ECO 3302 – Intermediate Macroeconomics

Lecture 9: The Monetary System & Inflation

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Introduction

Introduction

- In the past few lectures, we studied economic growth, highlighting role of:
  - Institutions
  - Good economic policies
- **Today, we start studying monetary economics**:
  - What is money? What are its functions? What are its types?
  - How to measure money?
  - Who controls the supply of money?
- **We then move to study inflation**:
  - How does inflation come about?
  - What are the causes, effects, and social costs of inflation?

What Is Money?

What is money?

- Important to not confuse money with wealth!
  - We informally use “has a lot of money” to mean someone is rich
  - But someone may be rich and have little money!
    - Example: someone wealthy has all wealth invested in real state
- **Economists use the term “money” to refer to the stock of assets that is readily available to make transactions**
- Roughly speaking, the quantity of money in an economy is the amount of currency (eg, USD, EUR, MEX,...) in hands of the public

The functions of money

- Money has three functions:
  - **Store of value**: money preserves value over time and thus allows to transfer wealth into the future (Eg, you can save $100 today and use them at latter date)
    - Because value of money changes over time, it is not a perfect store of value
  - **Unit of account**: money is the standard measure people use to price goods and services and record debts (Eg, cost of buying a house is $1 mill.)
  - **Medium of exchange**: money used to carry transactions of goods and services (Eg, when you go to the store to buy groceries, you pay with money)
    - "This note is legal tender for all debts, public and private" printed on US bills
    - Assets ranked in terms of liquidity: how easy is to convert asset to fiat money

Monetary economies vs. Barter economies

- **Today's economies are monetary economies**: people use money as store of value, unit of account, and medium of exchange
- **Monetary economies contrast with barter economies,** where people trade goods and services for one another
  - Example: buying 1 book requires 1 loaf of bread
- **Monetary economies**:
  - Circumvent the problem of *double coincidence of wants*: carrying a transaction in barter economy requires that both buyer and seller want something the other party has
  - As such, more transactions take place relative to barter economy

Types of money

- **Fiat money** has no intrinsic value and is not backed by physical commodities.
  (Eg, dollar bills and coins in the US, euro bills and coins in Spain, pesos in Mexico, ...)
  - Value derived from government decree and public trust
  - Most common type of money in the world today
- **Commodity money** has intrinsic value, determined by the material it is made of
  (Eg, gold, silver, tobacco, sugar, ...)
  - Historically used in ancient economies
  - Most common type of commodity money is gold; hence, the term **gold standard**
- **Cryptocurrency** is decentralized digital money with no intrinsic value
  (Eg, Bitcoin, Ethereum, Litecoin, ...)
  - Value derived from trust in cryptographic protocols and decentralized network
  - Used today as alternative to fiat currency

Measuring the Quantity of Money

How to measure the quantity of money?

- Measuring quantity of money in simple commodity economies is easy:
  - If all transactions occur with gold, quantity of money is quantity of gold
  - If all trade occurs with cigarettes, quantity of money is quantity of cigarettes
- Measuring quantity of money in fiat economies is more complicated:
  - Not all transactions occur with bills and coins
  - People also use deposits in checking and savings accounts
  - For that reasons, there are several measures for quantity of money

How to measure the quantity of money?

- Standard broad money aggregates in fiat economies:
  - Base money, M0: total amount of physical currency in circulation
    - Coins and banknotes in public's hands + reserves held by commercial banks at central bank
  - Liquid money, M1: broader measure that includes money immediately available
    - M0 + demand deposits + traveler checks + other checkable deposits
  - Broad money, M2: broader measure that includes money immediately available plus savings-related assets that are highly liquid
    - M1 + savings deposits + time deposits/CDs under $100k + retail money market mutual funds
  - Extended broad money, M3: broader measure that includes money immediately available plus moderately-liquid savings-related assets
    - M2 + time deposits/CDs over $100k + institutional MMFs + repos

Controlling the Quantity of Money

Controlling the quantity of money

- Quantity of money in circulation is called **money supply**
- In system of commodity money, money supply is quantity of that commodity
- **In economy with fiat money, money supply is controlled by the government**
  - Legal restrictions give the government a monopoly on printing money
  - Government's control over money supply is called **monetary policy**
  - In most countries, monetary policy is delegated to an independent institution called **central bank** (eg, Federal Reserve in the US, ECB in Europe, Bank of England, ...)

The Federal Reserve

- Central bank of the United States is the Federal Reserve (aka, the Fed)
- Fed was created by Congress in 1913 to look after monetary system
- **US monetary policy dictated by Federal Open Market Committee (FOMC)**:
  - 7 members of Board of Governors (elected by US president, confirmed by Senate)
  - 12 presidents of regional Feds (chosen by regional Feds' board of directors)
- **FOMC meetings and voting rights**:
  - 8 regular meetings scheduled each year ($\approx$ 1 every six weeks)
  - 8 members have permanent voting rights (ie, they vote on each meeting)
    - 7 members of Board of Governors + NY Fed president
  - 4 rotating voters: presidents of remaining regional Feds

The Federal Reserve

- **Chair of the Fed is most important member of Board of Governors**:
  - Chair directs the Fed, presides FOMC meetings, testifies regularly in Congress
  - Chair elected to 4-year terms by US president
    (Powell with Trump & Biden, Yellen with Obama, Bernanke with Bush & Obama, Greenspan, ...)
- **Although Fed is independent from US government, it has a (dual) mandate**:
  to promote maximum employment and stable prices
- **Fed pursues its mandate in two ways**:
  - **Regulating banks to ensure health of banking system**, also acting as *lender of last resort* (ie, lending money to banks when none else does)
  - **Setting monetary policy** (ie, controlling money supply)

Central banks and the money supply

- **Central banks can influence money supply through open-market operations**
  - Open-market operations are purchase and sale of government securities
- If central bank wants to increase money supply, it can create dollars and use them to buy government bonds from the public
  - Because dollars leave central bank and enter hands of the public, purchase of bonds by central bank increases quantity of money in circulation
- If central bank wants to decrease money supply, it can sell government bonds from its portfolio
  - Because selling bonds takes cash from hands of the public, sale of bonds by central bank decreases quantity of money in circulation

Central banks and the money supply

- Central banks can use other tools—apart from open-market operations—to influence money supply:
  - Managing federal funds rate (FFR)—the rate at which banks lend to each other
  - Managing reserve requirements—the percentage of deposits that banks are mandated to set aside as (cash) reserves
  - Using forward guidance: communicating future direction of monetary policy (eg, future changes in interest rates) to influence expectations and behavior
  - Using quantitative easing (QE) and tightening (QE): purchasing/selling long-term securities (eg, government bonds, mortgage-backed securities) to inject liquidity and stimulate economy (typically when interest rate is near zero)
  - Offering discount windows: giving short-term loans to eligible financial institutions to help meet liquidity needs and ensure stability in banking system

Read more about the Fed's policy tools **here**

Inflation

Inflation

- **Inflation rate**: overall increase in the level of prices
- Inflation can be measured for individual goods/svcs and for groups of them
  - Individual goods and services: New York Times, hour of production worker, ...
  - Several indices: GDP deflator, PCE deflator, CPI, ...
- Inflation examples:
  - New York Times costed $0.15 in 1970 and $3 in 2022
  - Average wage of production workers was $3.40/hr in 1970 and $27.55 in 2022
- **Important terminology**:
  - Inflation: price level rises
  - Hyperinflation: price level rises substantially (typically by at least 50% month)
  - Deflation: price level decreases

Inflation

- Inflation rates vary widely over time and across countries:
  - Over time:
    - Avg. annual inflation rate in US was 7% in 1970s, 6% in 1980s, and 2–3% thereafter
  - Across countries in 2024 (see here):
    - Zimbabwe: 635%
    - Argentina: 230%
    - Turkye: 61%
    - United States: 3%
    - Switzerland: 1.3%
    - China: 0.4%
    - Costa Rica: −0.3%
- We now try to understand what causes this differences in inflation rates

The quantity theory of money

- The quantity theory of money, which dates back to the 16th century, remains the leading explanation of how money affects the economy in the long run
  - Jean Bodin suggested in the 1560s that the influx of gold and silver from the New World was driving up prices in Europe
- **The theory's central idea is that changes in the money supply affect the price level and, consequently, inflation**
- Key equation is **equation of exchange**:

$$M_t \cdot V_t = P_t \cdot Y_t$$

M: (nominal) money supply V: velocity of money P: price level Y: real GDP

- The number of dollars exchanged in a year (ie, nominal economic activity) is equal to the money used to make transactions (ie, money times its velocity)

Money velocity and real money balances

- Equation of exchange is a re-arrangement of the definition of velocity:

$$V_t = \frac{P_t Y_t}{M_t}$$

"The velocity at which money travels is determined by the level of nominal expenditures over the amount of money in circulation"

- Equation of exchange and real money balances:

$$\frac{M_t}{P_t} = \frac{Y_t}{V_t}$$

"*Real money balances* M/P is quantity of goods and services money can buy"

Example: If only good is TX brisket, economy has \$100, and price of brisket is \$20/lb, real money balances are 5 lb of TX brisket

Equation of exchange vs. Cambridge equation

- Equation of exchange is directly related to the **Cambridge equation**, which expresses the demand for money in terms of income:

$$M_t = \gamma_t \times P_t Y_t,$$

M: money demand γ: fraction of income people holds as money PY: nominal GDP

- Rearranging equation of exchange, we can see that V^{-1} plays role of γ:
  when people hold lots of money (high γ), money changes hands infrequently (small V)

- Importantly, equation of exchange and Cambridge equation emphasize different aspects of the relationship between money and the economy:
  - Equation of exchange emphasizes money supply
  - Cambridge equation emphasizes money demand

Money supply and inflation

$$M_t \cdot V = P_t \cdot Y_t,$$

- **Class Exercise**. Suppose Venezuela has potential real GDP growth of 0% from year t to $t+1$. If money supply grows at rate g_M, what happens to price level?
  (1 bonus point for correct answer)
  - If $g_M > 0$, there is inflation
  - If $g_M = 0$, the price level remains stable
  - If $g_M < 0$, there is deflation

Money supply and inflation

- The equation of exchange:

$$M_t \cdot V_t = P_t \cdot Y_t,$$

- Usual assumptions:
  - Money travels at constant velocity (i.e., $V_t = V$ for all t)
  - Real GDP grows at a constant rate (i.e., $Y_{t+1}/Y_t = 1 + g_Y$ for all t)
- **Monetary authority's objective**: price stability $(P_{t+1}/P_t = 1, \forall t)$
- Taking ratio of equation of exchange at $t+1$ and t under usual assumptions:

$$\frac{M_{t+1}}{M_t} = \frac{P_{t+1}}{P_t}(1 + g_Y) \qquad \Longrightarrow \qquad \frac{P_{t+1}}{P_t} = \frac{1 + g_M}{1 + g_Y}$$

"*Price stability requires that the supply of money grows at exactly the same rate as real GDP when money velocity is constant*"

Money supply and inflation

- In general:

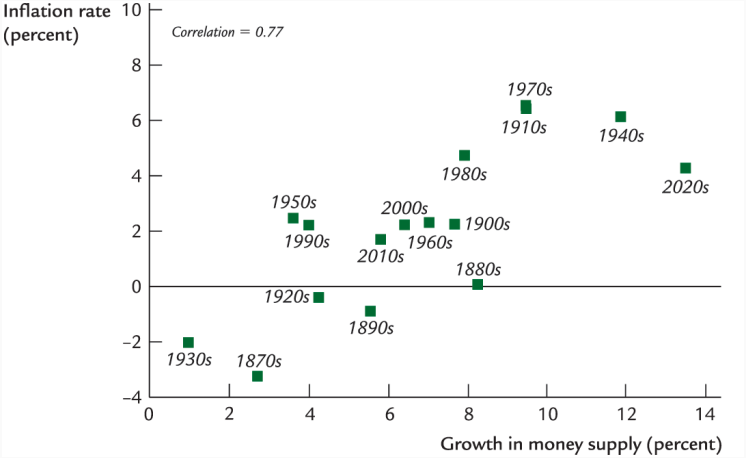
$$\frac{M_{t+1}}{M_t} = \frac{P_{t+1}}{P_t}\frac{Y_{t+1}}{Y_t}\frac{V_t}{V_{t+1}} \qquad \Longrightarrow \qquad \frac{P_{t+1}}{P_t} = (1 + g_M) \times \frac{1 + g_V}{1 + g_Y}$$

  "*Price stability requires that the supply of money grows at exactly the same rate as real GDP adjusted for changes in the velocity of money*"

- Let's see if the relationship between money supply and inflation has any bearing in the data

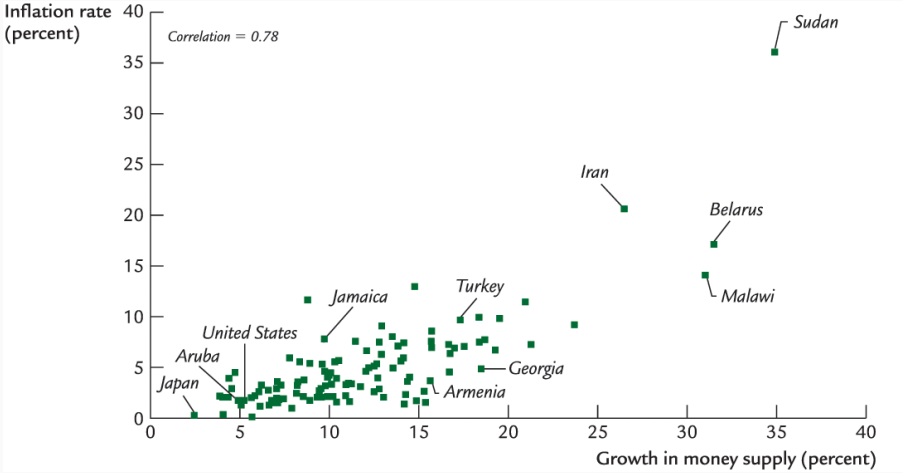
Money supply and inflation in the US

Periods of higher growth in supply of money associated with higher inflation rates



Money supply and inflation across countries

Countries where supply of money grows faster have higher inflation rates



Money supply growth and hyperinflation

Episodes of hyperinflation positively associated with money supply growth

Country	Period	CPI Inflation (%)	M2 growth (%)
Israel	1983–85	338	305
Brazil	1987–94	1,256	1,451
Argentina	1988–90	2,671	1,583
DR of Congo	1990–96	3,039	2,373
Zimbabwe	2005–07	5,316	9,914

Seigniorage

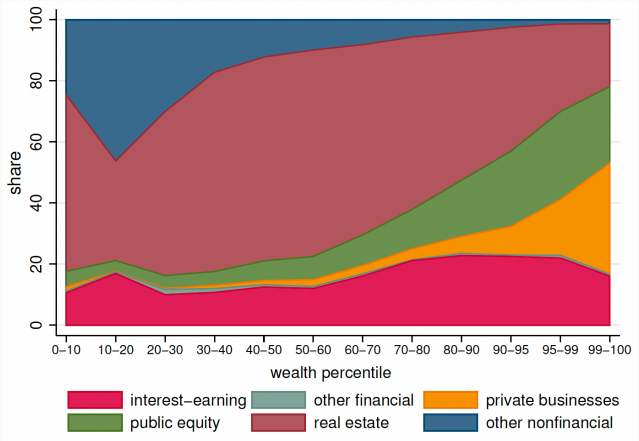
- Three options to finance government spending:
  1. Collect taxes
  2. Borrow money (ie, issue sovereign debt)
  3. Print money (ie, seigniorage)
- Seigniorage is the revenue raised by printing money
  - Cost of producing money generally lower than money's face value
  - Example: If cost of producing $100 bill is $1, profit from printing $100 bill is $99
- When government/central bank creates money, it increases the money supply, which in turn causes inflation
  - Printing money to raise revenue is like an "inflation tax"

Seigniorage

- **Why do we say that printing money is like an inflation tax?**
  - When new money is printed, money supply increases
  - Increases in money supply lead to inflation
  - Increases in prices lower real value of money: you can buy less for your bucks
  - Inflation is a tax for money holders!
- **Do all people suffer the same from an inflation tax?**
  - No, people who hold proportionately more money, suffer more
  - These are typically the poorest people in society

Distribution of wealth by asset type for US households in 2019

Poorer US households hold proportionally more cash (ie, other nonfinancial wealth)



Source: Xavier (2021). Data: SCF.

Seigniorage revenue by country

- Amount of revenue raised by printing money varies from country to country
- Stanley Fisher studied this in a famous paper

Table 1: Seigniorage and Inflation, 1960–1978

Country	Seigniorage (% of gvt revenue)	Avg. inflation rate (%)	Avg. real GDP growth rate (%)
Italy	12%	8%	4%
Argentina	46%	57%	3%
Greece	11%	7%	7%
UK	2.5%	8%	2.5%
United States	3%	5%	5%

Inflation and interest rates

- Useful to discuss two types of interest rates in relation to inflation
- Suppose you deposit $100 in a bank deposit offering 5% **nominal interest rate**
- One year from now, you have 5% more money, $105. But are you richer?
- It all depends on inflation:
  - If inflation is higher than the nominal interest rate, then you are poorer
    Example: If inflation is 8%, your purchasing power falls by 3%
  - If inflation rises less than the nominal interest rate, then you are richer
    Example: If inflation is 2%, your purchasing power increases by 3%
- **The gap between the nominal interest and the inflation rate is the real interest rate** ($r = i - \pi$), which measures changes in purchasing power of interest-earning deposits

Inflation and interest rates

- Together, quantity theory of money and Fisher equation tell us how money growth affect nominal interest rates:

$$1 + \pi = \frac{(1 + g_M)(1 + g_V)}{1 + g_Y} \qquad \text{(Quantity theory of money)}$$

$$i = r + \pi \qquad \text{(Fisher equation)}$$

  Fisher effect: one-for-one relationship b/w inflation & nominal interest rate

  (Ie, 1 percent increase in inflation translates into 1 percent increase in nominal interest rate)

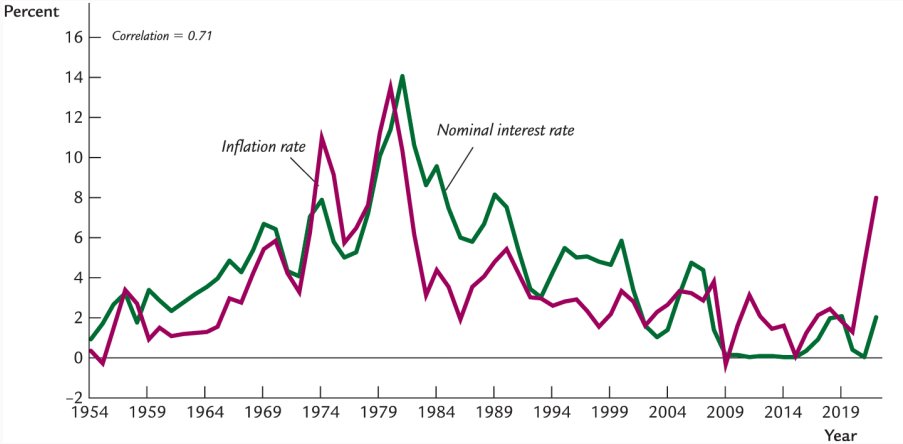
- Taking logs in the first equation and approximating: $\pi \approx g_M + g_V - g_Y$
  One-for-one relationship b/w money growth and inflation

- Hence, **one-for-one relationship b/w money growth & nominal interest rate:**

$$i \approx r + g_M + g_V - g_Y$$

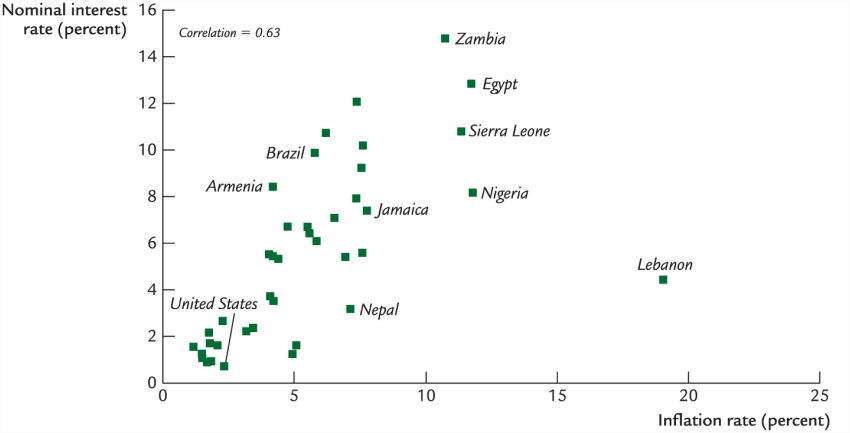
The Fisher effect in time-series US data

Fisher effect does a good job at explaining behavior of inflation rate in US data: changes in inflation positively correlated with nominal interest rates



The Fisher effect in cross-sectional data

Fisher effect does a good job at explaining cross-sectional inflation data: countries with high inflation tend to have high nominal interest rates



Two types of real interest rates

- When borrowers and lenders agree on a nominal interest rate for loan to be contracted, they don't know what the inflation rate will be during term of loan
- This leads us to distinguish between **two types of real interest rates**:
  - ***Ex-ante* real interest rate**: real interest rate expected when loan is made

$$\mathbb{E}_t r_t = i_t - \underbrace{\mathbb{E}_t \pi_{t+1}}_{\text{Expected inflation}}$$

  - ***Ex-post* real interest rate**: real interest rate realized at end of loan

$$r_t = i_t - \underbrace{\pi_{t+1}}_{\text{actual inflation}}$$

- Ex-ante and ex-post real interest rates differ when inflation expectations are not right: $\mathbb{E}_t \pi_{t+1} \neq \pi_{t+1}$

Two types of real interest rates

- Clearly, nominal interest rate does not adjust to actual inflation, so **Fisher effect accommodating inflation expectations**:

$$i_t = r_t + \mathbb{E}_t \pi_{t+1}$$

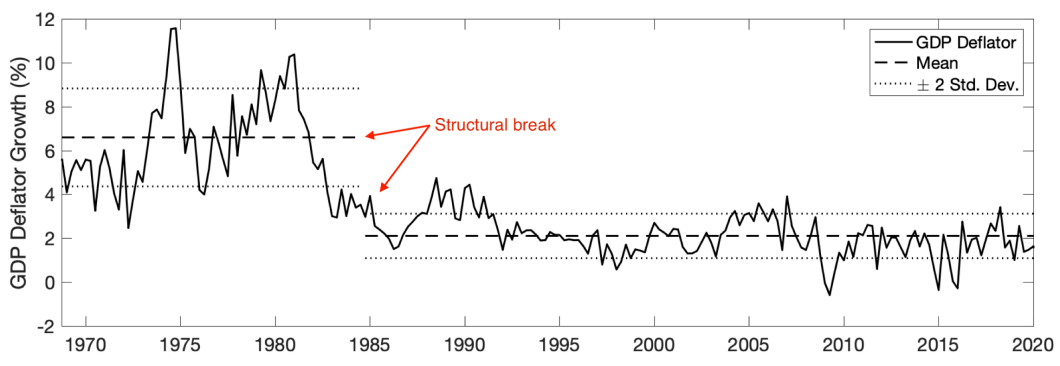
- This Fisher-effect equation with inflation expectations more accurately reflects the relationship between nominal interest rates and inflation:
  - Ex-ante real interest rate determined in equilibrium
  - Nominal interest rate moves one-for-one with expected inflation
- **But, if nominal interest responds to expected inflation rather than actual inflation, why do we see such a strong correlation between nominal interest rates and actual inflation?** Inflation is highly persistent

US inflation persistence

US inflation is persistent, although persistence has fallen over time

$$\pi_t = \alpha_\pi + \rho_\pi \pi_{t-1} + e_t$$

	pre 1985	post 1985
ρ_π	0.77	0.51



Source: Gallegos (2024). **Data**: BEA.

The nominal interest rate and the demand for money

- According to quantity theory of money, demand for real money balances is proportional to income:

$$\frac{M_t}{P_t} = \frac{1}{V_t} \times Y_t$$

- **However, when considering how much cash to hold, we also think of the nominal interest rate that we could earn on that money**
  - Nominal interest rate is the opportunity cost of holding money
    (Ie, the amount of money we give up for holding money)
- Suppose money in deposit earns real interest rate $r = i - \mathbb{E}_t \pi_{t+1}$. Expected return on cash holdings is $-\mathbb{E}_t \pi_{t+1}$, the expected loss in purchasing power
- Difference in returns is cost of holding money: $r - (-\mathbb{E}_t \pi_{t+1}) = i$

Real money demand

- Real money demand depends on both income and cost of holding money:

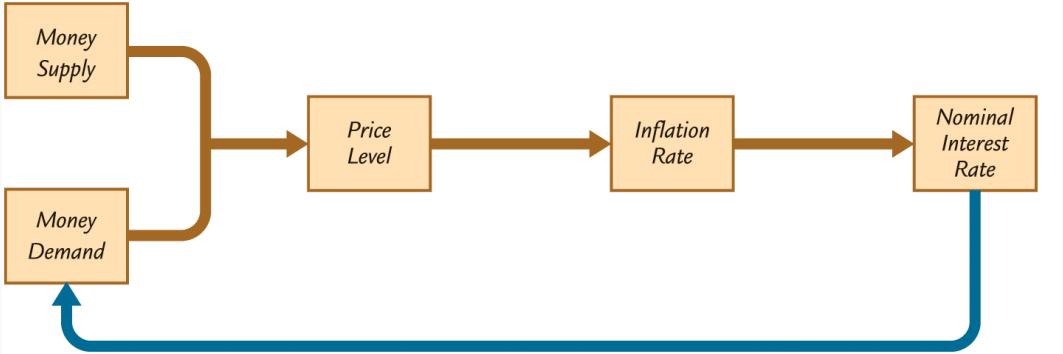
$$\left(\frac{M}{P}\right)^d = L(i, Y) \equiv L(r + \mathbb{E}\pi, Y)$$

- Money demand function L assumed to satisfy two properties:
  - The higher the income, the more money demanded
  - The higher the nominal interest rate, the less money demanded
    - The higher expected inflation is, the higher nominal interest rate (Fisher effect)
    - The higher expected inflation, the less money demanded

- We can now put together all we've learned about money, inflation, and interest rates

Linkages among money, prices, and interest rates

Money supply and demand determine equilibrium price level, change in prices cause inflation, which affects nominal interest rate and, in turn, money demand



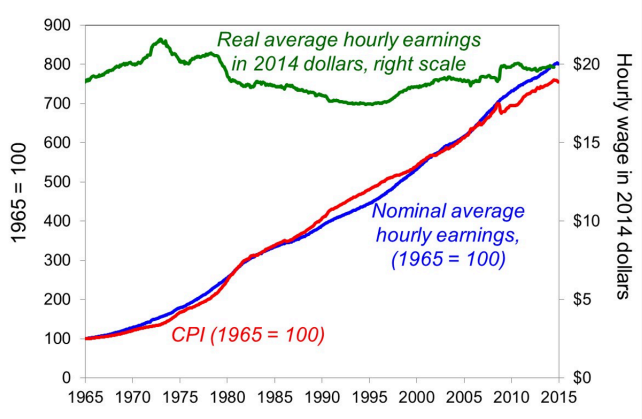
Different views on the social costs of inflation

- **Layman's view**: inflation makes us poorer because wages don't rise enough to compensate for price increases
  - Implicit assumption is wage raise would be the same without inflation (fallacy!)

- **Classical view**: Real wage depends on MRPL, not on inflation: $W/P = \text{MRPL}$
  - In the long run, real wages adjust so that workers get paid their MRP
  - Change in price level is merely a change in units of measurement
    (Higher price level translates into higher wages: $W = P \times \text{MRPL}$)
  - **In the long run, money is neutral**: changes in the money supply/price level have no real effect on the economy (real output depends on tech. & resources)

Inflation and average hourly wages in the US, 1965–2015

In the long run, nominal wages increase almost one-for-one with price level, and so the misperception in the layman's view that wages don't rise enough



Data source: BLS. **Data series**: AHETPI (wages), CPIAUCSL (CPI urban consumers).

Layman's view vs. Economist's view

- The idea that nominal wages don't rise enough to make up for inflation is clearly not true in the long run, as we just saw
- However, there's still some merit in that idea
- **In the short run, wages are rigid and inflation harms workers**
  (When wages are fixed by contracts, inflation causes loses in workers' purchasing power)
- Also, as we saw earlier, inflation has redistributive effects!
- **Economist's view**: inflation has no real effect on the long run, and small effects in the short run if inflation rates are moderate (ie, between 1–5%)

Social costs of inflation

- Useful to categorize social costs of inflation according to whether:
  - Inflation is expected
  - Inflation is unexpected

Social costs of expected inflation

1. **Shoeleather costs**: if π increases, i increases, so people reduce their money balances even if planning to have same monthly spending.
   - Same monthly spending, but lower money holdings means more trips to bank
2. **Menu costs**: if π increases, the more frequently firms must change prices
   - **Menu costs** are costs of printing new menus/catalogs and deciding new prices
3. **Relative price distortions**: firms respond to inflation by changing prices at different times, leading to distortions in relative prices & misallocation
4. **Unfair tax treatment**: some taxes (eg, capital gain tax) are not adjusted to account for inflation, and hence can erode gains
   - If your tesla stocks appreciate by 10% and inflation is 10%, real capital gain is 0%, yet you must pay capital gain tax on your nominal gain

Social costs of unexpected inflation

1. **Arbitrary redistribution of purchasing power**:
   - Many long-term contracts not indexed to actual inflation but based on expectations $\mathbb{E}\pi$
   - If $\pi \neq \mathbb{E}\pi$, some gain at the expense of others:
     - If $\pi > \mathbb{E}\pi$, $i - \pi < i - \mathbb{E}\pi$ and purchasing power transferred to borrowers
     - If $\pi < \mathbb{E}\pi$, $i - \pi > i - \mathbb{E}\pi$ and purchasing power transferred to lenders
2. **Increased uncertainty**: when inflation is more unpredictable (ie, π turns out different from $\mathbb{E}\pi$ more often and gaps are larger), more wealth redistribution takes place, harming risk-averse people more

Taking Stock

Taking stock

Today, we learned:

- **Money $\neq$ wealth**, but rather amount of currency in hands of the public
- **Functions of money**: store of value, unit of account, medium of exchange
- **Types of money**: fiat money vs. commodity money vs. cryptocurrency
- Standard **money aggregates** based on liquidity: M0, M1, M2, M3
- **Money supply and the role of the government/central bank**
- **Functioning of the Fed**: mandate, FOMC meetings and voting rights, open-market operations, other monetary policy tools

Taking stock

- **Quantity theory of money**: $M_t V_t = P_t Y_t$
- **Cambridge equation**: $M_t = \gamma_t \times P_t Y_t$, where γ_t is fraction of income in cash
- **Seigniorage**: government's revenue from printing money
- **Fisher effect**: 1-for-1 relationship b/w inflation & nominal interest rate ($i = r + \mathbb{E}\pi$)
- **Ex-ante vs. ex-post real interest rates**
- **Inflation persistence**: $\pi_t = \alpha_\pi + \rho_\pi \pi_{t-1} + e_t$
- **Social costs of inflation**: shoeleather costs, menu costs, relative price distortions, unfair tax treatment, redistribution of purchasing power, ...

Taking stock

- **Classical dichotomy**: separation of nominal and real variables
  - **Nominal variables**: variables expressed in terms of money
    (Eg, price level, inflation rate, nominal wages, nominal interest rate, ...)
  - **Real variables**: variables expressed in terms of physical quantities
    (Eg, real GDP, real wage, real interest rate, ...)
- **Long-run money neutrality**: In the long run, changes in the money supply / price level do not have real effects on the economy
  - Real variables depend only on technology and available resources (eg, real GDP)
  - Nominal variables adjust to reflect changes in prices (eg, as we saw with wages)

Questions?

Thank You!

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