# Money, Inflation, and Output

Jesús Bueren

Católica-Lisbon

2025-2026

# Monetary Economics

- The role of money in the economy is one of the most mysterious aspects of economics
- Key questions:
  - What gives money its value?
  - Why does its value change over time?
  - How and why does monetary policy affect output and employment?

# What Is Money?

- This question is trickier than it sounds.
- Economists usually define **money** by what it does.
- Money is anything that serves three roles:
  - **Medium of exchange**: it is used to pay for goods and services
  - **Unit of account**: prices are written in terms of it
  - **Store of value**: you can hold it and use it later
- Many different things have been used as money:
  - Paper bills and coins
  - Gold and silver
  - Cigarettes (in prisons and during wars)

# A Society Without Money

- Imagine a society of small farmers.
- Each household is **self-sufficient**:
  - They produce everything they consume
  - Food, clothing, shelter, tools
- There is **no trade**.
- What role does money play in such a society? Money has no role.
- If there is no trade, there is no need for money.

# Specialization Appears

- Over time, people realize they are good at different things.
- For example:
  - One person is very good at making shoes
  - Another at baking bread
- People begin to specialize.
- They produce more than they need of one good
- And exchange it for other goods
- Trade begins.

# The Problem with Trade

- Now imagine:
  - The baker makes bread
  - The shoemaker makes shoes
  - The teacher teaches
- Trade becomes complicated.
- Example:
  - The baker wants shoes $\rightarrow$ goes to the shoemaker
  - The shoemaker wants a lesson $\rightarrow$ goes to the teacher
  - The teacher wants bread $\rightarrow$ goes to the baker
- Everyone has what someone else wants — yet no trade happens!
- This is the **double coincidence of wants problem**.
- Trade may fail even when gains from trade exist.

## Something Becomes Money

- To make trading easier, people start accepting things they don't need right away.
- Example:
  - The shoemaker takes bread even if she does not want to eat it now
  - Because she knows the teacher will accept bread
- Bread starts to move around as a way to pay.
- But bread is not perfect:
  - It goes bad
  - It is hard to carry
- A better solution:
  - Bread tickets (pieces of paper that can be exchanged for bread)
- These tickets start to circulate and become money.

# Bread Tickets as Money

- What can go wrong with bread tickets?
  - People might try to make fake tickets (**counterfeiting**)
  - Baker might not have enough bread to give when tickets are exchanged (**default**)
  - If people don't trust the baker, they may rush to trade tickets for bread (**run on the baker**)
- The value of tickets depends on people trusting the baker

# What Makes Good Money?

For something to work well as money, it usually needs several key properties:

- Hard to fake: People must trust that it is real.
- Easy to carry: Transactions happen in many places.
- Durable: Should last a long time and not spoil (coffee beans better than strawberries!).
- Divisible: Can pay exact prices and give change easily.
- Widely accepted: Everyone must agree it is money and accept it.
- Stable value: Its worth should not change too much over time so people can plan and save.

# From GDP to Inflation

- In Chapter 1, we wanted to measure changes in **real GDP**, not changes coming just from prices.
- Now the focus is different: we want to measure changes in prices.
- That is what **inflation** is about.
- First, we study how to measure inflation.
- Then we ask whether inflation matters for the **real economy**, and if so, how.

# Measuring Inflation

- **Definition:** A generalized increase in the price level.
- **The Challenge:** Not all prices move together. A *Bifana* might cost more while Netflix gets cheaper.

## Inflation Formula

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

Where $P_t$ is the price index today. If $\pi < 0$, we have **Deflation**.

# Measure 1: The Consumer Price Index (CPI)

- The most common measure. Based on what households **consume**.

Example: The Erasmus/Student Basket

| Good | Qty | Price 2024 | Price 2025 |
|---|---|---|---|
| Imperial (Beer) | 50 | €1.50 | €2.00 |
| Pastel de Belém | 20 | €1.20 | €1.30 |
| Padel Court Rent | 5 | €20.00 | €25.00 |
| **Total Basket** | | **€199** | **€251** |

- **Inflation:** $\pi_{2025} = \dfrac{251 - 199}{199} = 26.1\%$ (Expensive year in Santos!)

# Measure 2: The GDP Deflator

- Derived from production (everything produced in Portugal).
- **Formula:**

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

- Example: If we produce a lot of Cork and Port Wine for export, their price changes affect the Deflator, even if local students don't buy them.
- A surge in the price of Port wine would increase the GDP deflator but would not change much the CPI
- Pro: The basket is allowed to change
- Con: Might be relatively different from how inflation impacts household budgets

# Nominal vs. Real Interest Rates

- **Nominal Rate ($i$):** The % extra you get in Euros.
- **Real Rate ($r$):** The % extra you get in **purchasing power** (actual goods).

## The Fisher Equation

$$1 + r_{t+1} = \frac{1 + i_{t+1}}{1 + \pi_{t+1}}$$

$$r_{t+1} \approx i_{t+1} - \pi_{t+1}$$

*"The real return is what is left after the inflation 'monster' eats your gains."*

- **Scenario:** You lend €100 to a friend to buy a surfboard, at 10% interest.
- In one year, you get €110.
- **But:** If surfboard prices rose by 10% ($\pi = 10\%$), your **real interest rate is 0%**. You can still only buy exactly one surfboard.

# The Quantity Equation

- The quantity theory of money links money to prices and inflation.
- Let:
  - $M_t$ = money supply (currency in circulation)
  - $V_t$ = velocity of money
  - $P_t$ = price level
  - $Y_t$ = real GDP
- The **quantity equation** is:

$$\underbrace{M_t V_t}_{\text{effective amount of money used in transactions}} = \underbrace{P_t Y_t}_{\text{nominal GDP}}$$

- Velocity $V_t$ measures how often, on average, each unit of money is used in transactions during a year.

# The Quantity Equation

## Example 1

- Suppose nominal GDP is:

$$P_t Y_t = 1000$$

- And the amount of money in circulation is:

$$M_t = 200$$

- From the quantity equation:

$$M_t V_t = P_t Y_t$$

- Velocity must satisfy:

$$V_t = \frac{P_t Y_t}{M_t} = \frac{1000}{200} = 5$$

- Each unit of money is used 5 times per year to finance all transactions in the economy

# The Quantity Equation

## Example 2: Theory of the Price Level

- Consider two economies, A and B:
  - Same real output: $Y = 100$
  - Same velocity of money: $V = 5$
- Money supply differs:
  - Economy A: $M^A = 200$
  - Economy B: $M^B = 400$
- Implied price levels:

$$P^A = \frac{M^A V}{Y} = \frac{200 \cdot 5}{100} = 10$$

$$P^B = \frac{M^B V}{Y} = \frac{400 \cdot 5}{100} = 20$$

- Economy B has twice as much money and prices are twice as high

# The Classical Dichotomy

- The classical dichotomy separates the economy into:
  - Real GDP determined by real variables (technology, preferences, invesmtment, institutions)
  - Nominal GDP determined by money
- As we saw in the previous example money affects prices, but not real quantities in the long-run:

$$M \uparrow \Rightarrow \; P \uparrow \quad \text{but} \quad Y, r, w \text{ unchanged}$$

- This implies long-run monetary neutrality:
  - Changes in money supply affect nominal variables only
  - Real economic outcomes are unchanged

# The Classical Dichotomy

## Example: A Meteorite from the Sky

- Consider an economy where money consists of gold.
- One day, a meteorite made of pure gold falls from the sky.
  - The total stock of gold in the economy doubles
  - Real resources, technology, and preferences are unchanged
- What happens in the long run?
  - The money supply doubles: $M' = 2M$
  - Real output remains unchanged: $Y' = Y$
  - Velocity is unchanged: $V' = V$
- By the quantity equation:

$$MV = PY \quad \Rightarrow \quad P' = 2P$$

  - Prices double
  - Real quantities are unaffected
  - Gold is neutral in the long run

# The Quantity Theory for Inflation

- Recall the quantity equation:

$$M_t V_t = P_t Y_t$$

- Take logs and first differences:

$$g^M + g^V = g^P + g^Y$$

where:

- $g^M$ = growth rate of money supply
- $g^V$ = growth rate of velocity (assume 0)
- $g^P$ = inflation rate ($\pi$)
- $g^Y$ = growth rate of real GDP

- With $g^V = 0$, we obtain the key long-run relation:

$$\pi = g^M - g^Y$$

# Example: Inflation from Money Growth

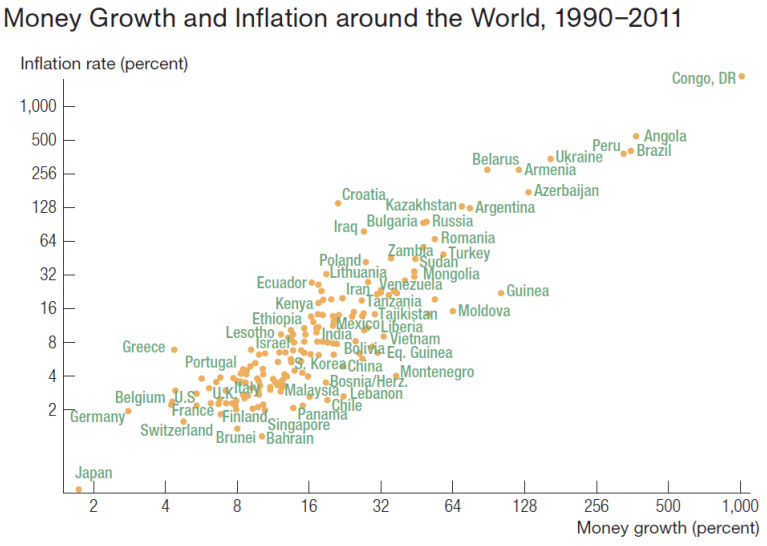
- Suppose the economy grows at $g_Y = 4\%$ per year (real GDP growth)
- Case 1: Money grows at $g_M = 7\%$

$$\pi = g_M - g_Y = 7\% - 4\% = 3\%$$

- Case 2: Central bank increases money growth to $g_M = 10\%$

$$\pi = g_M - g_Y = 10\% - 4\% = 6\%$$

- Higher money growth leads to higher inflation in the long run
- Real output $Y$ is unaffected (classical dichotomy)


Money Growth and Inflation around the World, 1990–2011
Inflation rate (percent)
1,000
500
256
128
64
32
16
8
4
2
Congo, DR
Angola
Peru
Brazil
Belarus
Ukraine
Armenia
Azerbaijan
Croatia
Kazakhstan
Argentina
Iraq
Bulgaria
Russia
Romania
Zambia
Turkey
Poland
Sudan
Lithuania
Mongolia
Ecuador
Iran
Venezuela
Guinea
Kenya
Tanzania
Moldova
Ethiopia
Tajikistan
Mexico
Liberia
Lesotho
India
Vietnam
Israel
Greece
Bolivia
Eq. Guinea
Portugal
S. Korea
China
Montenegro
Italy
Bosnia/Herz.
Malaysia
Belgium
U.S.
Lebanon
U.K.
Chile
France
Panama
Germany
Finland
Singapore
Switzerland
Brunei
Bahrain
Japan
2
4
8
16
32
64
128
256
500
1,000
Money growth (percent)

# Money in the Short-Term

- The general consensus among economists is that the classical dichotomy provides a good description of how the economy behaves in the long run but not in the short.
- Empirically, the evidence suggest that when a central bank increases the money supply it can trigger changes in the real economy.

# A Simple Monetary Model

- To understand how money affects output and inflation in the short and in the long-run, we develop a simple model of a medieval economy: Lisbon in the 1500s.
- Medium of exchange: gold coins.
  - All payments are made with gold coins.
  - Gold is the only asset people accept for transactions.
- Every transaction requires coins to change hands.
- People hold money to engage in transactions.

# Stock of Money

- In the medieval economy, the money supply is just the stock of gold coins in the country.
- Exogenous: $M_t$ is set from outside the model.
- Usually, $M_t$ does not change much:
  - Economy is isolated—no trade with other countries.
  - No gold mines, so new coins are not produced.
- Exogenous: $V_t = V$ constant money velocity.

# Production in the Medieval Lisbon

- Each household in Lisbon runs a small business: bakery, pub, shoe shop, etc.
- There exists a desired level of production $Y^*$:
  - They don't want to work more or less.
- Businesses post a price at the beginning of each period
- They then service all customers that demand their goods:
  - if demand is high, they will have to work more and $Y_t > Y^*$
  - if demand is low, they will have to work less and $Y_t < Y^*$
- Key assumption of Keynesian models:
  - Prices set in advance
  - Firms produce to meet demand

# How Firms Decide Whether to Change Prices

- At the end of the period, businesses compare actual production $Y_t$ with their desired level $Y^*$.
- If $Y_t > Y^*$:
  - demand was stronger than expected
  - the firm had to work more than it wanted
  - next period it raises its price to cool demand
- If $Y_t < Y^*$, the opposite happens:
  - demand was too weak
  - the firm worked less than desired
  - next period it lowers its price to attract more customers
- If $Y_t = Y^*$, the firm is satisfied and keeps the same price.

# Price Adjustment in the Medieval Lisbon

- We summarize that behavior with the rule:

$$P_{t+1} = P_t \left( \frac{Y_t}{Y^*} \right)^{\theta}$$

- The ratio $\frac{Y_t}{Y^*}$ tells the firm how busy it was relative to its desired output.
- If $Y_t > Y^*$, then $\frac{Y_t}{Y^*} > 1$ and the firm raises its price: $P_{t+1} > P_t$.
- If $Y_t = Y^*$, then $\frac{Y_t}{Y^*} = 1$ and the price stays unchanged.
- If $Y_t < Y^*$, then $\frac{Y_t}{Y^*} < 1$ and the firm lowers its price.
- $\theta$ captures how aggressively firms react:
  - small $\theta$: prices are sticky and adjustment is slow
  - large $\theta$: firms react more strongly
- Price stickiness can come from limited attention, "menu costs", fear of upsetting customers, or concern that competitors may not adjust prices.

# Model of the Medieval Lisbon

- Quantity equation:

$$M_t V = P_t Y_t$$

- Money supply:

$$M_t = \bar{M}$$

- Price Adjustment Rule:

$$P_{t+1} = P_t \left( \frac{Y_t}{Y^*} \right)^{\theta}$$

- Endogenous variables: $Y_t$ (output) and $P_t$ (price level)
- Exogenous variables: $M_t$ (money supply)
- Parameters: $\theta$ (speed of price adjustment), $V$ (velocity of money)

# Price Level at Desired Output ($Y_t = Y^*$)

- If $Y_t = Y^*$, then from the price adjustment equation:

$$P_{t+1} = P_t$$

- At what level? From the quantity equation:

$$P_t = \frac{\bar{M}V}{Y^*} = \bar{P}$$

- Prices stay constant at $\bar{P}$ as $P_1 = \bar{P}(Y^*/Y^*)^\theta = \bar{P}$.
- The economy is in steady-state

# Conquistadores Bring Back Gold from Brazil

- Lisbon sends off a fleet of Conquistadores to Brazil.
- They return with a huge shipment of gold coins.
- What happens to the economy?
  - What happens in the very short run?
  - What happens over time?
  - What is the result in the long run?

# Short-Run Effect of New Gold

- At first: Conquistadores spend a lot their gold.
- Gold coins spread through Lisbon's economy.
- Everyone now has more gold coins than before.
  - At the current price level, households hold larger money balances.
  - Output needs to rise: **Boom time!!**

# Boom Time in Lisbon

- Producers work too much: face higher demand for their goods than their desired level.
- How do they respond?
  - Prices start to rise.
  - How much do prices rise?
  - How does this affect the boom in output?
- Not clear without a formal model.
- Using our medieval economy model helps understand the effects.

# Conquistadores Raise Money Supply

## Long-Run Effect of New Gold

- The economy is knocked out of its initial state by the shock of more gold coins: $\hat{M} > \bar{M}$.
- As we saw in the meteorite example, output will go back to its desired level $Y^*$ (classical dichotomy).
- The new steady-state price level is:

$$\hat{Y} = Y^* \quad \text{and} \quad \hat{P} = \frac{\hat{M}V}{Y^*}$$

- Difference in price level between old and new steady states :

$$\frac{\hat{P}}{\bar{P}} = \frac{\hat{M}}{\bar{M}}$$

# Before Gold Arrives ($t = -1$)

- The economy starts in the old steady state:

$$Y_{-1} = Y^*, \qquad \pi_{-1} = 0, \qquad g^M_{-1} = 0$$

- At the end of period $t = -1$, firms set the price for day 0.
- Because output was exactly at the desired level, they choose a normal price $P_0$.
- When the gold arrives unexpectedly, the price $P_0$ is already fixed.

# Gold Arrives ($t = 0$)

- Conquistadores arrive at $t = 0$ with extra gold coins.
- At $P_0$ and with all the extra gold, households spend more, so demand jumps.

- Firms cannot adjust prices immediately because $P_0$ was chosen yesterday.
- So on impact there is no inflation:

$$\pi_0 = 0$$

- The immediate effect of the shock is therefore higher output.

# Impact Effect on Output

- Start from the quantity equation in growth rates:

$$g_t^M = \pi_t + g_t^Y$$

- On day 0, prices are fixed, so $\pi_0 = 0$:

$$g_0^M = \cancel{\pi_0} + g_0^Y$$

- Therefore:

$$g_0^Y = g_0^M$$

- The money shock shows up one-for-one as an output boom on impact.

# End of Day 0: Firms Raise Prices

- By the end of the day, firms observe that output was above normal:

$$Y_0 > Y^*$$

- They were busier than desired, so they raise tomorrow's price:

$$P_1 = P_0 \left( \frac{Y_0}{Y^*} \right)^{\theta}$$

- Because $\frac{Y_0}{Y^*} > 1$, the new price is higher:

$$P_1 > P_0 \qquad \Rightarrow \qquad \pi_1 > 0$$

- $\theta$ measures how strongly firms react: a small $\theta$ means prices adjust slowly.

# Next Day After Gold Arrives ($t = 1$)

- No more gold arrives on day 1, so money growth is now zero:

$$g_1^M = 0$$

- But firms raised prices overnight, so inflation is positive:

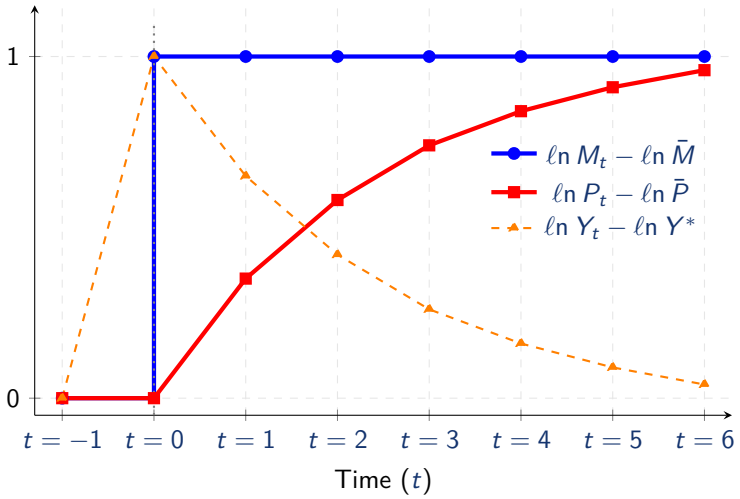
$$\pi_1 > 0$$

- Using the quantity equation in growth rates,

$$g_1^M = \pi_1 + g_1^Y \qquad \Rightarrow \qquad g_1^Y = -\pi_1 < 0$$

- Output falls relative to day 0: the boom starts fading.
- Output may still be above $Y^*$, but it is now moving back toward normal.

# Dynamics of the Gold Shock in Lisbon



# Why Do Governments Print Money?

- The quantity theory tells us that high inflation is caused by excessive money creation.
- But inflation is costly. Why would a government allow it? $\Rightarrow$ Printing money is one way to finance government spending
- The government's budget constraint summarizes its financing options:

$$G = T + \Delta B + \Delta M$$

- Where:
  - $G$ = government spending
  - $T$ = tax revenue
  - $\Delta B$ = new borrowing
  - $\Delta M$ = new money creation
- If taxes and borrowing are limited, the government may resort to printing money.

# Inflation and Fiscal Stress

- Governments often face large and persistent budget deficits:

$$G > T$$

- Borrowing may become difficult:
  - Rising debt increases default risk
  - Lenders demand higher interest rates or stop lending
- Raising taxes may be politically infeasible.
- Printing money becomes the last available source of finance.

# Seigniorage and the Inflation Tax: Who Pays?

- Seigniorage or the inflation tax is the revenue the government obtains by printing money:

$$\text{Seigniorage} = \Delta M$$

- When the government finances spending by creating money, the long-run effect is higher inflation.
- This rise in the price level reduces the real value of existing money balances
- **Example**:
  - Suppose each person holds $200 in currency.
  - The government doubles the money supply.
  - In the long run, prices double.
  - The $200 held by each person now buys only half as much as before.
- Inflation redistributes wealth from money holders to the government.

# Money Holders vs. Asset Holders

- Consider another example:
  - Ralph holds his wealth in money (bank deposits, cash)
  - Alice holds her wealth in real assets (land, property)
- When inflation doubles prices:
  - Ralph's real wealth falls
  - Alice's asset prices double, preserving real value
- The inflation tax primarily hits money holders, not asset holders.

# Central Bank Independence

- Governments face a constant temptation to finance spending by printing money.
- Doing so relaxes the budget constraint in the short run, but creates inflation in the long run.
- To limit this temptation, many countries separate:
  - Fiscal policy: spending and taxation
  - Monetary policy: control of money supply and interest rates
- Central bank independence is designed to prevent fiscal needs from driving monetary policy.

# Central Bank Independence: Institutions and Limits

- **United States**:
  - Congress and the President set spending and taxes.
  - The Federal Reserve independently conducts monetary policy.
  - The government cannot order the Fed to print money to pay its bills.
- **Euro Area**:
  - National governments control fiscal policy.
  - Monetary policy is centralized at the European Central Bank.
  - This creates an even stronger separation between fiscal and monetary policy.
- **Limits to independence**:
  - Central bank leaders are political appointees.
  - Severe fiscal stress can threaten independence.
  - Independence is an institutional ideal, not an absolute guarantee.