP = **Gross Domestic Product** = measure of aggregate (total) output/income produced by an economy in a given period (usually 1 year, denoted Y).

> **Why "gross"?** Because it does **not** account for depreciation of capital. If we subtracted depreciation we would get Net Domestic Product.

GDP gives rise to **3 definitions**, which are also **3 ways of computing GDP**.

1.1 Definition 1 – The Production Approach (MKT Value of Final Goods)

> **GDP is the market value of all final goods and services produced by an economy in a given period.**

Key points:

- Goods are evaluated at **market prices** (average of all prices in the economy)
- **Intermediate goods** = goods used in the production of another good (e.g. flour used to produce bread)
  - We do **not** count intermediate goods sold domestically → avoids **double counting**

- Intermediate goods are already included within the value of the final goods

You **include** in GDP:

- Final goods sold to the **domestic market**
- Final goods **sold abroad** (exports)
- Intermediate goods sold abroad that **become final goods** for the foreign country
- If you buy an intermediate good from abroad to produce a final good → you consider: **Revenue from sales – cost of the imported intermediate good**

Exercise 1 — Company A produces steel, Company B buys steel to produce cars:

	Company A (Steel)	Company B (Cars)
Revenue from sales	$100	$200
Wages	$80	$70
Steel purchase	—	$100

→ **GDP = $200** (B is the only producer of a final good; A's steel is intermediate)

1.2 Definition 2 – Value Added Approach

> **GDP is the sum of value added by all firms in the economy in a given period.**

Value added (VA) = value of production – value of intermediate goods used in production = all revenues – cost of intermediate inputs

Exercise 1 continued:

$$\text{GDP} = VA_A + VA_B = (100 - 0) + (200 - 100) = 200$$

Definitions 1 and 2 are both called definitions of the **production side**.

1.3 Definition 3 – Income Approach

> **GDP is the sum of all incomes produced in an economy in a given period.**

> In macroeconomics, **output and income are the same thing**.

There are **4 types of income**:

Type of Income	Description
Labour income	Revenues that go to workers = **wages**
Capital / Profit income	Revenues that go to firms = all revenues – all costs (intermediate goods, wages, taxes) OR = Value Added – wages – taxes
Rent income	Income of people who own a building or property
Tax income	Revenues that go to the government

> $\text{GDP} = \text{wages} + \text{profit} + \text{rent} + \text{taxes}$

Exercise 1 income approach:

> $\text{GDP} = (80 + 70) + [(100 - 80) + (200 - 70 - 100)] + 0 + 0 = 200$

Definition 3 is called the definition of the **income side**.

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2. 📈 Nominal and Real GDP

2.1 Nominal GDP

Nominal GDP = GDP at current prices = $\$Y_t$ or $€Y_t$

- Sum of quantities of final goods and services times their **current price**

$$\$Y_t^{\text{NOM}} = P_A^t \cdot q_A^t + P_B^t \cdot q_B^t + \dots$$

Macroeconomists **do not use nominal GDP much** because it does not distinguish between the **price effect** (change in P) and the **quantity effect** (change in q). An increase in nominal GDP could reflect higher production or simply higher prices.

2.2 Real GDP

Real GDP = GDP in terms of goods = GDP in constant prices = GDP adjusted for inflation

- You choose a **base year** and use its prices to compute GDP across different years → eliminates the price effect

$$\text{GDP}_{\text{REAL}}^{2024} = P_A^{\text{base}} \cdot q_A^{2024} + P_B^{\text{base}} \cdot q_B^{2024} + \dots$$

$$\text{GDP}_{\text{REAL}}^{2025} = P_A^{\text{base}} \cdot q_A^{2025} + P_B^{\text{base}} \cdot q_B^{2025} + \dots$$

→ By fixing prices at the base year, we **get rid of the price effect** and capture only changes in quantities.

> **In the base year:** Nominal GDP = Real GDP

2.3 Notation

Variable	Notation
Real GDP in year t	Y_t
Nominal GDP in year t	$\$Y_t$ or $€Y_t$

2.4 GDP Growth Rate

$$g_y = \frac{Y_t - Y_{t-1}}{Y_{t-1}}$$

- $g > 0$ → **growth** (expansion)
- $g < 0$ → possible **recession** (two consecutive quarters of negative growth)

Similarly for nominal GDP: $g_{\$y_t} = \frac{\$Y_t - \$Y_{t-1}}{\$Y_{t-1}}$

2.5 GDP per Capita

$$\text{GDP per capita} = \frac{\text{GDP}}{\text{Total Population}}$$

Used to compare average standards of living across countries.

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3. ⚠️ Problems with GDP

GDP is still considered an **essential macroeconomic variable**, but it has several limitations:

- It is **not a measure of wellbeing**
- It does **not account for**:
  - Negative/positive **externalities**

- **Leisure** time
- Goods and services produced by **households** (e.g. unpaid domestic work)
- **Inequalities** in income distribution
- The **underground economy** (though recent estimates attempt to include it)

GDP needs to be supported by other measures, such as **Green GDP** and the **HDI** (Human Development Index).

HDI – Human Development Index

The HDI depends on:

- **GNI** (Gross National Income) = GDP + net income from abroad
  - Net income from abroad = money flowing from abroad – money sent to foreign countries
- **Health**: life expectancy at birth
- **Education**: average years of schooling
- **Income distribution**

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4. 👷 Unemployment Rate

Key Variables

Variable	Definition
N	**Employment** = number of people who have a job
U	**Unemployment** = number of people who do not have a job but are **looking for one** (in the last 4 weeks)
L	**Labour Force** = $N + U$

Unemployment is not easy to assess → measured through **surveys**:

- **US**: CPS – Current Population Survey
- **EU**: LFS – Labour Force Survey

Unemployment Rate

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$$u = \frac{U}{L}$$

Unemployment rates (December 2025):

Area	Unemployment Rate
EU-27	5.9%
Euro area	6.2%
Italy	5.6%
Spain	10%
France	7.7%
Germany	3.8%
US	4.4%

Discouraged Workers and Participation Rate

People who do not have a job and are **not searching** are **outside the labour force**. Among these, **discouraged workers** are those who were previously searching but stopped.

$$\text{Participation rate} = \frac{L}{\text{Total population of working age}}$$

Working age definitions:

- OECD: 15–64 years
- Eurostat: 15–74 years

Why Unemployment Matters

- **High** u → not using resources efficiently; human cost of unemployment (financial and psychological suffering)
- **Very low** u → labour shortages → upward pressure on wages → risk of overheating

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5. 📉 Inflation Rate

Inflation = a sustained increase in the price level.

Inflation rate (π_t) = the rate at which the price level increases.

To compute it → **2 methods:**

5.1 Method 1 – GDP Deflator (P_t)

> **GDP Deflator** compares the price of all currently produced domestic final goods and services to the price of those same goods and services **in the base year**.

$$P_t = \frac{\$Y_t}{Y_t} = \frac{\text{Nominal GDP}}{\text{Real GDP}}$$

Rearranging: $\$Y_t = P_t \cdot Y_t$

P_t is an **index number**: its level alone has no economic meaning, but its **rate of change does**.

$$\pi_t = \frac{P_t - P_{t-1}}{P_{t-1}}$$

- $\pi_t > 0$ → **inflation**
- $\pi_t < 0$ → **deflation**

If nominal GDP grows faster than real GDP, the increase must be due to **rising prices**.

In the base year: $P_{\text{base}} = 1$ (by construction).

Key relationship (Proposition 7, p. 564):

$$\$Y_t = P_t \cdot Y_t$$

$$g_{\$y_t} = g_{P_t} + g_{y_t}$$

Where: $g_{\$y_t}$ = growth rate of nominal GDP, g_{P_t} = inflation rate (computed using P_t), g_{y_t} = growth rate of real GDP.

This is also useful as an **inverse formula**: $g_{y_t} = g_{\$y_t} - g_{P_t}$

5.2 Method 2 – CPI (Consumer Price Index)

> **CPI** = Consumer Price Index — consumers care about the **average price of the goods they consume**, not all final goods produced in the economy.

The set of all final goods produced in an economy may differ from the set of goods actually bought by consumers because:

- Some final goods are sold abroad or to the government
- Consumers buy imported goods (not counted in domestic production)

$$\pi_t = \frac{\text{CPI}_t - \text{CPI}_{t-1}}{\text{CPI}_{t-1}}$$

Like P_t, the **CPI is an index number**: only its rate of change is meaningful, not its level.

In the EU, the official inflation measure is the **HICP** (Harmonised Index of Consumption Prices):

- Measures average changes in the price paid by consumers for a **specific and annually updated** basket of goods and services
- Each country computes its own HICP → aggregated into the EU HICP, weighted by consumer expenditure share
- EU HICP gives the average change in price of the **typical basket of the typical EU consumer**
- **Ideal rate: 2%**

HICP (January 2026):

Area	HICP
Euro area	1.7%
Italy	1%
France	0.3%
Spain	2.4%
Germany	2.1%

5.3 GDP Deflator vs. CPI

GDP Deflator (P_t)	CPI
Considers all final goods and services **produced** domestically	Considers all final goods and services **consumed** domestically, independently of the country of production

P_t and CPI **tend to move together** — usually differ by less than 1%.

If CPI is significantly larger than P_t: this is usually due to the price of **imported goods** rising relative to the price of domestically produced goods.

5.4 Problems with CPI

- The **basket composition** is hard to define
- Consumers **change consumption habits** within a year (they substitute goods in response to price changes)
- **Quality and technological improvements** do not wait for one year → the basket may not capture quality gains

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5.5 Pure Inflation

Pure inflation = a proportional increase in **both** prices and wages.

- This is a **theoretical concept** — in practice, not all prices and wages rise proportionally
- Under pure inflation, real wages and relative prices would be unaffected → no real economic distortion

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5.6 Problems Caused by Inflation

- ↓ **Purchasing power**
- ↑ **Inequality** (a rich person becomes richer; a poor person becomes poorer)
- ↑ **Uncertainty** → harder for firms to make investment decisions
- **Tax distortion** (bracket creep: nominal incomes rise into higher tax brackets even if real incomes are unchanged) — even more serious problem

High deflation also causes problems:

- ↑ Uncertainty → people **postpone important investments** → reduced aggregate demand

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6. ⏳ The Short Run, the Medium Run, and the Long Run (Section 2.5)

Three answers to the question "what determines aggregate output?", each applying over a different time horizon:

Time Horizon	Determinant of Output	Key Factors
Short run (few years)	**Demand side**: movements in output are driven by movements in demand (consumer confidence, government spending, interest rates)	Monetary policy, fiscal policy, confidence
Medium run (≈ a decade)	**Supply side**: the economy returns to the level of output determined by supply factors	Capital stock, level of technology, size of the labour force
Long run (decades)	**Structural factors**: education, saving rate, quality of government and institutions	Education system, saving rate, R&D, institutions

> **Key message:** All three answers are correct — each applies over a different time frame.

📚 Readings & Exercises

- **Book**: Chapter 2 + Section 2.5 (on your own)
- **EB**: Chapter 1, Exercise 2
- **BB**: Slides, Problem Set 1, Multiple-Choice Questions
- **Optional**: Chapter 2 → 2nd and 3rd readings on GDP

Chapter 3 - The goods market

Reviewed ☑

📦 Macroeconomics: Chapter 3 – The Goods Market

Reference: Lectures 3 & 4 and Official Slides

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1. Composition of GDP

GDP is composed of several key parts that represent different types of spending in the economy:

- **Consumption (C):** The largest component of GDP. It includes all goods and services purchased by consumers.
- **Investment (I):** Also called fixed investment. It consists of ***nonresidential investment*** (firms' purchases of new plants and machinery) and **residential investment** (purchases of new housing by people).
- **Government Spending (G):** Purchases of goods and services by federal, state, and local governments. It **excludes** government transfers (e.g., social security, pensions) and interest payments on debt.
- **Net Exports (NX):** The difference between **Exports (X)**, domestic goods bought by foreigners, and **Imports (IM)**, foreign goods bought by domestic residents
  - **Trade Surplus:** $X > IM$
  - **Trade Deficit:** $X < IM$
  - **Trade Balance:** $X = IM$
- **Inventory Investment:** The difference between goods produced and goods sold in a given year. It is usually a small component and can be positive or negative.

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2. The Demand for Goods (Z)

The total demand for goods is defined by the following identity:

$$Z \equiv C + I + G + X - IM$$

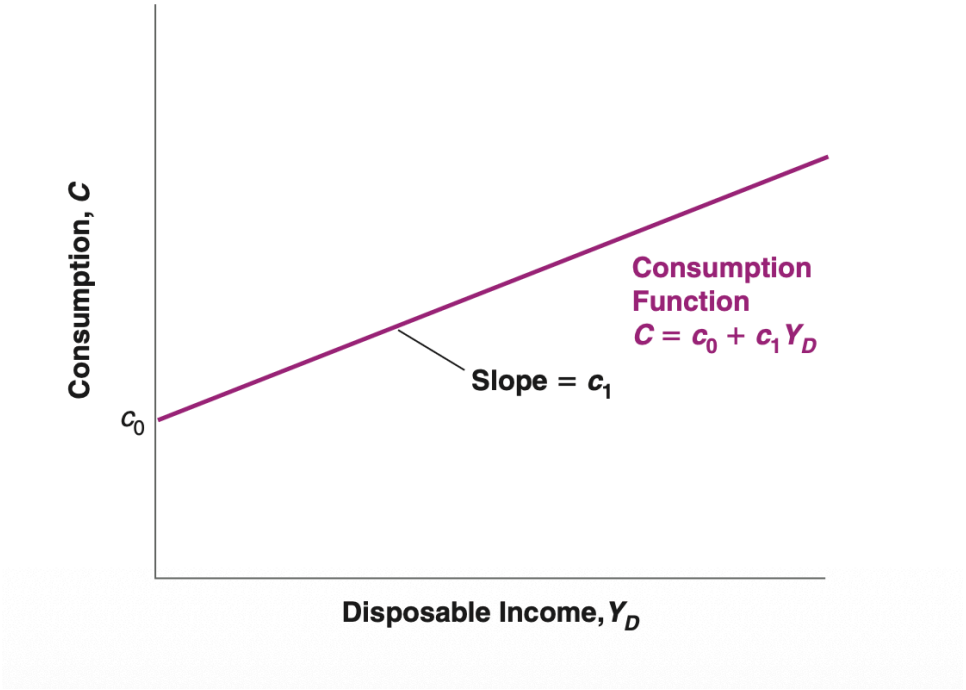
> [!IMPORTANT]
> Inventory investment is **not** part of the demand (Z).

Assumptions of the Standard Model

To analyze demand, we simplify the model with the following assumptions:

1. All firms produce the **same identical good.**
2. Firms are willing to supply **any amount** of the good at a certain price level P (Short Run assumption) .
3. The economy is **closed**: $X = IM = 0$. Demand thus becomes: $Z = C + I + G$

The Consumption Function



Consumption depends primarily on **disposable income (Y_D)**, which is the income left after receiving government transfers and paying taxes .

- **C is endogenous** → depends on y, T, c0, c1

$$C = C(Y_D) \implies C = c_0 + c_1 Y_D$$

$$C = c_0 + c_1(Y - T)$$

- c_0 **(Autonomous Consumption): What people consume even if their disposable income is zero** . It is always positive because "you need to eat" . It can represent changes in consumer confidence.
- c_1 **(Marginal Propensity to Consume):** T**he effect of one additional unit of** Y_D **on consumption** . It is **positive and less than 1** $(0 < c_1 < 1)$, meaning we consume part of extra income and save the rest .
  - $(1 - c_1)$ = marginal propensity to save

Government spending

- in the standard model G and T are exogenous
  - fixed
  - $G = \bar{G}$
  - $T = \bar{T}$

Investment

- in the standard model I is exogenous
  - $I = \bar{I}$

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3. Equilibrium Output in the Standard Model

Equilibrium in the goods market requires that **Production (**Y**) equals Demand (** Z**)**:

$$Y = Z$$

$$Y = c_0 + c_1(Y - T) + I + G$$

there are tree ways of describe mechanisms and results:

1. Using Algebra

By solving for Y, we obtain the fundamental equilibrium equation:

$$Y^* = \frac{1}{1-c_1}[c_0 - c_1 T + I + G]$$

- **Autonomous Spending (A):** The **part of demand that does not depend on output**:
  $[c_0 - c_1T + I + G]$. In macroeconomics, A is assumed to be positive.

- **The Multiplier:** The term $\frac{1}{1-c_1}$. Since $c_1 < 1$, the multiplier is always greater than 1 . Any variation in autonomous spending causes a more than proportional change in Y .

2. Using Graph

- look at paragraph 4

3. Using words

- Production depends on demand which depends on income which is itself equal to production.
- If the demand shifts, the end results is an increase in output that is larger than the initial shift by a factor equal to the multiplier.
- The size of the multiplier is directly related to the value of the propensity to consume.
  - To estimate behavioural equations and parameters economists use Econometrics.

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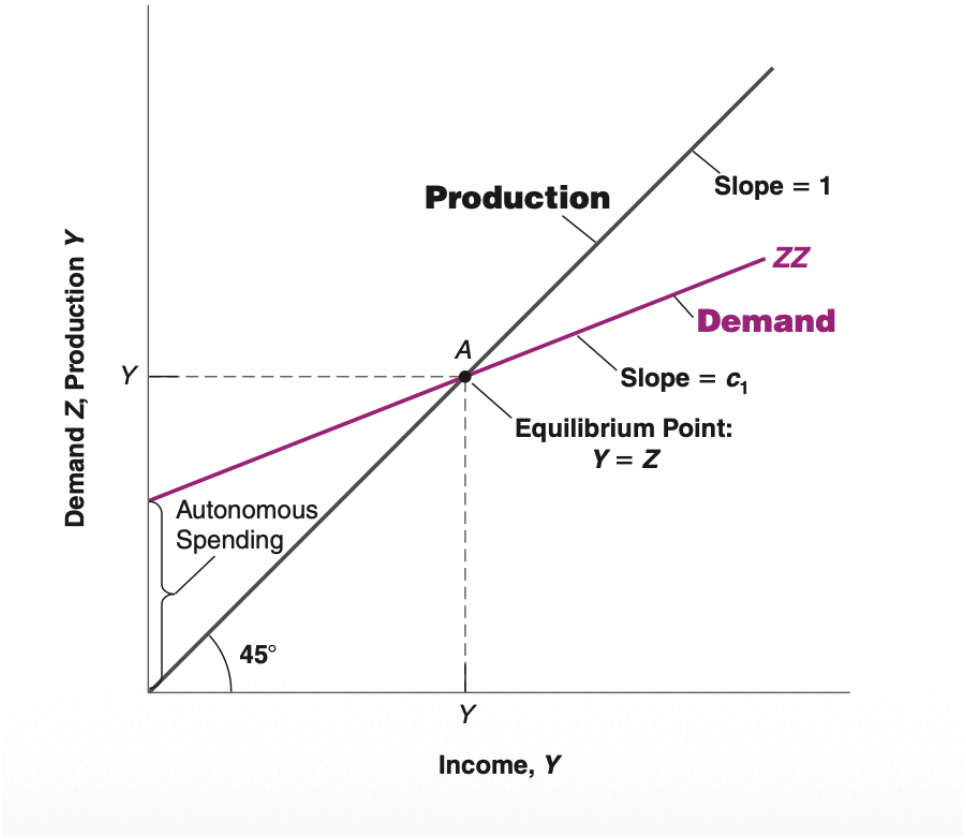
4. Graphical Analysis

The equilibrium of the standard model can be visualised graphically:



- **ZZ Line (Demand):** Represents the equation $Z = A + c_1 Y$. It has a vertical intercept A and a slope c_1 **that is flatter than a 45° line** (0<c1).
- **45° Line:** Represents the **equilibrium condition where production equals income** ($Y = Z$).
- **Equilibrium Point:** Where the ZZ line intersects the 45° line.
  - **Excess Demand ($Y < Z$):** To the left of equilibrium, production increases .
  - **Excess Supply ($Y > Z$):** To the right of equilibrium, production decreases .

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5. Reasoning using the Standard Model

The model explains how changes in exogenous variables (like consumer confidence) affect the economy through the multiplier:

- **Increase in c_0:** If consumer confidence rises, **autonomous consumption increases** (i.e. people are optimistic about the future and willing to spend more). This **shifts the ZZ line up in a parallel way** (slope c_1 is unchanged).

Equilibrium output increases by more than the initial change in c_0 due to the multiplier effect .

- **Intuition for the Multiplier:** An initial **increase in demand leads to an increase in production and income**. This **higher income triggers a further increase in consumption, which increases demand again, and so on** . The total increase is the sum of a **geometric series** .
  - total increase = income increase x $(1 + c_1 + \ldots + c_1^n)$

ADD PARTS ON DYNAMICS OF ADJUSTMENT → P 64

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6. Investment = Saving (The IS Relation)

Another way to think about equilibrium in the goods market is through the equality of Investment and Saving.

Types of Saving

- **Private Saving (S):** The income left after taxes and consumption:

  $$S = Y - T - C$$

  - **Behavioural Equation:** $S = -c_0 + (1 - c_1)(Y - T)$.
  - **Marginal Propensity to Save:** $(1 - c_1)$ tells us how much of an additional unit of income people will save .
- **Public Saving (S_{PUB}):** The **government budget balance:**
  - $S_{PUB} = T - G$
  - **Budget Surplus:** $T > G$
  - **Budget Deficit:** $T < G$ $(Def = G - T)$
- **National Saving (S_{NAT}): The sum of private and public saving** ($S + S_{PUB}$).

The Equilibrium Condition

Starting from $Y = C + I + G$ and subtracting T and C from both sides:

$$Y - T - C = I + G - T$$

$$S = I + G - T \implies \mathbf{I = S + (T - G)}$$

This means **Investment = National Saving**. Solving for Y using this condition yields the same equilibrium output as the production = demand condition.

- **IS relation!**

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7. The Paradox of Saving

The paradox of saving **describes how an attempt by consumers to save more results in lower output without increasing total saving.**

Logic in the Standard Model:

1. Consumers decide to save more, so c_0 **decreases** (it can also be c1).
2. Consumption decreases, causing demand and **output (Y) to fall** through the multiplier .
3. Based on the equilibrium condition $I = S + (T - G)$, if I, T, and G are **exogenous (fixed)**, then **Saving (S) cannot change**.
4. The initial increase in saving (from lower c_0) is exactly offset by the decrease in saving caused by the reduction in total income (Y) .
   a. $S = Y - T - C$ → Y falls → S falls
   b. $S = -c_0 + (1 - c_1)(Y - T)$ → c_0 falls → S increases

> [!NOTE]
> This paradox holds only in the **short run** and when Investment is **exogenous** . In the long run, higher saving leads to capital accumulation and growth . If Investment depends on output ($I = I(Y)$), an increase in saving leads to a decrease in total saving.

Chapter 4 - Financial markets

Reviewed ☑

🏦 Macroeconomics: Financial Markets I

Reference: Chapter 4 (Handwritten Lecture 5 & Official Slides)

1. Core Definitions & Distinctions

To understand financial markets, we must distinguish between different types of financial variables:

- **Money:** An asset used for transactions. It is the most **liquid** asset (it can be used directly to buy things) but typically pays **no interest**.
  - *Currency:* Coins and banknotes supplied by the Central Bank.
  - *Checkable Deposits:* Bank deposits held at private banks.

- **Bonds:** Assets that pay a positive interest rate (i) but cannot be used for transactions. They are less liquid than money.

- **Income (Y):** A **flow** variable. It is what you earn (from working plus interest/dividends) per unit of time.

- **Saving (S):** A **flow** variable. The part of after-tax income that is not consumed.

- **Financial Wealth:** A **stock** variable. The value of all your financial assets minus all your financial liabilities at a given point in time.

- **Investment (I):** In macroeconomics, this refers to the purchase of new capital goods (machines, plants, office buildings). It is *not* the purchase of shares or bonds.

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2. The Demand for Money (M^d)

The demand for money represents the **total amount of money people want to hold rather than invest in bonds.**

- all individual demands for money by firms and people

Determinants of Demand:

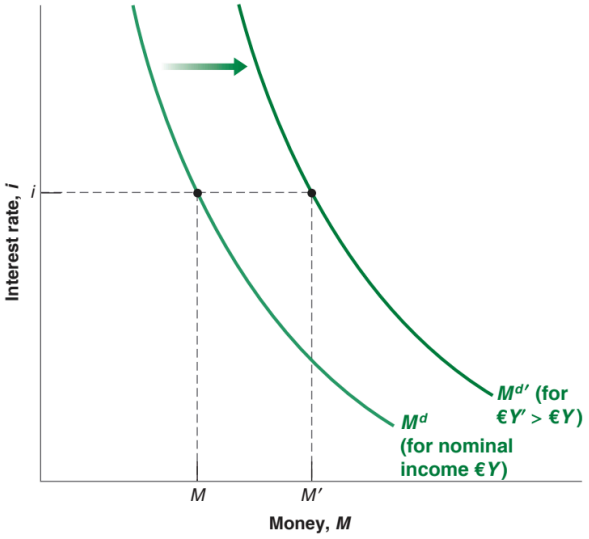
1. **Level of Transactions:** As transactions increase, people need more money. This is proportional to **Nominal Income ($€Y$)**.
2. **The Interest Rate (i):** This is the "opportunity cost" of holding money. As i increases, bonds become more attractive, so people want to hold less money.

The Equation:

$$M^d = €Y \cdot L(i)$$

- $€Y$: Nominal income.
  - \+
- $L(i)$: A function of the interest rate (with a negative sign, meaning as $i \uparrow$, $M^d \downarrow$).
  - \-
- if i grows, Md decreases → bonds are more convenient

Graphical Representation:



The money demand curve is downward sloping. → the lower the i, the higher the M (money people want to hold)

- $i = \frac{F_1}{F_2}Y - \frac{1}{F_2}\frac{M^d}{P}$
- **Movement along the curve:** Caused by a change in the interest rate.
- **Shifts of the curve:** An increase in nominal income ($€Y$) shifts the M^d curve to the **right**, as people need more money for a given interest rate.

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3. The Supply of Money

There are two primary kinds of money in the economy:

- Currency**:** Supplied directly by the **Central Bank (CB)**.
- Deposit/Checkable Deposits**:** Supplied by **private banks**.

Simplifying Assumption: For the initial model, **we assume the only type of money is *currency* supplied by the CB**. Therefore, the money supply is a fixed amount determined by the CB:

$$M^s = M$$

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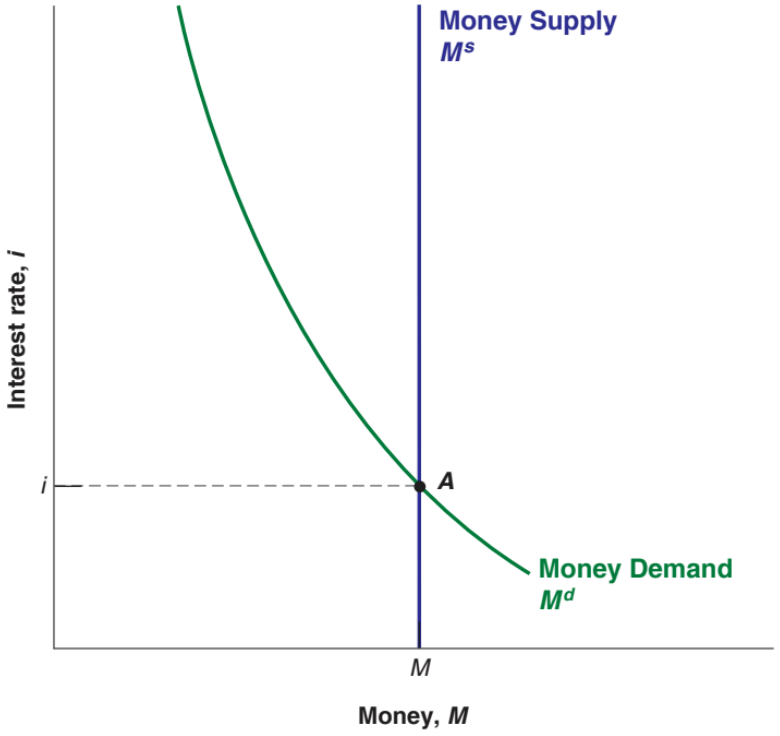
4. Equilibrium in Financial Markets

Equilibrium occurs when the demand for money equals the supply of money:

$$M^s = M^d$$

$$M = €Y \cdot L(i)$$

Graphical Representation



- **Supply (M^s):** A **vertical line** because it is independent of the interest rate (i).
- **Demand (M^d):** A downward-sloping curve.

Market Dynamics: Effect of an Income Increase ($€Y \uparrow$)

If **nominal income (Y) increases**:

1. The level of transactions rises, so people demand more money for a given interest rate.
2. The M^d **curve shifts to the right**.
3. At the initial interest rate, there is **excess demand** for money.
4. To restore equilibrium, the **interest rate (i) must increase to discourage money demand and make bonds more attractive**.

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5. Open Market Operations (OMO)

The **Central Bank changes the money supply by buying or selling bonds in the "open market".**

- CB targets a certain i

- **Expansionary Monetary Policy:**
  - **Action:** The CB **buys bonds**.
  - **Effect:** By paying for them, the **amount of money in the economy increases ($M^s \uparrow$).**
  - **Result:** The interest rate decreases ($i \downarrow$).
- **Contractionary Monetary Policy:**
  - **Action:** The CB **sells bonds**.
  - **Effect:** By receiving money in exchange, the **amount of money in the economy decreases ($M^s \downarrow$).**
  - **Result:** The interest rate increases ($i \uparrow$).

- → inflation
  - when high: contractionary monetary policy
    - CB tighten money to cool spending and slow down price growth
    - i grows, and investments, Z, y, C decreases
      - prices decrease
  - counter effect
    - ex. if investment decreases firms don't grow and unemployment increases

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6. Central Bank's Balance Sheet

The balance sheet tracks the CB's financial position during these operations:

- **Assets: Bonds held by the Central Bank.**
- **Liabilities:** The amount of money **(currency) in circulation.**

> ***Buying a bond increases the "Bonds" asset and simultaneously increases "Currency" as a liability.***

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7. Bond Prices and Interest Rates

There is a mathematical inverse relationship between the **price of a bond today (€P_B)** and the **interest rate (i)**.

Assumptions:

a. **One-year bonds.**

b. A **fixed future promised payment (e.g., $100**) one year from now.

Formulas:

1. **To find the Interest Rate:**

   $$i = \frac{\$100 - €P_B}{€P_B}$$

2. **To find the Bond Price:**

   $$€P_B = \frac{\$100}{1+i}$$

Core Intuition:

- If the price of the bond (€P_B) goes **up**, the interest rate (i) goes **down**.
- If the **CB buys bonds**, the increased demand for bonds **drives their price up**, which automatically **lowers the interest rate**.

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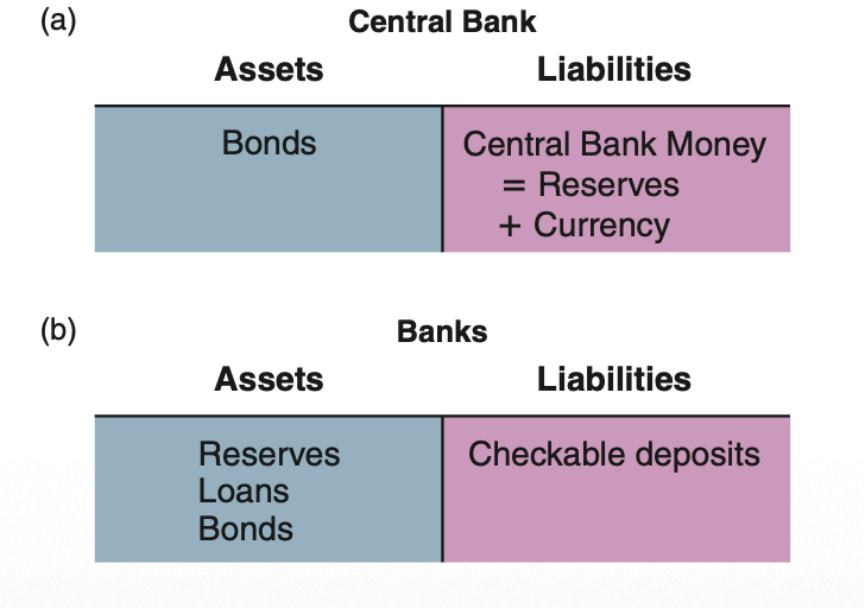
8. The Role of Banks

In a modern economy, the money supply is not just currency; it includes **checkable deposits provided by private banks**. Banks act as financial intermediaries that receive funds from people and use them to buy assets or make loans.

Bank Balance Sheet



- **Assets:**
  - **Financial Assets:** Bonds, stocks, and other securities.
  - **Loans:** Money lent to individuals and firms.
  - **Reserves:** A portion of bank deposits that banks must keep and cannot use for lending.
- **Liabilities:**
  - **Deposit Accounts:** Money held by the public in checkable deposits.

Reserves and the Reserve Ratio (θ)

- **Purpose:** Banks keep **reserves to be ready to satisfy depositors who want to withdraw money or write checks**.
- **Location:** Reserves are kept partly in cash and partly in an account that banks have at the Central Bank (CB).
- **Reserve Ratio (θ):** The **proportion of reserves banks hold for each dollar of checkable deposits**. This is set by the CB (e.g., 1% in the EU, 0% in the US).
  - **fraction of deposits that banks must keep liquid instead of lending out**.

---

9. Equilibrium in the Market for Central Bank Money

Central Bank money (H) is also known as the **monetary base** or **high-powered money**.

> The **monetary base (H)** is the total stock of money issued by the central bank, defined as the sum of **currency in circulation outside the central bank and commercial banks' reserve balances held at the central bank**.

First Model: No Currency (Only Deposits)

In this simplified model, **people hold 100% of their money as checkable deposits and zero currency**.

- **Demand for CB Money (H^d):** Since there is no currency, the demand for CB money is simply the demand for reserves by banks (R^d).
- **Formula:** $H^d = R^d = \theta \cdot D^d = \theta \cdot €YL(i)$.
  - D^d**: demand for checkable deposit** → **=** M^d
  - the base here is just the fraction of the total money that banks must park as reserves
- **Equilibrium:** $H = \theta \cdot €YL(i)$.

Second Model: Currency and Deposits (not in the book!!!)

In this more realistic model, **people decide how much money to hold in currency and how much in checkable deposits.**

- **Currency/Money Ratio (c):** The fixed proportion of money people choose to hold as **currency**.
  - $c = \frac{CU}{CU+D}$ (D: checkable deposit)
- **Deposit Ratio ($1-c$):** The proportion of money held as **checkable deposits**.
- **Demand for CB Money (H^d):** Now consists of the **demand for currency (CU^d) plus the demand for reserves (R^d).**
  - **Equation:** $H^d = [c + \theta(1-c)]€YL(i)$.

- equilibrium condition of the mkt for the monetary base in this second model:
  $H = [c + \theta(1 - c)]€YL(i)$

Federal funds rate and refi rate

While the theoretical model shows the Central Bank (CB) choosing the quantity of money (H), in practice, **Central Banks typically conduct monetary policy by targeting specific interest rates.**

1. **The Federal Reserve (Fed) & The Federal Funds Rate**
   In the United States, there is a physical market for bank reserves where the interest rate adjusts to balance the supply and demand for reserves.
   - **The Federal Funds Market:** The market where **banks trade reserves with one another.**
   - **The Federal Funds Rate:** The **interest rate determined in this market.**
   - **Policy Mechanism:** The **Fed influences this rate by changing the supply of central bank money** (H). Because the Fed can effectively "choose" this rate, it is considered the primary indicator of U.S. monetary policy.

2. **The European Central Bank (ECB) & The Refi Rate**
   The ECB manages the Eurozone using a slightly more complex system involving several controlled rates.
   - **Main Refinancing Rate ("Refi Rate"):** The most important rate in the Eurozone, representing the **cost of loans that private banks obtain from the ECB.**
   - **The Inverse Relationship:** A higher refi rate increases the cost of borrowing for banks, leading to a lower amount of reserves borrowed and a lower overall money supply.
   - **Transmission Mechanism:** By **adjusting the refi rate, the ECB exerts an indirect "cascade" influence on all other interest rates in the economy**—starting with interbank transactions and moving to loans for businesses and real estate.

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10. Relation Between Money Supply (M) and Monetary Base (H)

- definition
  - Monetary base (H, or high–powered money, or M0) is basically the **amount of central bank money in an economy**. In the absence of banks, this represents the total amount of money in an economy, hence it is equal to the money supply (H = Ms). With the presence of banks, however, the money supply can be 'expanded' thanks to the possibility of creating deposit accounts.

- assume no private banks → $M^s = H$
- if private banks exist → $M^s = H +$ *private banks' money*

By combining the equilibrium conditions, we can find the **relationship between the total money supply and the amount of money issued by the Central Bank:**

$M = \frac{1}{c+\theta(1-c)}H$

→ from $H = [c + \theta(1 - c)]M$

- **The Money Multiplier:** The term $\frac{1}{c+\theta(1-c)}$ is the money multiplier.
- **Intuition:** Because $\theta < 1$ and $c < 1$, the **multiplier is greater than 1**. This means the total **money supply is a multiple of the monetary base because banks "create" money by lending out deposits.**

---

11. The Liquidity Trap

The liquidity trap occurs when the interest rate (i) is at or very near zero.

- **Zero Lower Bound:** The **nominal interest rate cannot be negative ($i \geq 0$).**
- **Indifference:** Once people have enough money for transactions and the interest rate is zero, they are **indifferent between holding money and bonds because neither pays interest.**
- **Horizontal Demand:** The **demand for money becomes horizontal at $i = 0$.**

- **Policy Ineffectiveness:** In this state, expansionary monetary policy (increasing H^s) fails to lower the interest rate further, making conventional policy ineffective.
    - The Government might intervene with an additional fiscal policy

---

12. Money Demand in Real Terms

While we often discuss money demand in **nominal terms** ($M^d = €YL(i)$), it can also be expressed in **real terms**.

- **Real Income (y):** This is nominal income divided by the price level (P).
- **Real Money Demand Equation:**

  $$\frac{M^d}{P} = f_1 y - f_2 i$$

    - f_1**: Sensitivity of money demand to real income.**
    - f_2**: Sensitivity of money demand to the interest rate.**

Central Bank Rule: Targeting the Interest Rate

In modern practice, the **CB often targets a specific interest rate ($\bar{i}$) rather than a specific quantity of money.**

- If an increase in real income ($y \uparrow$) shifts money demand to the right, the CB must increase the money supply ($H \uparrow$ or $M \uparrow$) to keep the interest rate stable.
- This is achieved through expansionary open market operations (buying bonds).

Chapter 5 - The IS-LM model

Reviewed ☑

📉 Macroeconomics: Chapter 5 – The IS-LM Model

Reference: Lectures 7, 8 & 9 and Chapter 5 Textbook

> **IS** = *Investment–Saving*
>
> It represents equilibrium in the **goods market**, where planned investment equals saving.

> **LM** = *Liquidity preference–Money supply*
>
> It represents equilibrium in the **money market**, where money demand (liquidity preference) equals money supply.

1. The Goods Market

In this chapter, we revisit the goods market equilibrium by **removing the simplifying assumption that investment is fixed**.

- **The Investment Function**: **Investment (I) is now an endogenous variable** that depends on two factors:
  1. **Level of Sales (Y)**: As production and income increase, firms must increase investment to expand capacity.
  2. **The Interest Rate (i)**: A higher interest rate increases the cost of borrowing, making investment less attractive.
  - **Equation**: $I = I(Y, i)$
    - $I = \bar{I} + d_1 Y - d_2 i$
      - $d1$ and $d2$ → sensitivities with respect to y and i

- **The IS Relation**: The equilibrium condition where production (Y) equals the demand for goods (Z).

- **Equilibrium Equation**: $Y = C(Y - T) + I(Y, i) + G$

- **The IS Curve**: Represents the **set of all pairs** (Y, i) **such that the goods market is in equilibrium**.
  - **Slope**: The IS curve is **downward sloping**. An increase in the interest rate reduces investment and demand, leading to lower output.
  - **Shifts**: The curve **moves if any variable other than the interest rate changes**. For example, an increase in taxes (T) or a decrease in government spending (G) shifts the IS curve to the **left**.
    - a change in i would lead just to a movement on the curve
  - you obtain the curve making i explicit in the equilibrium equation
    - $Y = [c_0 + c_1(Y - \bar{T})] + [\bar{I} + d_1 Y - d_2 i] + \bar{G}$
      - **Horizontal Version (Y on left):** $Y = \frac{1}{1-c_1-d_1}[A - d_2 i]$
      - **Vertical Version (i on left):** $i = \frac{1}{d_2} A - \frac{1-c_1-d_1}{d_2} Y$
        - $A = c_0 - c_1 \bar{T} + \bar{I} + \bar{G}$
        - slope: $-\frac{1-c_1-d_1}{d_2}$
        - vertical intercept: $i = \frac{1}{d_2}(c_0 - c_1 \bar{T} + \bar{I} + \bar{G})$
        - horizontal intercept: $Y = \frac{1}{1-c_1-d_1} A$

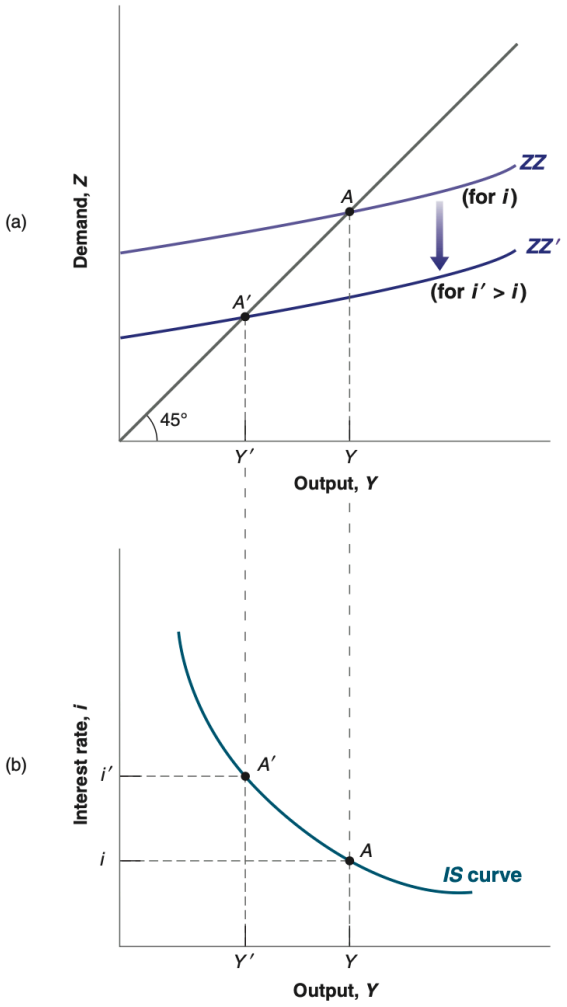


Figure 5.2

The IS curve

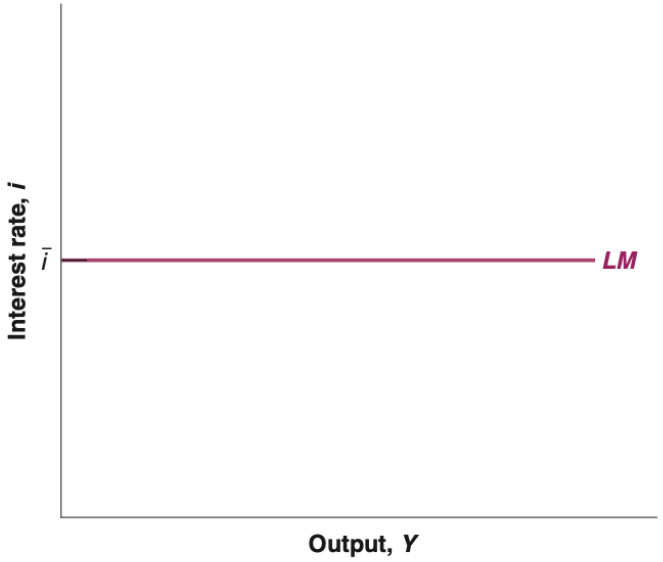
(a) An increase in the interest rate decreases the demand for goods at any level of output, leading to a decrease in the equilibrium level of output.

(b) Equilibrium in the goods market implies that an increase in the interest rate leads to a decrease in output. The IS curve, which gives the relation between the interest rate and output, is therefore downward sloping.

2. LM

The LM relation represents equilibrium in the money market, where the **supply of money equals the demand for money.**

- **The LM Equation**: Simply stated as $i = \bar{i}$
  - $M^D = M = M^S \rightarrow P(f_1 Y - f_2 i) = P(f_1 Y - f_2 \bar{i})$
- **The LM Curve**: A **horizontal line** at the level of the target interest rate $\bar{i}$



Real Money Demand and Supply

- **Equilibrium Condition**: $\frac{M}{P} = YL(i)$
- **Real Money Supply**: $\frac{M}{P}$
- **Real Money Demand**: $YL(i)$

Two Versions of the LM Model

1. **Standard Model**: The Central Bank (CB) targets a specific **interest rate** ($i = \bar{i}$)
2. **Non-Standard Model**: The CB targets a specific **money supply** ($M = \overline{M}$)

The LM relation represents the **equilibrium in financial markets.**

- **Central Bank Conduct**: Modern monetary policy typically involves the Central Bank choosing a target interest rate ($\bar{i}$) rather than a specific money stock.
- **Money Supply Adjustment**: To maintain this rate, the Central Bank automatically adjusts the money supply to match the demand for money at that interest rate.

---

3. The Standard IS-LM Model

The "Standard" model is the version where the **Central Bank targets the interest rate**.

- **Joint Equilibrium**: The model puts the goods and financial markets together to determine output and the interest rate in the short run.
- **Components**:

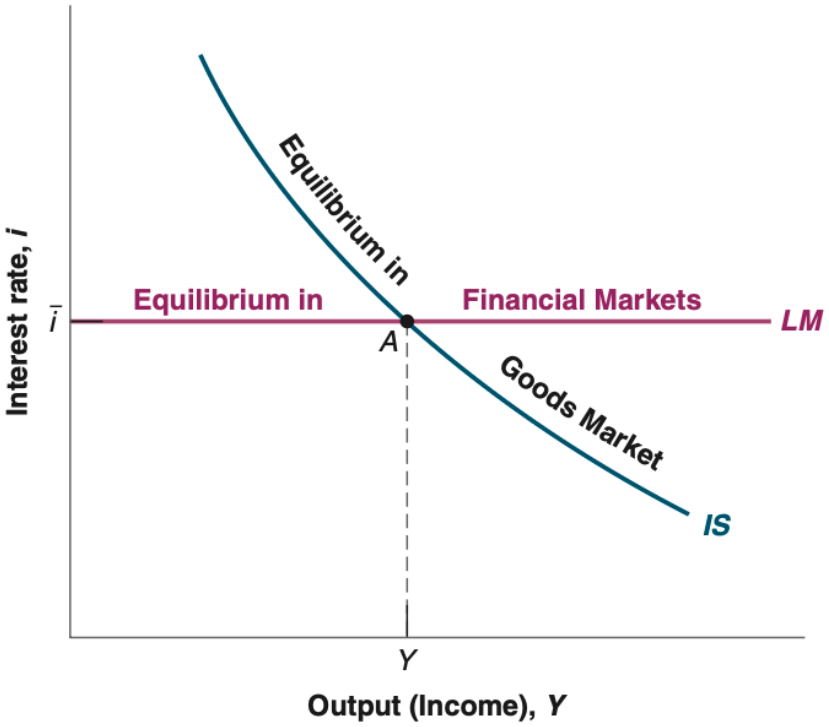
> **IS**: $Y = C(Y - T) + I(Y, i) + G$
> **LM**: $i = \bar{i}$

- **Investment and Saving**: Equilibrium can also be viewed as the point where Investment equals National Saving: $I(Y, i) = S + (T - G)$

---

4. Equilibrium in the Standard IS-LM Model

- **Graphical Equilibrium**: The point where the downward-sloping IS curve crosses the horizontal LM curve.
  - **Equilibrium Output ($\hat{y}$)**: $\hat{y} = \frac{1}{1-c_1-d_1}A - \frac{d_2}{1-c_1-d_1}\bar{i}$
    - by solving the system withe the IS and LM relations
  - **Fiscal Policy Multiplier**: $\frac{1}{1-c_1-d_1}$
    - how much y changes following a change in A
  - **Monetary Policy Multiplier**: $-\frac{d_2}{1-c_1-d_1}$
    - how much y changes following a change in i



- **Fiscal Policy Changes**:
  - *Fiscal Contraction*: $T \uparrow$ or $G \downarrow$ shifts the IS curve **left**, leading to lower output (Y) and an unchanged interest rate.
  - *Fiscal Expansion*: $T \downarrow$ or $G \uparrow$ shifts the IS curve **right**, leading to higher output.
- **Monetary Policy Changes**:
  - *Monetary Expansion*: The Central Bank **lowers the interest rate** ($i \downarrow$), shifting the horizontal LM curve **down**. This stimulates investment and increases output.
  - *Monetary Contraction*: The Central Bank **raises the interest rate** ($i \uparrow$), shifting the LM curve **up**, which reduces output.
- **Policy Mix**: The **combination of monetary and fiscal policies to achieve a target output**. For example, to fight a recession, a government might use expansionary fiscal policy (IS right) while the Central Bank uses expansionary monetary policy (LM down).

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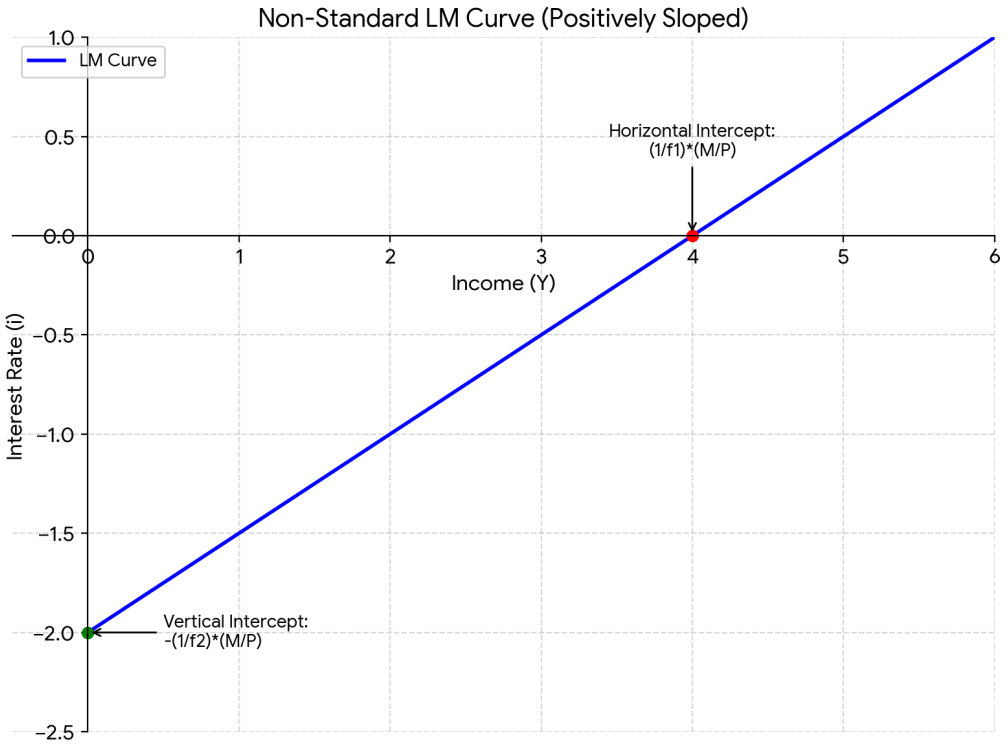
5. The Non-Standard IS-LM Model (no book)

In the **Non-Standard IS-LM Model**, the primary difference from the "standard" version is the Central Bank's behaviour: instead of setting a fixed interest rate, the Central Bank chooses a fixed **Money Supply** ($\overline{M}$)

- **Financial Market Equilibrium**: In this model, **the interest rate is determined by the intersection of money supply and money demand:** $\frac{\overline{M}}{P} = YL(i)$.
- **The LM Curve**: In this version, the LM curve is **upward sloping**. An increase in income (Y) increases the demand for money; with a fixed supply, the interest rate must rise to restore equilibrium.
  - Here is the logic:
    - **Income Increase ($Y \uparrow$)**: When output and income rise, people need more money for transactions, so the **demand for money (M^d) increases.**
    - **Fixed Supply**: Since the Central Bank is keeping the **money supply ($\overline{M}$) constant, there is now a "shortage" of money relative to demand**.
    - **Interest Rate Hike ($i \uparrow$)**: To restore equilibrium, the **interest rate must rise to discourage people from holding cash and encourage them to hold bonds instead**.
    - **Result**: **Higher income leads to higher interest rates, creating that upward-sloping line.**
  - **Functional form of LM**
    - $\frac{\overline{M}}{P} = f_1 Y - f_2 i$
      - solve for Y: $Y = \frac{1}{f_1}\frac{\overline{M}}{P} + \frac{f_2}{f_1} i$
      - solve for i: $i = -\frac{1}{f_2}\frac{\overline{M}}{P} + \frac{f_1}{f_2} Y$
        - $\text{Slope} = \frac{f_1}{f_2}$
        - $\text{Vertical Intercept} = -\frac{1}{f_2}\frac{\overline{M}}{P}$
        - $\text{Horizontal Intercept} = \frac{1}{f_1}\frac{\overline{M}}{P}$



- **Crowding Out**: Unlike the standard model, a fiscal expansion ($G \uparrow$) in the non-standard model leads to a higher interest rate, which "crowds out" some private investment.

6. Equilibrium in the Non-Standard IS-LM Model

To find the equilibrium, we solve the system of IS and LM equations simultaneously under the fixed money supply assumption.

- **System of Equations**:

> **IS**: $i = \frac{1}{d_2}(c_0 - c_1\overline{T} + \overline{I} + \overline{G}) - \frac{1-c_1-d_1}{d_2}Y$
>
> **LM**: $i = \frac{f_1}{f_2}Y - \frac{1}{f_2}\frac{\overline{M}}{P}$

- **Non-standard Fiscal Policy Multiplier**: The effect of a change in autonomous spending ΔA on output is governed by a specific multiplier:

$$\Delta Y = \frac{1}{(1 - c_1 - d_1) + \frac{d_2 f_1}{f_2}} \Delta A$$

- **Comparison**: This multiplier is **lower** than the standard fiscal policy multiplier. This is because the interest rate increase (due to higher Y) dampens the overall expansionary effect.
  - d_2: Sensitivity of investment to the interest rate.
  - f_1: Sensitivity of money demand to the income.
  - f_2: Sensitivity of money demand to the interest rate.
- **Non-standard Money Policy Multiplier:** the effect of change in the nominal M^s on output is governed by a specific multiplier

$$\Delta Y = \left(\frac{d_2}{f_1 d_2 + f_2(1 - c_1 - d_1)} \right) \cdot \frac{\Delta \overline{M}}{P}$$

Chapter 6 - The extended IS-LM model

Reviewed ☑

1. Interest rate

- **nominal interest rate** i_t
  - interest rate **in term of dollars**
    - If you borrow $1 next year you repay $(1 + i_t)$$
- **real interest rate** r_t
  - interest rate **in term of basket of goods**
    - if you borrow 1 basket of goods, next year you repay $(1 + r_t)$ baskets of goods

→ Suppose you can buy only bread

- Nominal terms:
  - you can borrow P_t dollars and next year you pay $(1 + i_t)P_t$
- Real terms:
  - You care about **converting the amount of money you have in terms of bread**
  - P^e_{t+1} = expected price of bread next year
  - you're expected to repay $\frac{(1+i_t)P_t}{P^e_{t+1}}$ quantity of bread
    - after dividing by P^e_{t+1} you know how much bread will be possible to buy with $(1 + i_t)P_t$
    - that's: $(1 + r_t) = (1 + i_t)\frac{P_t}{P^e_{t+1}}$

- INFLATION

- **expected inflation**: $\pi^e_{t+1} = \frac{P^e_{t+1} - P_t}{P_t}$

  - rewriting: $1 + \pi^e_{t+1} = \frac{P^e_{t+1}}{P_t} \rightarrow \frac{1}{1+\pi^e_{t+1}} = \frac{P_t}{P^e_{t+1}}$
  - substituting into the real rate formula we have:
    - $(1 + r_t) = \frac{1+i_t}{1+\pi^e_{t+1}}$
      - since $\frac{1}{1+\pi^e_{t+1}} = \frac{P_t}{P^e_{t+1}}$ and $(1 + r_t) = (1 + i_t)\frac{P_t}{P^e_{t+1}}$

  - if the real and nominal rates are small **we can approximate**: $r_t \approx i_t - \pi^e_{t+1}$
  - since expected inflation is usually positive, **then** $r_t < i_t$ **usually**
  - the higher π^e_{t+1}, the lower the rates
    - $r_t = i_t - \pi^e_{t+1}$ = ex-ante real interest rate
    - $r_t = i_t - \pi_{t+1}$ = ex-post real interest rate
      - Interpretation:
        - **ex-ante real rate** uses expected inflation (what borrowers/lenders *think* will happen)
        - **ex-post real rate** uses actual inflation (what *actually* happened)
          - difference exists because π_{t+1} may differ from π^e_{t+1}

- **Basic Relation**: $r = i - \pi^e$ (Real interest rate equals nominal interest rate minus expected inflation).

2. Bonds

Bonds differ based on **maturity**, **issuer**, and **risk**.

To compensate for risk, bondholders require a **risk premium "x"**, which depends on:

- **Degree of risk aversion:** The higher the aversion, the higher the x.
- **Probability of default (p):** If the probability of default is high, x is high.

- **relation that holds:** $(1+i) = (1-p)(1+i+x) + p(0).$
  - $(1+i)$ → riskless output
  - $(1+i+x)$ → risky output

- **Formula for x:** $x = \frac{p(1+i)}{1-p}$.

- Approximation (when i and p are small):

  $x \approx p$
- Key idea:
  - The policy rate i is not necessarily the rate firms/households borrow at.
  - The **borrowing rate includes the risk premium, so it can rise when x rises even if the central bank cuts i**

---

3. Versions of the Extended IS-LM Model

First Version (Nominal Policy Rate)

In this version, the **Central Bank targets the nominal interest rate.**

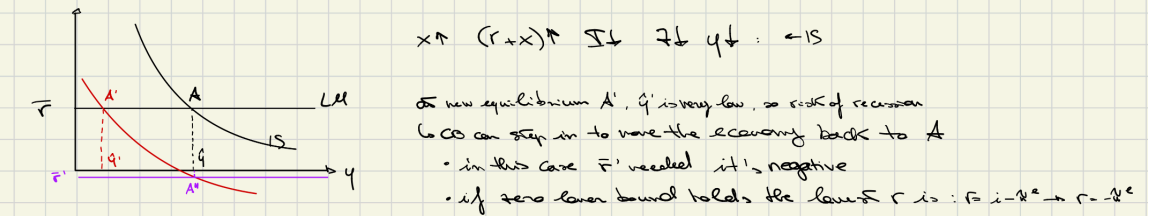
- **IS Relation**: $Y = C(Y - T) + I(Y, r + x) + G$
  - $r + x$: Represents the **real borrowing rate** for people and firms.
    - $r = i - \pi^e \rightarrow Y = C(Y - T) + I(Y, i - \pi^e + x) + G$
  - x: Captures the probability of defaults and risk aversion.
    - when it increases
      - Lenders perceive an a higher risk that borrowers won't repay
      - Lenders become more risk-averse
- **LM Relation**: $i = \bar{i}$
  - i is called **nominal policy rate**

Second Version (Real Policy Rate)

In this version, the **Central Bank targets the real policy rate (r).**

- **IS Relation**: $Y = C(Y - T) + I(Y, r + x) + G$
- **LM Relation**: $r = \bar{r}$ (Real Policy Rate)

- In this version, the **CB is assumed to choose i so that the implied real rate $r = i - \pi^e$ equals $\bar{r}$** (unless constrained by the ZLB).
- suppose $\uparrow x$



4. Impact of a Risk Premium Increase ($x \uparrow$)

If investors become more risk-averse or the probability of default increases:

1. **Borrowing Rate Increases**: $(r + x) \uparrow$
2. **Investment and Demand Fall**: $I \downarrow \Rightarrow Z \downarrow \Rightarrow Y \downarrow$
3. **IS Curve Shift**: The IS curve shifts to the **left**
4. **Recession Risk**: Equilibrium moves from A to A', resulting in significantly lower output (Y).

- **Policy Response**: The Central Bank can lower the policy rate to $\overline{r}'$ to move the economy back toward the original output level.
- **Zero Lower Bound (ZLB)**: If $\overline{r}'$ needs to be negative, the ZLB might prevent the policy rate from going low enough, as the **lowest nominal rate i can reach is 0**
  - $r = i - \pi^e \Rightarrow r = -\pi^e$
  - ZLB constraint:
    - Since $i \geq 0$, the real rate satisfies:
      - If $\pi^e > 0$, then $r_{\min} = -\pi^e < 0$ (negative real rates possible).
      - If $\pi^e < 0$ (expected deflation), then $r_{\min} = -\pi^e > 0$, so real rates cannot fall enough $\Rightarrow$ recession can persist.

- How much should policy move to offset a financial shock?
  - to **neutralise an increase in the risk premium, we want $(r + x)$ unchanged so the Central Bank must cut r** by the same amount: $\Delta r = -\Delta x$
- Feedback loop (endogenous x):
  - $Y \downarrow \Rightarrow$ defaults more likely $\Rightarrow x \uparrow \Rightarrow (r + x) \uparrow \Rightarrow Y \downarrow$ again

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Chapter 7 - The labour market

☑ Reviewed ☑️

👷 Macroeconomics: Chapter 7 – The Labour Market

Reference: Lecture (26/02/2026) and Chapter 7 Textbook

Context: Medium Run analysis – we now abandon the fixed price level assumption of the IS-LM model and explore how wages and prices adjust over time.

> 💡 **Key message:** The natural rate of unemployment is the rate at which the **wage demands of workers are consistent with the price decisions of firms**.

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0. Key Definitions (→ see also Chapter 2 slides)

- **Labour Force**: Employed + Unemployed (those actively looking for work)

> **Unemployment Rate** (u): $u = \frac{\text{Unemployed}}{\text{Labour Force}}$

> **Participation Rate**: $\frac{\text{Labour Force}}{\text{Working-Age Population}}$

> **Employment Rate**: $\frac{\text{Employed}}{\text{Working-Age Population}}$

Labour market flows are large: each year in the EU, roughly 64.5% of the unemployed exit unemployment. Being unemployed is, for most workers, a *quick transition* rather than a long wait — though duration increases significantly during recessions.

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1. Wage Determination

What wages depend on

Wages depend on two main factors:

- **Labour market conditions**

    - if unemployment (u) ↑ → workers' bargaining power ↓ → W ↓
- **Workers' bargaining power**
    - which itself depends on:
        - **Labour market conditions** (↑ u → ↓ bargaining power)
        - **Nature of the job**: the more skills required, the higher the bargaining power

Why firms pay above the reservation wage

Firms usually offer a wage **higher than the reservation wage** (the wage that makes a worker indifferent between working and being unemployed). Reasons:

- **↓ Turnover**
- **Attract talent**
- **↑ Productivity**

> This is what ***efficiency wage theories*** suggest — read textbook box p. 153

▼ Efficiency Wage – Ford Example (1914) - page 153

1. Core idea
    - Firms may pay wages above the market-clearing level to increase worker performance.
    - Higher wage → workers value job more → better behaviour and effort.
2. Ford's wage increase
    - Wage doubled (2.30 dollars → 5 dollars per day), workday shortened.
    - Not to attract workers, but to reduce high turnover and dissatisfaction.
3. Immediate effects
    - Turnover: 370 percent → 16 percent

- Layoffs: 62 percent → almost 0 percent
- Absenteeism: about 10 percent → 2.5 percent

  → Higher wages improved discipline and worker attachment.

4. Productivity and profits
   - Productivity increased (about 30 to 50 percent).
   - Profits also increased, but unclear how much was due to wages versus strong Model T sales.

     → Supports efficiency wage logic, but optimal wage level uncertain.
5. Mechanisms behind efficiency wages

   Higher wages can:
   - Reduce turnover (lower hiring and training costs)
   - Reduce shirking (job loss becomes costly)
   - Increase morale and effort
   - Attract better workers (selection effect)
6. Other motives (not pure theory)
   - Keep unions out
   - Generate publicity
   - Improve company reputation

     → Firms may pay more than strict profit maximization would suggest.
7. Modern parallel: Amazon (2018)
   - Raised minimum wage to 15 dollars per hour.
   - Motives: attract workers, improve image, possibly raise productivity.
   - Effects still uncertain.

Bottom line:

Efficiency wage theory argues that paying above-equilibrium wages can increase productivity enough to justify higher labor costs, though firms may also have strategic motives.

The Wage Determination Equation

$$W = P^e \cdot F(u, z)$$

Where:

- W = aggregate nominal wage in the economy
- P^e = **expected price level** — because wages are set with a future outlook (in nominal terms, before the price level is known)
- $F(u, z)$**: function of unemployment and the catch-all variable** z**.**
  - $\frac{\partial F}{\partial u} < 0$: $\uparrow u \rightarrow \downarrow W$ (negative effect)
  - $\frac{\partial F}{\partial z} > 0$: $\uparrow z \rightarrow \uparrow W$ (positive effect)

The catch-all variable z

z captures **all factors that affect** W **positively**, given u and P^e. Examples of z ↑:

Factor	Mechanism	Effect on W
↑ Unemployment benefits/subsidies/protection/insurance	↑ workers' bargaining power	↑ W
↑ Minimum wage	↑ workers' bargaining power	↑ W
Citizen income	↑ workers' bargaining power	↑ W
↑ Power of unions	↑ workers' bargaining power	↑ W
Firing becomes less easy	↑ workers' bargaining power	↑ W
↑ Centralisation in the wage bargaining process	↑ workers' bargaining power	↑ W

2. Price Determination

Production Function

Firms set prices. We assume they use **only labour** to produce.

- production function: $Y = A \cdot N$
  - Where Y = **output**, A = labour **productivity**, N = **employment**.
    - $A = \frac{Y}{N}$ = output per worker (depends on technology)
- In the textbook: $A = 1$ (simplification) → $Y = N$
- To produce one unit of output, you need $N = \frac{Y}{A} = \frac{1}{A}$ workers

Cost Function

- total costs: $TC = W \cdot N = W \cdot \frac{Y}{A}$

The Price Determination Equation

$$P = (1 + m) \cdot \frac{W}{A}$$

No perfect competition

- firms charge a **markup** m over marginal cost:
  - Marginal Cost: $MC = \frac{W}{A}$ (from $\frac{d(TC)}{dY}$)
  - **Price Determination Equation**: $\boxed{P = (1 + m) \cdot \frac{W}{A}}$

With $A = 1$ → $P = (1 + m) \cdot W$

The markup m depends on:

- **Competition**: if competition ↑ → m ↓
- **Barriers to entry**
- **Demand and its elasticity**

---

3. Equilibrium in the Labour Market

Equilibrium requires two relations:

3a. Wage Setting (WS)

- Comes from the wage determination equation. We now **assume wages depend on the actual price level** P (not P^e), because:
  - It is hard for people to guess P^e
  - In the medium run, $P = P^e$

- Starting from $W = P \cdot F(u, z)$, divide both sides by P:
  - $\frac{W}{P} = F(u, z)$
    - This is the **Wage Setting (WS) relation** — it gives the **real wage that workers obtain**.

- **Properties of WS:**
  - **Downward sloping** in $(u, W/P)$ space
  - The higher u, the lower the real wage workers can obtain (↑ u → ↓ bargaining power → ↓ W/P)
  - A change in u → **movement along** the WS curve
  - If z ↑ (e.g., ↑ bargaining power) → WS curve **shifts up**

3b. Price Setting (PS)

- Comes from the price determination equation: $P = (1 + m) \cdot W$
  - $\frac{W}{P} = \frac{A}{1+m}$
    - This is the **Price Setting (PS) relation** — it gives the **real wage that firms are willing to pay**.
    - With $A = 1$:
      - $\frac{W}{P} = \frac{1}{1+m}$

- **Properties of PS:**
  - **Horizontal line** in $(u, W/P)$ space at $\frac{1}{1+m}$

- Employers don't look at the unemployment rate u when setting prices
- If m ↑ (e.g., less competition) → PS shifts **down** → W/P ↓

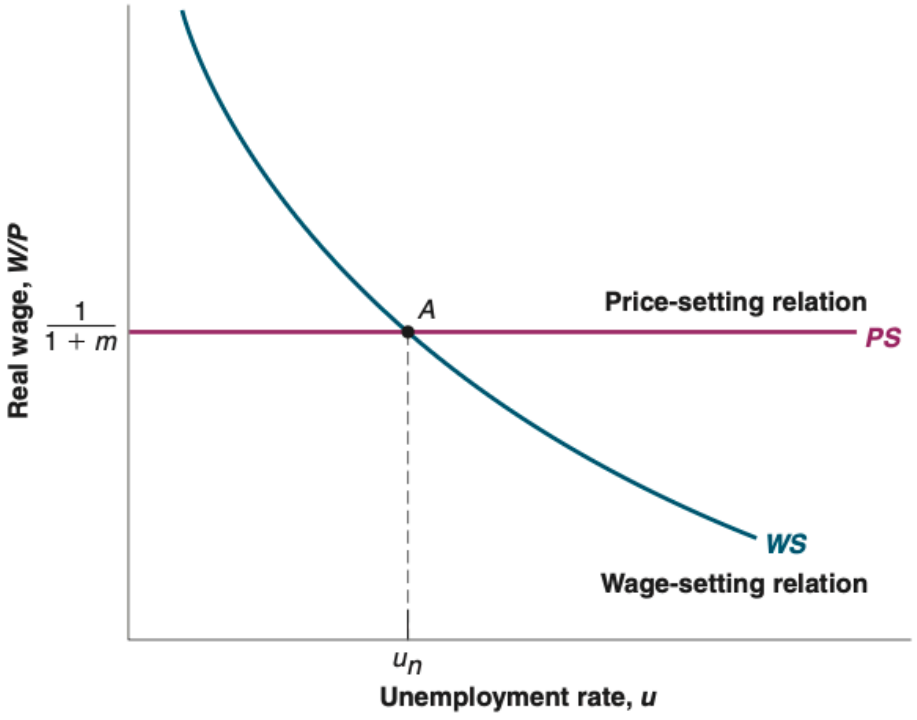
3c. Equilibrium

Setting WS = PS:

> $\frac{W}{P} = \frac{A}{1+m}$
>
> $\frac{W}{P} = F(u, z)$

→ $F(u_n, z) = \frac{A}{1+m}$

Graphically, equilibrium is at the intersection of PS and WS:



4. The Natural Rate of Unemployment

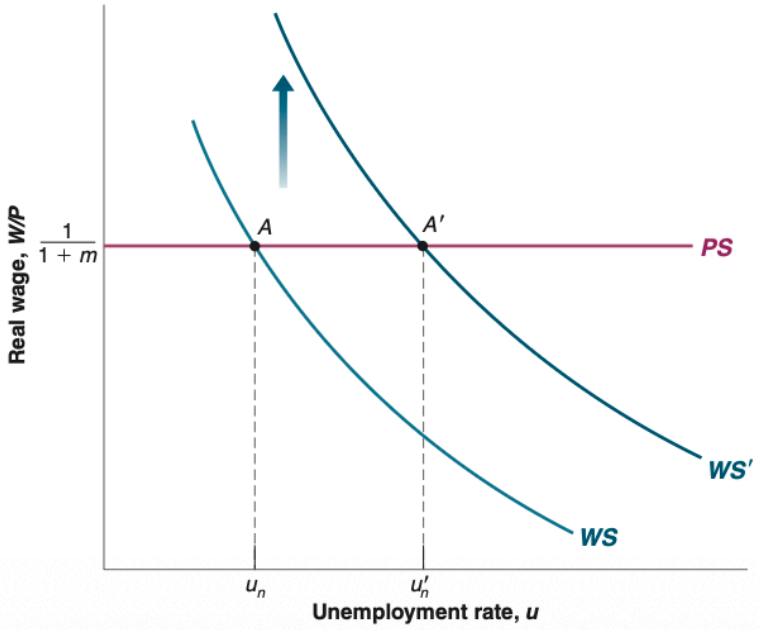
assuming A=1:

$$u_n = \text{ unemployment rate such that } F(u_n, z) = \frac{A}{1+m} = \frac{1}{1+m}$$

> u_n = **Natural (Structural) Rate of Unemployment**: the unemployment rate at which the real wage chosen by **wage setters (workers)** is the same as the real wage chosen by **price setters (firms)**.

Important: The word "natural" is misleading — u_n is **not** a constant of nature. It depends on **institutions and policy through z and m.**

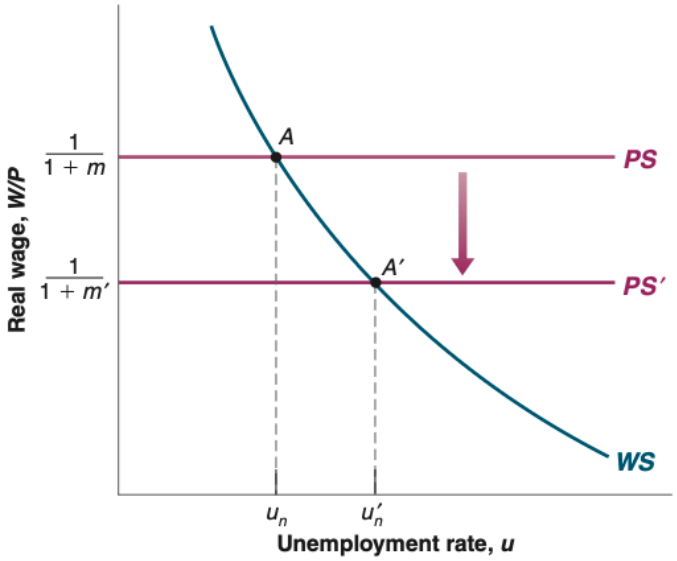
Effect of ↑ Unemployment Benefits (z ↑)



- **WS shifts up (workers demand higher wages at any u)**
- Economy moves along PS from A to A'
- u_n **increases**

> Logic: at a given u, higher benefits → higher real wage demands. **A higher u is needed to bring wages back in line with what firms are willing to pay.**

Effect of ↑ Markup (m ↑)



- **PS shifts down (firms pay lower real wages)**
- Economy moves along WS from A to A'
- u_n **increases**

> Logic: ↑ m → ↑ prices given wages → ↓ real wage. **Workers must face higher unemployment to accept this lower real wage.**

Functional form of F

To make the model operational, we need a specific functional form for $F(u, z)$. A common assumption is:

$$F(u, z) = 1 - \alpha u + z$$

Where $\alpha > 0$ captures how sensitive wages are to the unemployment rate.

Substituting into the equilibrium condition $F(u_n, z) = \frac{1}{1+m}$:

$$1 - u_n + z = \frac{1}{1 + m}$$

Solving for u_n:

$$\boxed{u_n = \frac{1}{\alpha}(1 + z - \frac{1}{1+m})}$$

This makes the comparative statics explicit:

- $z \uparrow \rightarrow u_n \uparrow$ (higher z directly raises u_n)
- $m \uparrow \rightarrow \frac{1}{1+m} \downarrow \rightarrow u_n \uparrow$ (higher markup reduces the real wage firms pay, requiring higher unemployment to push workers to accept it)

---

5. Short Run vs. Medium Run

	Short Run	Medium Run
P vs P^e	$P \neq P^e$ possible	$P = P^e$
Unemployment	Can differ from u_n	Tends toward u_n
Output	Determined by IS-LM factors	Determined by labour market
Key factors	Monetary policy, fiscal policy, confidence	z, m

> **Coming next:** Chapter 8 relaxes $P = P^e \rightarrow$ derives the **Phillips curve** (relation between unemployment and inflation). Chapter 9 integrates everything.

---

5. Reasoning Using the Model

Using the functional form $F(u, z) = 1 - u + z$ and the price-setting relation, we can trace the effects of any shock step by step.

Example 1: Increase in unemployment benefits ($z \uparrow$)

Step	What happens
$z \uparrow$	**Workers' outside option improves → they demand a higher wage at any u**
WS shifts **up**	$\frac{W}{P} = 1 - u + z$ — for any given u, the real wage is now higher
PS unchanged	$\frac{W}{P} = \frac{1}{1+m}$ — firms' pricing is unaffected

Step	What happens
New equilibrium	The intersection moves right → u_n **increases**
Intuition	**A higher unemployment rate is needed to discipline workers back to the wage firms are willing to pay**

Example 2: Increase in markup (m ↑, e.g. less antitrust enforcement)

Step	What happens
m ↑	**Firms raise prices given wages → real wage they pay falls**
PS shifts **down**	$\frac{W}{P} = \frac{1}{1+m}$ decreases
WS unchanged	Workers' wage-setting behaviour is unaffected
New equilibrium	The intersection moves right → u_n **increases**
Intuition	**Workers must face higher unemployment to accept the now-lower real wage firms impose** **→ workers won't accept lower real wages if unemployment does not grow**

> 🔑 In both cases u_n increases, but through **different channels**: in Example 1 the WS moves; in Example 2 the PS moves.

---

6. Natural Level of Output

- Given the natural rate of unemployment u_n, we can derive the corresponding **natural level of output** Y_n.
- remember:
  - L = labour force
  - N = people employed
  - U = people unemployed

From unemployment to employment:

$$u_n = \frac{U}{L} = \frac{L - N_n}{L} = 1 - \frac{N_n}{L}$$

$$\implies N_n = L(1 - u_n)$$

From employment to output (using $Y = N$ with $A = 1$):

$$\boxed{Y_n = N_n = L(1 - u_n)}$$

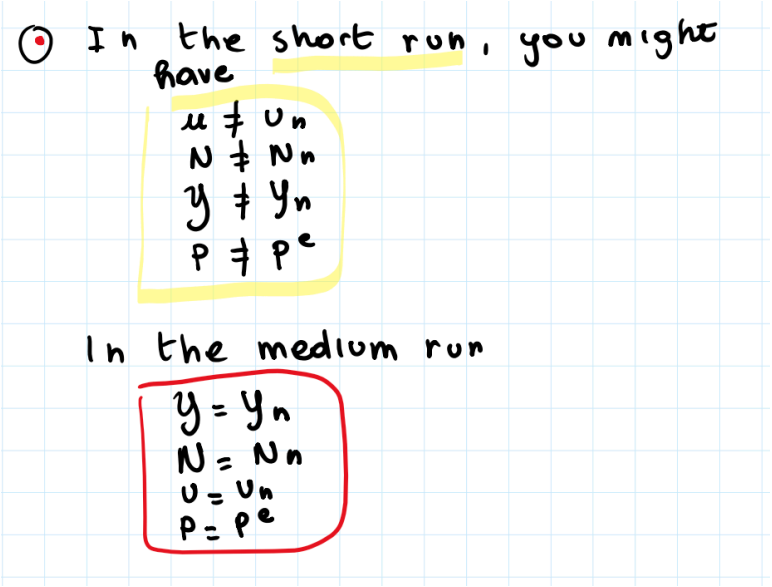
Where L = labour force (assumed constant).

> This means **any factor that changes u_n (i.e., a change in z or m) also changes Y_n in the opposite direction: u_n ↑ → N_n ↓ → Y_n ↓.**

The natural level of output is **not** affected by monetary or fiscal policy in the medium run — only by structural factors z and m.

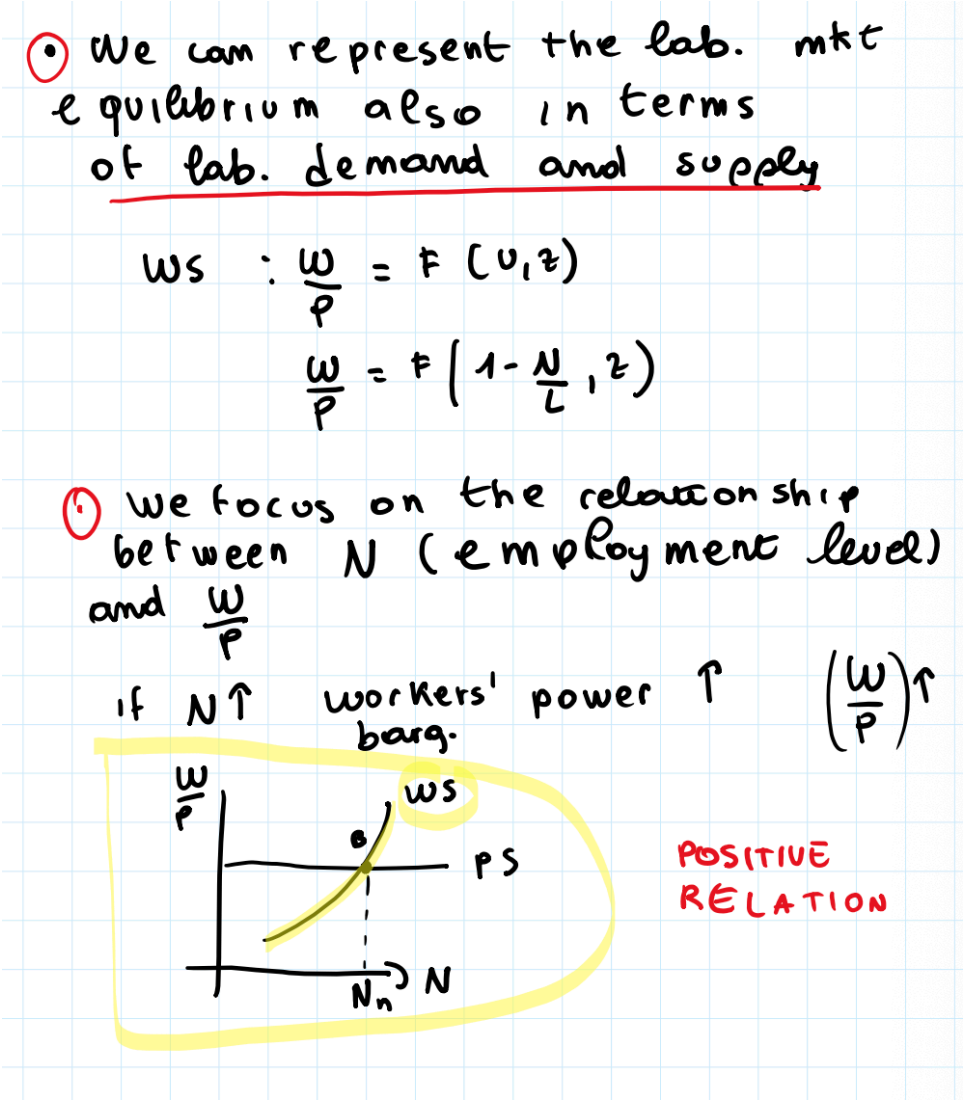
- then at equilibrium

$$F\left(1 - \frac{Y_n}{L}, z\right) = \frac{1}{1+m}$$



Appendix: WS/PS Relations vs. Labour Supply and Demand

- as U rise then u decreases, so as W/S is decreasing on u for WS then it is increasing on N



Final remarks

- **In the medium run the price level is equal to the expected price level.**
- In the **short run, the price level may well turn out to be different from what is expected when nominal wages are set.** Hence, in the short run, unemployment is not necessarily equal to the natural rate or output is not necessarily equal to its natural level. Output in the short run is determined by monetary and fiscal policy.
- **In the medium run, output tends to return to its natural level.** In the medium run, the economy will converge to the natural level of output and **deviations from this level of production are transitory**. If there is a permanent supply shock, the natural level of production changes and the economy will converge to this new level.

- We will see that **monetary and fiscal policies have no effect on the natural level of production.**
- **Monetary policy in the medium run affects the price level only; in the medium run, fiscal policy affects the price level and the composition of aggregate demand.**
- The policies that affect the natural level of unemployment, and therefore the natural level of production, are **supply-side policies**, which are policies that affect the degree of competition in the goods market or the degree of flexibility of the labour market.

Chapter 8 - The Phillips Curve

☑ Reviewed ☐

📈 Macroeconomics: Chapter 8 – The Phillips Curve

Reference: Lectures 12 & 13 and Chapter 8 Textbook

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① - The Phillips Curve

> Derived from the **wage** and **price determination** equations of Chapter 7.

- **Wage determination:** $W = P^e F(u, z)$
- **Price determination:** $P = (1 + m)W$ *(assuming $A = 1$)*

Substituting the wage equation into the price determination equation:

$$\frac{P}{1+m} = P^e F(u, z) \quad \Rightarrow \quad P = P^e(1+m)F(u, z)$$

Intuition

- If $P^e \uparrow \rightarrow W \uparrow \rightarrow$ firms increase prices $\rightarrow P \uparrow$
- If $u \uparrow \rightarrow$ bargaining power $\downarrow \rightarrow W \downarrow \rightarrow P \downarrow$

Using the specific functional form $F(u, z) = 1 - \alpha u + z$:

$$P_t = P_t^e(1+m)(1 - \alpha u_t + z)$$

Introducing Inflation

Divide both sides by P_{t-1}:

$$\frac{P_t}{P_{t-1}} = \frac{P_t^e}{P_{t-1}}(1+m)(1 - \alpha u_t + z)$$

Since $\frac{P_t}{P_{t-1}} = 1 + \pi_t$ and $\frac{P_t^e}{P_{t-1}} = 1 + \pi_t^e$:

$$(1+\pi_t) = (1+\pi_t^e)(1+m)(1-\alpha u_t + z)$$

If π_t, π_t^e and m are very small

- the cross terms are even smaller and can be eliminated in the approximation
- we approximate to get:

> **Equation ① — General Phillips Curve**
>
> $$\pi_t = \pi_t^e + (m+z) - \alpha u_t$$

Inflation depends on: expected inflation π_t^e, markup & labour market factors $(m+z)$, and the unemployment rate u_t.

---

② The Original Phillips Curve

We assume $\pi_t^e = \bar{\pi}$ (inflation expectations are **anchored**):

- Inflation is not persistent → current inflation **cannot** be used to predict future inflation
- Expected inflation revolves around a constant value $\bar{\pi}$

Substituting into Equation ①:

> **Equation ② — Original Phillips Curve**
>
> $$\pi_t = \bar{\pi} + (m+z) - \alpha u_t$$

→ There is a stable **negative trade-off between u and π: low unemployment → high inflation, and vice versa.**

> 📌 **Historical note:** In 1958, **A.W. Phillips** used UK data (1861–1957) and found a clear inverse relation between wage inflation and unemployment. In 1960, **Samuelson & Solow** confirmed it for the US (1900–1960). It appeared to give policymakers a menu: accept higher π to achieve lower u.

> Throughout the 1960s, the US moved steadily up the curve — u fell from 6.8% to 3.4%, while π rose from 1% to 5.5%.

---

③ Expectation-Augmented PC (The 1970s Breakdown)

In the 1970s, the relation between u and π broke down. High u and high π appeared **simultaneously**.

Why? Wage setters changed how they formed inflation expectations, because **inflation became persistent** — high inflation in one year became more likely to be followed by high inflation the next.

Expectations are now formed as:

$$\pi_t^e = (1-\theta)\bar{\pi} + \theta\pi_{t-1}$$

- $\bar{\pi}$ = constant anchored value
- π_{t-1} = last year's actual inflation
- The **higher** θ, the more important past inflation is for forming expectations → **expectations started to de-anchor**

Historical shift in θ:

Period	θ	Interpretation
Before 1970s	≈ 0	Expectations anchored to $\bar{\pi}$
Mid-1970s	≈ 1	People expect this year's $\pi \approx$ last year's

Substituting into Equation ①: $\pi_t = (1-\theta)\bar{\pi} + \theta\pi_{t-1} + (m+z) - \alpha u_t$

- If $\theta = 0$ → back to the **original PC** (Equation ②)
- If $\theta = 1$ → **fully de-anchored** → Equation ③

When $\theta = 1$:

> **Equation ③ —** Modified / Accelerationist PC

$$\pi_t - \pi_{t-1} = (m + z) - \alpha u_t$$

Also called: **Expectations-Augmented PC** / **Adaptive-Expectations PC**

→ u now affects the **change in inflation** $\Delta\pi$, **not** the level of π.

> 📌 **Friedman & Phelps (late 1960s):** Predicted the breakdown *before* it happened. They argued the trade-off was an illusion — it could only hold if wage setters were *permanently* wrong about inflation. They introduced the concept of the **natural rate of unemployment** u_n, arguing u cannot be kept below u_n in the long run. Both received the Nobel Prize (Friedman 1976, Phelps 2006).

---

④ Empirical PC for US Data — Re-anchoring in the 1990s

In the **1980s**, Central Banks (especially the Fed) committed to **low and stable inflation** (target $\approx 2\%$). By the **mid-1990s**, inflation expectations became **re-anchored** to the CB target → back to Equation ②.

Collecting US data for **1996–2018**, the estimated Phillips Curve is:

> **Equation ④** — Empirical US Phillips Curve (1996–2018)
>
> $$\pi_t = 2.8\% - 0.16\, u_t$$

Where $2.8\% = \bar{\pi} + (m + z)$ and $\alpha = 0.16$.

> The shape of the PC depends entirely on how **expectations are formed**, which itself depends on the **behaviour of inflation**.

PC and u_n — The Natural Rate of Unemployment

- u_n = **natural level of unemployment**
  - achieved in the **medium run** when $P = P^e$, i.e. $\pi = \pi^e$.

- From Equation ①: $\pi - \pi^e = (m + z) - \alpha u$
  - In the medium run $\pi = \pi^e$, so:

$$0 = (m + z) - \alpha u_n \quad \Rightarrow \quad u_n = \frac{m + z}{\alpha}$$

    - Higher m or z → higher u_n (see Chapter 7)

⑤ and ⑥ - Rewriting the PC using u_n

Starting again from Equation ①:

$$\pi_t - \pi_t^e = (m + z) - \alpha u_t = -\alpha\left(u_t - \frac{m + z}{\alpha}\right) = -\alpha(u_t - u_n)$$

> **Equation ⑤ —** Modified PC with natural rate
>
> $$\pi_t - \pi_t^e = -\alpha(u_t - u_n)$$

- If $u_t < u_n \rightarrow \pi_t > \pi_t^e$.
- If $u_t > u_n \rightarrow \pi_t < \pi_t^e$.

Now assume $\pi_t^e = \pi_{t-1}$ (adaptive expectations):

> **Equation ⑥ —** Modified PC (adaptive expectations)
>
> $$\pi_t - \pi_{t-1} = -\alpha(u_t - u_n)$$

The change in inflation depends on the gap between actual and natural unemployment.

- $u_t < u_n \rightarrow \pi_t > \pi_{t-1}$:
  - **Workers underestimate the general price level** (since $P_t > P_t^e$)
  - They **overestimate their real wage** → supply **more labour** → $u_t < u_n$ realised

    - **Workers gain bargaining power** → demand higher nominal wages → firms' costs ↑ → $P \uparrow \rightarrow \pi_t > \pi_{t-1}$

- $u_t > u_n \rightarrow \pi_t < \pi_{t-1}$: downward pressure on inflation

RECAP — Medium-Run Equilibrium

If $\pi_t = \pi_{t-1}$, then $P_t = P_{t-1}$, $u_t = u_n$, $Y = Y_n$:

> - Inflation **expectations are correct**

- **Monetary policy** affects **only the price *level*** → but Y_n unchanged
- **Fiscal policy** affects the **price level** and the ***composition*** **of demand** → but Y_n unchanged

> **To change Y_n, you need supply-side / structural reforms**: labour market flexibility, competition policy

> u_n is also called the **NAIRU** — ***Non-Accelerating Inflation Rate of Unemployment*** —
>
> → the unemployment rate needed to **keep inflation constant**.

Example

Given the empirical PC: $\pi_t - \pi_{t-1} = 3\% - 0.5\, u_t$

Find u_n: set $\pi_t = \pi_{t-1} \rightarrow 0 = 3\% - 0.5\, u_n$

$$u_n = \frac{3\%}{0.5} = 6\%$$

---

⑦ - Wage Indexation

- **Empirical fact:** when inflation is high, it tends to be **more variable** → bad for workers.
    - If $\pi_t > \pi_t^e$ → real wage $\frac{W}{P}$ falls → workers are worse off.

Solution: Wage Indexation — wages increase automatically in line with inflation.

> 📌 Example: Argentina's problem with inflation, where complete wage indexation caused inflation to feed itself.

Let λ = proportion of labour contracts that are **indexed** (respond to **actual inflation** π_t).

$(1-\lambda)$ = proportion that are **not indexed** (respond to **expected inflation** π_t^e).

→ $[\lambda\pi_t + (1-\lambda)\pi_t^e]$ = effective expected inflation

Starting from Equation ⑤ and substituting both types of contract:

$$\pi_t = [\lambda\pi_t + (1-\lambda)\pi_t^e] - \alpha(u_t - u_n)$$

Assuming $\pi_t^e = \pi_{t-1}$ and solving for $(\pi_t - \pi_{t-1})$:

> **Equation ⑦ — Modified PC with wage indexation**
>
> $$\pi_t - \pi_{t-1} = -\frac{\alpha}{1-\lambda}(u_t - u_n)$$

Key Takeaways on Indexation

$\frac{\alpha}{1-\lambda}$ = **sensitivity of $\Delta\pi$ to unemployment**

- **increasing in λ:**

λ	Effect
$\lambda = 0$	No indexation. $u \downarrow \rightarrow W \uparrow \rightarrow P \uparrow \rightarrow \pi \uparrow$. But wages don't respond further once set.
$\lambda \uparrow$	When $P \uparrow$, wages immediately adjust ↑, pushing P further ↑. Effect of u on $\Delta\pi$ is **amplified**.
$\lambda \rightarrow 1$	**Full indexation**. Small changes in u → **large** changes in π. The relation between π and u can eventually **disappear** altogether.

Deflation & Stagflation

Deflation

When inflation is **very low or negative**, the PC relationship may **break down**.

- **Workers resist cuts in nominal wages even when prices are falling (*money illusion*) — they accept a real wage cut via inflation more easily than an overt nominal wage cut.**
    - Workers are **more likely to be dissatisfied by a cut in the nominal wage with inflation = 0, than seeing their wage unchanged but with a positive inflation**
        - **In a world with 3% inflation:** A company that is struggling can simply give 0% raises. They have effectively cut their labor costs by 3% without any worker realising they've been "cut."
        - **In a world with 0% or negative inflation (Deflation):** That same company is stuck. They can't cut the nominal wage without a riot, so their only choice to save money is to **fire people.**

> 📌 Evidence: during the Great Depression (1930s), very high unemployment led to only **limited deflation**. Similar dynamics appeared in some European countries during the 2008–09 crisis.

Stagflation

Stagflation = Stagnation + Inflation

Component	Description
Stagnation	Low growth, high unemployment
Inflation	High and persistent inflation

→ u is **high** and π is **high** simultaneously — difficult for policymakers.

> 📌 The 1970s oil shocks are the classic example: adverse supply shocks shifted the PC, producing stagflation that exposed the limits of the original trade-off.

Summary of Key Equations

#	Equation	Condition	Name
①	$\pi_t = \pi_t^e + (m + z) - \alpha u_t$	General	Phillips Curve
②	$\pi_t = \bar{\pi} + (m + z) - \alpha u_t$	$\pi_t^e = \bar{\pi}$ (anchored)	Original PC
③	$\pi_t - \pi_{t-1} = (m + z) - \alpha u_t$	$\theta = 1$ (de-anchored)	Modified / Accelerationist PC
④	$\pi_t = 2.8\% - 0.16\, u_t$	US 1996–2018	Empirical PC
⑤	$\pi_t - \pi_t^e = -\alpha(u_t - u_n)$	With u_n	Modified PC
⑥	$\pi_t - \pi_{t-1} = -\alpha(u_t - u_n)$	$\pi_t^e = \pi_{t-1}$	Modified PC (adaptive)
⑦	$\pi_t - \pi_{t-1} = -\dfrac{\alpha}{1-\lambda}(u_t - u_n)$	With wage indexation	Modified PC + Indexation

Chapter 9 - The IS-LM-PC Model

Reviewed ☐

Reference: Macro1.pdf and Chapter 9 Textbook

This model bridges the **short run** (where demand determines output) and the **medium run** (where output returns to its potential level), by combining the IS-LM model with the Phillips Curve.

- **Short run:** $Y \neq Y_n$, $u \neq u_n$ — output and unemployment are not at their natural levels.
- **Medium run:** $Y = Y_n$, $u = u_n$ — the economy returns to potential.

---

1. Short Run

→ Extended IS-LM model (2nd version)

The short-run equilibrium is defined by the extended IS-LM system:

> IS: $Y = C(Y - T) + \mathcal{I}(Y, r + x) + G$
> LM: $r = \bar{r}$

- ***IS***:
  - **Output is determined by demand** (consumption + investment + government spending). Investment depends on output and the **real borrowing rate** $r + x$, where r is the CB's policy rate and x is a risk premium.
- ***LM***:
  - The **Central Bank directly sets the real interest rate** $\bar{r}$**.** The CB adjusts the money supply behind the scenes to achieve this target rate.

Point **A** = short-run equilibrium: the intersection of the IS and LM curves.

- If $Y > Y_n$: **positive output gap** → the economy is overheating, putting upward pressure on inflation ($\pi > \bar{\pi}$).

---

2. Medium Run

→ Defined by the **Phillips Curve (PC)**

The PC in terms of unemployment (equation 5):

$$\pi - \pi^e = -\alpha(u - u_n)$$

- **Intuition:** if $u < u_n$, then $\pi > \pi^e$ — **unemployment below the natural rate means workers gain bargaining power, wages rise, firms' costs rise, and prices rise more than expected.**

We want to rewrite the PC in terms of Y instead of u. This takes 4 steps.

Step 1 – From unemployment to output

- By definition: $u = 1 - \frac{N}{L}$ → $N = L(1 - u)$
- With $Y = AN$ and $A = 1$: $Y = N = L(1 - u)$
- Hence:
  - $u = 1 - \frac{Y}{L}$

Step 2 – Potential output and the output gap

- If $u = u_n$, then $N = N_n = L(1 - u_n) = Y_n$
- Policy makers want to keep output around Y_n (potential output)
- **Output gap**: $Y - Y_n$ = difference between actual output and its natural/potential level

$$Y - Y_n = L(1 - u) - L(1 - u_n) = -L(u - u_n)$$

Condition	Implication
$u = u_n$	$Y = Y_n$ — zero output gap
$u > u_n$	$Y < Y_n$ — negative output gap
$u < u_n$	$Y > Y_n$ — positive output gap

Step 3 – General PC equation in terms of output

From Step 2: $u - u_n = -\frac{Y - Y_n}{L}$. Substituting into equation (5):

> $\pi - \pi^e = \frac{\alpha}{L}(Y - Y_n)$ — **General equation of the PC in the IS-LM-PC model**

Step 4 – How inflation expectations are built

There are 2 main ways:

a. Anchored expectations: $\pi^e = \bar{\pi}$ → anchored to the CB target (or a fixed value)

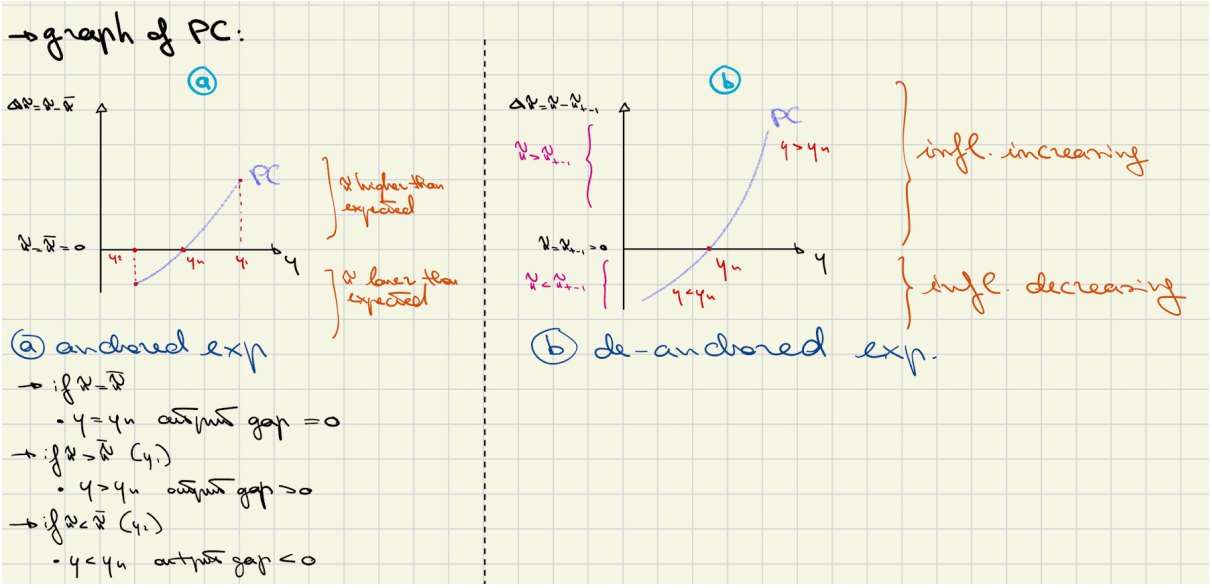
> $\pi - \bar{\pi} = \frac{\alpha}{L}(Y - Y_n)$ — anchored expectations

- If $Y > Y_n$: $\pi > \bar{\pi}$
  - → **inflation is higher than expected** (not increasing, just above target)
  - Intuition: $Y > Y_n \rightarrow u < u_n \rightarrow$ workers' power ↑ → W ↑ → firms' cost ↑ → P ↑ → so $\pi > \bar{\pi}$

b. De-anchored expectations: $\pi^e = \pi_{t-1}$ → people expect this year's inflation = last year's (don't believe the CB's target)

> $\pi - \pi_{t-1} = \frac{\alpha}{L}(Y - Y_n)$ — de-anchored expectations

- If $Y > Y_n \rightarrow \pi > \pi_{t-1}$
  - → **inflation is increasing**



- There are also other ways to define π^e:
  - **c.** $\pi^e = 0$: PC becomes $\pi = \frac{\alpha}{L}(Y - Y_n)$
  - **d.** $\pi^e = \bar{k}$ (given number): PC becomes $\pi - \bar{k} = \frac{\alpha}{L}(Y - Y_n)$

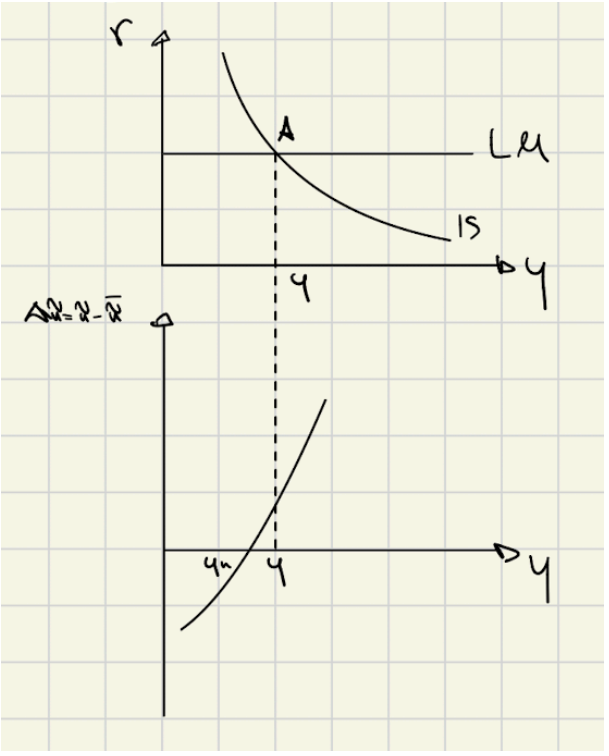
---

3. The IS-LM-PC Model

let's consider a positive output gap

Short-run analysis

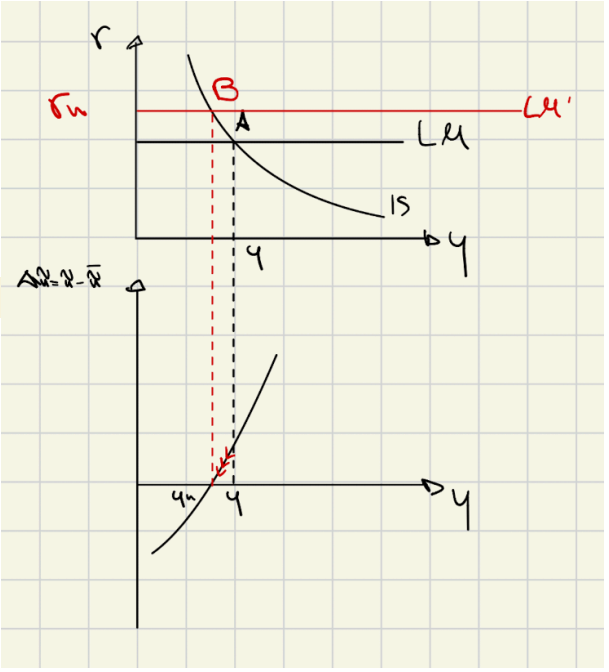
- SHORT RUN
  - Point **A** = short-run equilibrium: $Y > Y_n$, $Y \neq Y_n$ → **positive output gap**



- MEDIUM RUN
  - Using anchored expectations (a): at A, since $Y > Y_n$, **inflation is higher than expected** ($\pi > \bar{\pi}$)

Medium-run analysis

- **If no policy change:**
  - Y remains above potential → unlikely to persist
  - Inflation remains above the target
  - If π is always $> \bar{\pi}$ → people will **de-anchor**: $\pi^e = \pi_{t-1}$
    - With $Y > Y_n$, inflation starts to **increase**
      - **becomes self-reinforcing**
      - if inflation is high, people also expect it will continue to be high



- **CB needs to intervene:** **contractionary monetary policy**
  - it wants $\pi = \bar{\pi} \rightarrow \uparrow r \rightarrow \downarrow I \rightarrow \downarrow Z \rightarrow \downarrow Y$ back to Y_n
  - The economy moves **along the PC** and reaches **B = medium-run equilibrium:**

$$Y = Y_n, \quad u = u_n, \quad \pi = \bar{\pi}, \quad P = P^e, \quad r = r_n$$

r_n: **real natural interest rate / Wicksellian rate of interest**

- = the real interest rate **associated with Y_n, which is in turn associated with u_n, N_n**
- = the real interest rate for which the **goods market is in equilibrium in the medium run**

In reality, the CB's role is not easy:

- Doesn't exactly know Y_n
- r **is adjusted slowly to observe what happens** → it takes time to reach Y_n

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4. Real Borrowing Rate

The actual rate at which firms and consumers borrow is $r_n + x$, where x is the **risk premium**.

- From the Fisher equation: $i = r + \pi^e$
- At **medium run, with anchored expectations**: $i = r_n + \bar{\pi}$
  - the higher $\bar{\pi}$, the higher i

Money market equilibrium:

- -

$$\frac{M}{P} = Y \cdot L(i)$$

- In the **medium run:**

> $$\frac{M}{P} = Y_n \cdot L(r_n + \bar{\pi})$$

  - Since Y_n and r_n are constant in the medium run → we reach a **steady state**:
    - M/P must be constant
      - Since M/P constant $\Longrightarrow$ P grows at the same rate as M
        - → $\pi = g_M$ (where gm is **rate of nominal money growth**)
  - So, since in the medium run $\pi = \bar{\pi}$:

> $$i = r_n + \bar{\pi} \Longrightarrow i = r_n + g_M$$

  - **In the medium run, real variables are independent of monetary policy.**

    → **"Neutrality of money in the medium run"** — no effect on real variables.
    - When M^s changes → P, nominal wages, and nominal variables are affected, but Y_n is **not**
      - output raises temporarily, but over time everything start to cost more
    - **Monetary policy cannot change Y_n**

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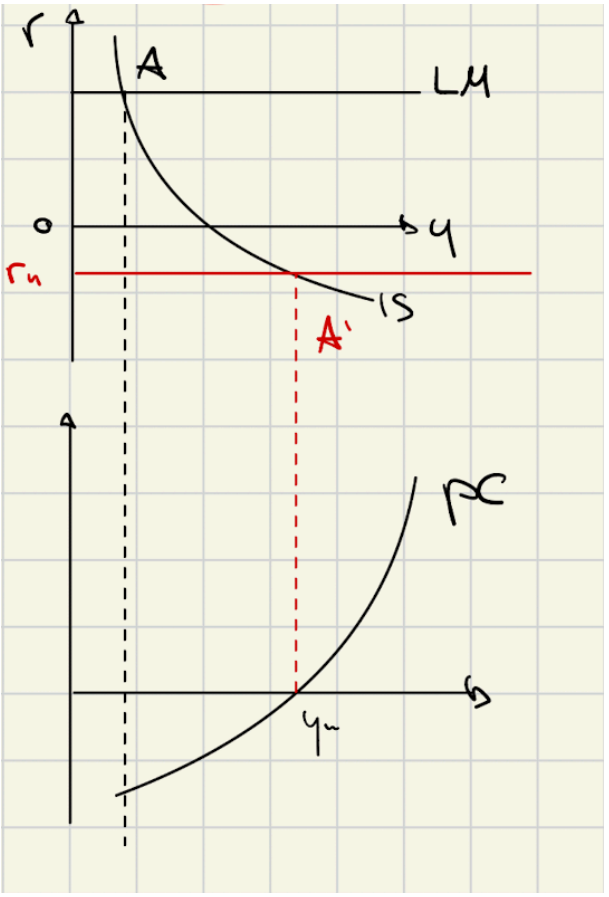
5. The Zero Lower Bound and the Deflation Spiral

Short run

- Assume that the economy is in a **recession**.
  - Initial equilibrium at point A (S.R.):
  - Y very low ($Y \ll Y_n$) → **negative output gap**
  - $\pi < \bar{\pi}$



Medium run

- The CB should lower r until $Y = Y_n$ (LM shifts right to LM').
  - At A': $r = r_n$, $Y = Y_n$, $\pi = \bar{\pi}$
  - But the r_n needed **may be negative** because the recession is very deep

Suppose the CB cannot lower r further and the economy stays at A:

- People realise π is always $< \bar{\pi}$ → they **de-anchor**: $\pi^e = \pi_{t-1}$
- People **anticipate deflation** → deeper and deeper deflation: Y ↓ and π continues to fall
  - they delay purchases and investments because they expect prices to decrease, so Y continues to fall
    - saving/buying bonds is more convenient than borrowing or consuming in general (which become more expensive)

→ "Deflation spiral or trap"

- **The self-reinforcing mechanism:**
  - Low output → deflation (π ↓↓)

- At ZLB ($i = 0$): $r = i - \pi = -\pi$
  - **As deflation increases → r rises** (even without CB action)
    - → ↓ I → ↓ Y → even more deflation
    - saving is more attractive than spending

Key distinction:

- If CB doesn't intervene **but** π^e remains anchored → no deflation spiral
- **The spiral only becomes self-reinforcing once expectations de-anchor and people start anticipating progressively larger deflation**

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