Macroeconomics in One Equation
Lecture 5: Money and Interest Rates

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For His Glory and Mission

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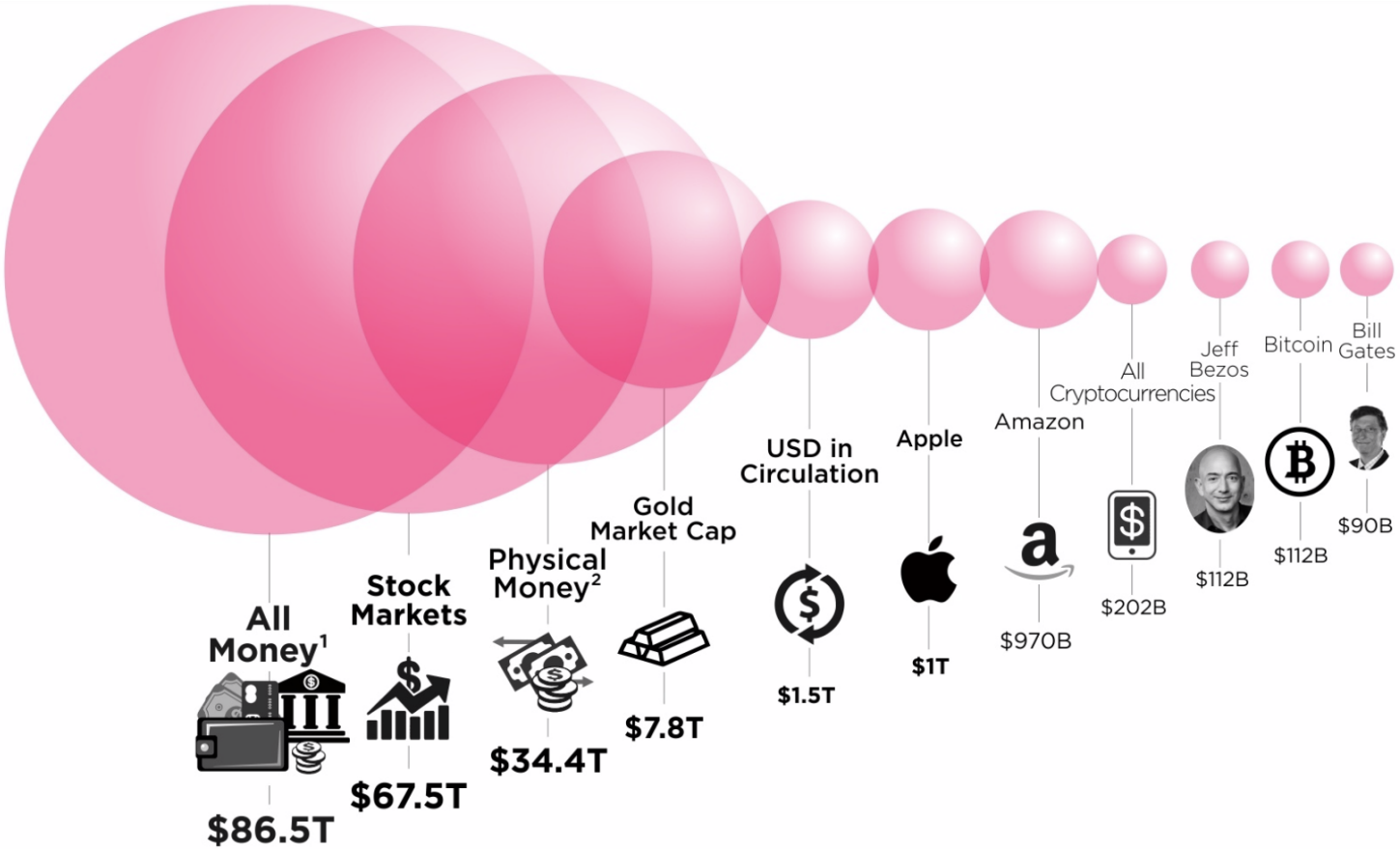
Introduction

- In MV=PY, the quantity of money in circulation is, first of all, a medium of market exchange for the goods and services in the economy, and then it measures the nominal value of all exchanges. Therefore, the quantity theory of money is considered as a transaction equation.
- What is money? Why do we need money? What are the functions of money? Where are the money coming from? And how do economists measure the quantity of money in the economy?
- What is interest (rate)? Why does interest (rate) exist? What are the determinant of interest (rate)? Why is interest rate so important in the economy and financial markets?
- What is the relationship between money and interest rate? How are they determined in the money market? How do economists apply the money market equilibrium model to financial market conditions?

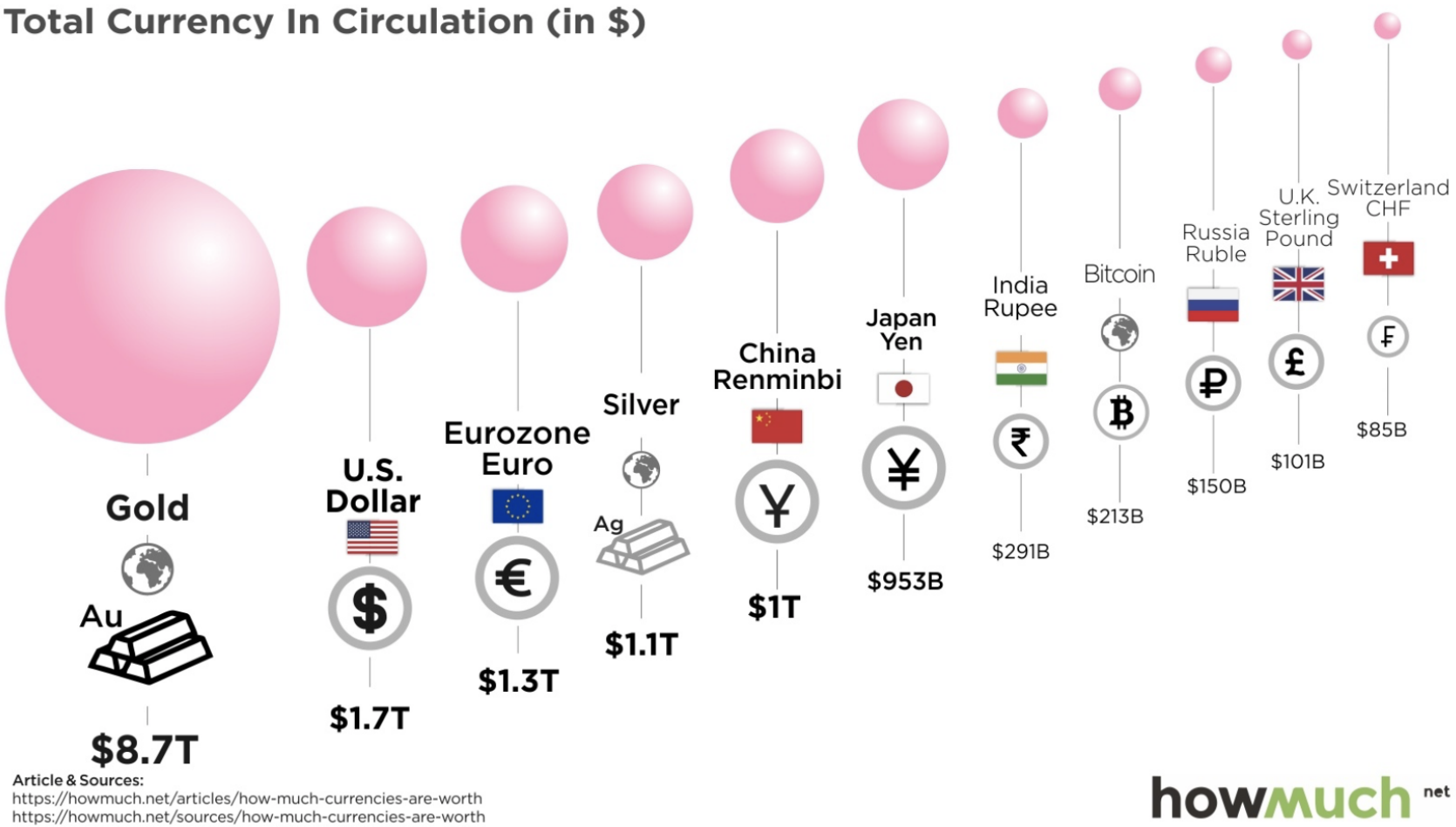
Outline

Global Money in Perspective, 2018 (w)



https://howmuch.net/articles/worlds-money-in-perspective-2018

Global Currencies, 2019 (w)



https://howmuch.net/articles/how-much-currencies-are-worth

Global Reserve Currencies, 2019 (w)

Central banks hold foreign exchange reserves are for international payments and to support a national currency.

1. U.S. Dollar: $6.74 trillion (61.82%)
2. Euro: $2.21 trillion (20.24%)
3. Japanese Yen: $572 billion (5.25%)
4. Pound Sterling: $495 billion (4.54%)
5. Chinese Renminbi: $213 billion (1.95%)

Article & Sources:
https://howmuch.net/articles/worlds-top-reserve-currencies-2019
International Monetary Fund - http://data.imf.org

howmuch.net

Money: Definition and Functions

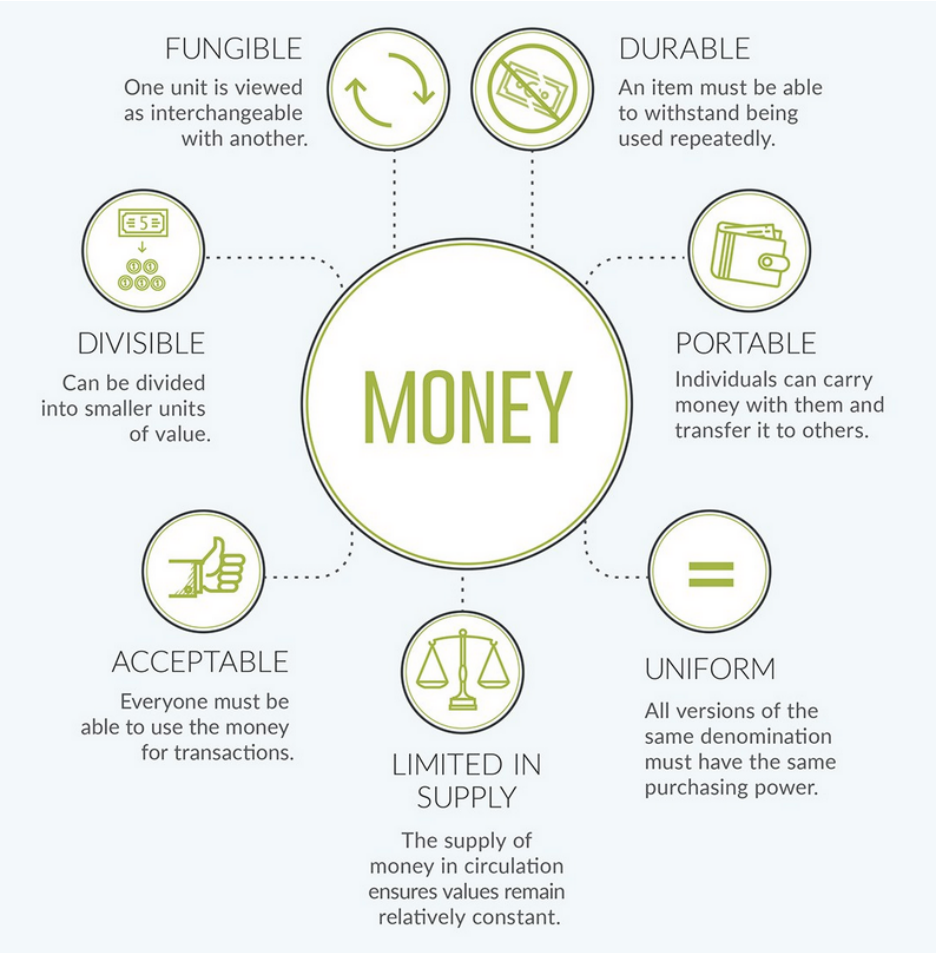
- Definition: Money is a standardized medium of exchange.
- Money, as a medium of exchange, evolves from society's persistent endeavor to reduce transaction cost.
- Money, as a unit of account, measures the value of the goods and services being exchanged. Prices are expressed in monetary units.
- Money, as a store of value, enables its owner to finance inter-temporal exchange, balancing consumption over time.
- In history, any good being chosen and developed as a universal medium of exchange can be defined as money. Other functions of money are derived henceforth. In a modern economy, however, money carries a more vital role —- credit and debt instrument.
- Money stores joint memories of income and wealth in human society.

All money is a matter of belief. –Adam Smith

Properties of Money (w)

Are these money?

- Checks
- Pensions
- Gold and silver
- Checking accounts
- Savings accounts
- Credit card
- Debit card
- Diamond
- Bitcoin



https://sunnyclo.ipower.com/pearlsofliberty/

The Evolution of Money (w)

Medium of Exchange (Commodities)

During the period of early human civilization, any commodity that was demanded and chosen by common consent was used as a form of currency.

Goods like furs, salt, rice, wheat, weapons, animals, and much more were used as an exchange which was known as 'Barter Exchange.'

Metallic

With the progress of human civilization, commodity exchange transitioned into metallic money. Metals like gold, silver, copper, nickel, and much more were used as they could be easily handled and their quantity can be readily ascertained.

Paper

The inconveniences of carrying metallic currency seemed too dangerous and difficult because of thefts and the weight of the money. The invention of banknotes marked a very important stage in the development of money.

Paper money is regulated and controlled by a Central Bank of the country. Today, the vast majority of money consists mainly of currency notes or paper money issued by the Central Bank.

Plastic

The next type of money was the plastic payment money such as credit cards and debit cards. The aim was to remove the need for carrying cash when making transactions. With the debit card, the money comes directly from your bank account unlike the credit cards, which is a loan from the bank institution with a promise to pay back the amount used with interest each month.

Crypto

Cryptocurrency is a new revolutionary type of currency. Like any other currency or unit of account, they only have value because people give it value. Cryptocurrencies were designed as a unit of exchange and as a place to store assets without relying on a Central Bank, thus cutting out the middle person with lower fees and faster transactions time.

A move towards a more direct money transaction without having other people take a cut of your hard-earned cash.

In Mesopotamia, around the third millennium B.C., there were two types of money circulating: barley and silver. The interest rate on a barley loan was usually 33%, whereas, on silver, it was 20%. (w)

`https://blog.coinpayments.net/news-features/the-evolution-of-money`

`https://www.huffpost.com/entry/what-is-money-explained-video_n_6511972`

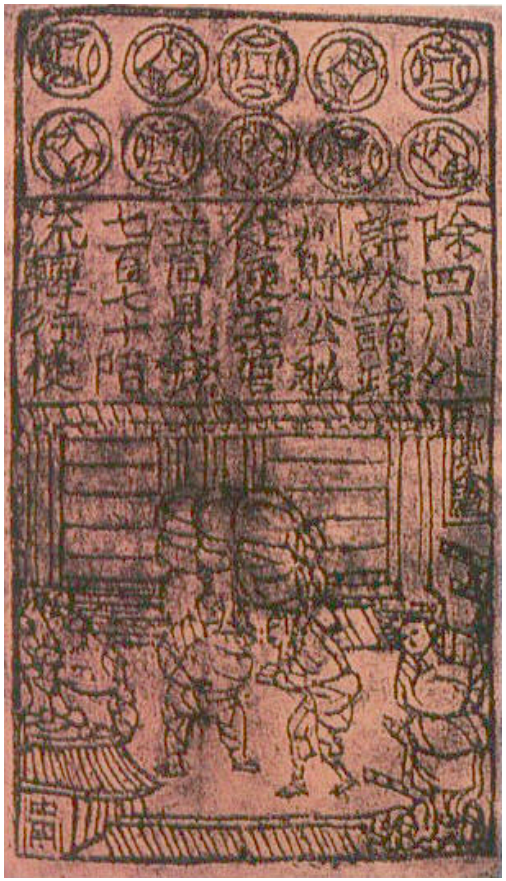
A Brief History of Money (w)

Source: Publish0X.

- In the beginning: Barter
- 9000 - 6000 B.C.: Cattle
- 1200 B.C.: Cowrie shells
- 1000 B.C.: First metal money and coins
- 500 B.C.: Modern coinage
- 118 B.C.: Leather money
- 806: Paper currency
- 1816: The gold standard
- 1930: End of the gold standard
- The present: Fiat money
- The future: Digital money

The Earliest Paper Money - Banknote (w)

Development of the banknote began in the Tang dynasty during the 7th century, with local issues of paper currency, although true paper money did not appear until the 11th century, during the Song dynasty. Before the use of paper, the Chinese used coins that were circular, with a rectangular hole in the middle. Several coins could be strung together on a rope. Merchants in China, if they became rich enough, found that their strings of coins were too heavy to carry around easily. To solve this problem, coins were often left with a trustworthy person, and the merchant was given a slip of paper recording how much money they had with the person. Eventually, the Song Dynasty paper money called "jiaozi" originated from these promissory notes.

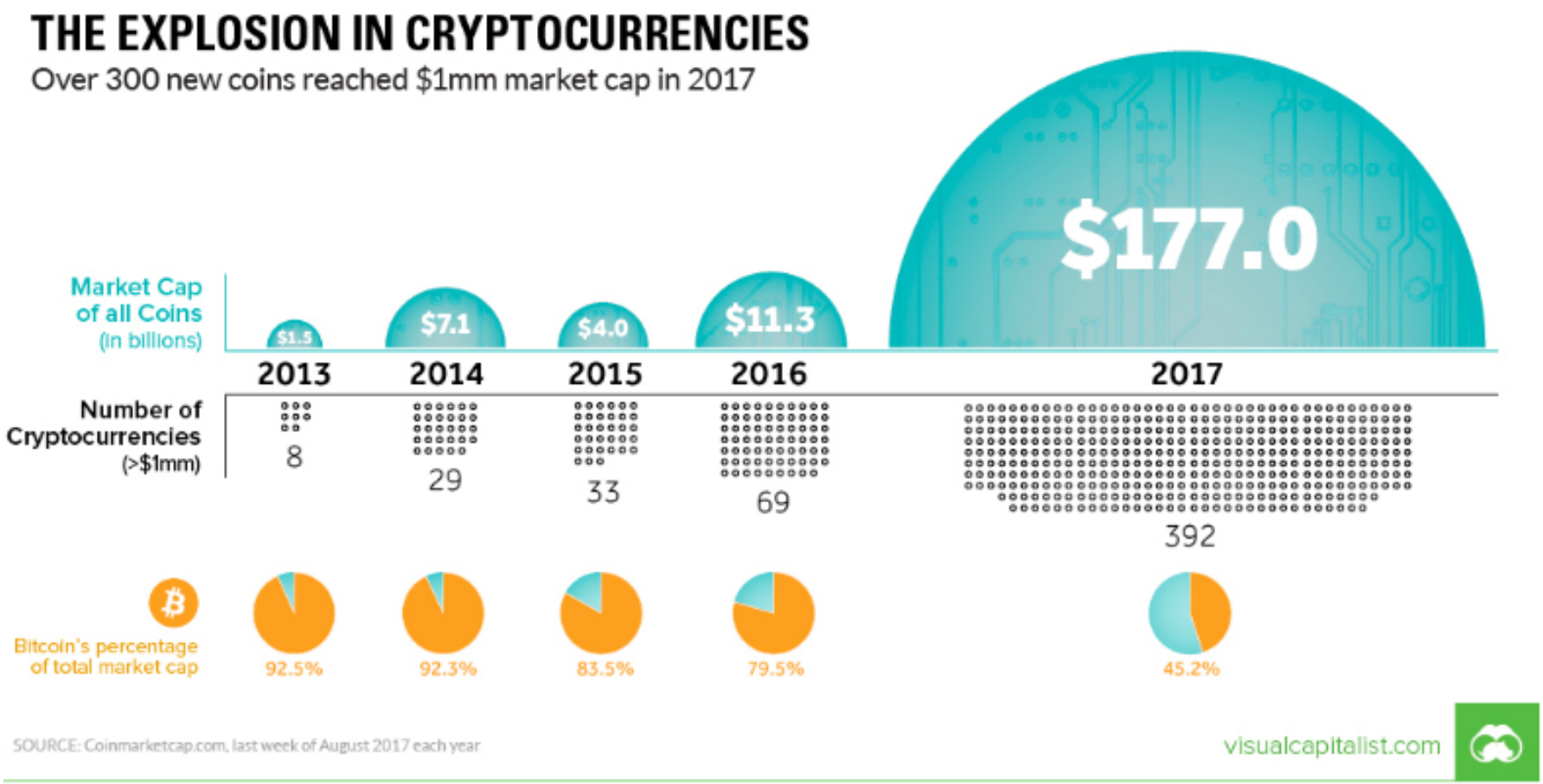


Source: Wiki–Song "Jiaozi."

The Island Of Stone Money (w)

Source: NPR Planet Money.

Explosion in Cryptocurrencies (w)



BIS: Money and Fintech (w)

Bank for International Settlements - Media & Speeches Videos

- Money through cooperation (4:46) Jan 2022
  `https://youtu.be/UWkisaoYtSg`
- Changing finance today (4:51) Jan 2022
  `https://youtu.be/0whW9J4tybg`
- The future of finance (4:42) Jan 2022
  `https://youtu.be/Y1jSgOEcgFY`
- Risk and stability (4:48) Jan 2022
  `https://youtu.be/O9arJKkR1tM`
- Cross-border transactions with CBDC (3:12) Apr 2021
  `https://youtu.be/CJt8w9HIcfE`
- How to make cross-border payments faster and cheaper (2:58) Jul 2021
  `https://youtu.be/wED3i_4spP8`

U.S. Money Stock Measures: Background

- The Central Bank of the United States, Federal Reserve System, has constructed and published monetary statistics since 1914.
- Timely and accurate data on the monetary aggregates are needed by the Board of Governors and the Federal Open Market Committee for use in monetary policy deliberations and by the public in assessing financial flows and conditions and their implications for the economy.
- Concepts and definitions of the money stock have evolved over time, reflecting changes in the regulatory and institutional environment.
- H.6 (money stocks) statistical release:

  `http://www.federalreserve.gov/releases/h6/current/`
- H.3 (aggregate reserves and monetary base):

  `https://www.federalreserve.gov/releases/h3/current/`
- H.4.1 (factors affecting reserve balances):

  `https://www.federalreserve.gov/releases/h41/current/default.htm`

U.S. Money Stock Measures: H.6 Release (w)

- The H.6 release, published monthly, provides measures of the monetary aggregates (M1 and M2) and their components.
- M1, the more narrowly defined measure, consists of the most liquid forms of money, namely currency and checkable deposits. Beginning May 2020, M1 also includes other liquid deposits.
- Beginning May 2020, M2 consists of M1 plus small-denomination time deposits (with the amount less than $100,000) and retail money market funds (MMFs), less IRA and Keogh balances.
- Currency in circulation consists of Federal Reserve notes and coin outside the U.S. Treasury and Federal Reserve Banks. Reserve balances are balances held by depository institutions in master accounts and excess balance accounts at Federal Reserve Banks.
- Monetary base equals currency in circulation plus reserve balances. Total reserves equal reserve balances plus, before April 2020, vault cash used to satisfy reserve requirements.

U.S. Money Stock Measures (w) (w)

Base Money (M0)

Monetary base, or M0, equals currency in circulation plus reserve balances.

Narrow Money (M1)

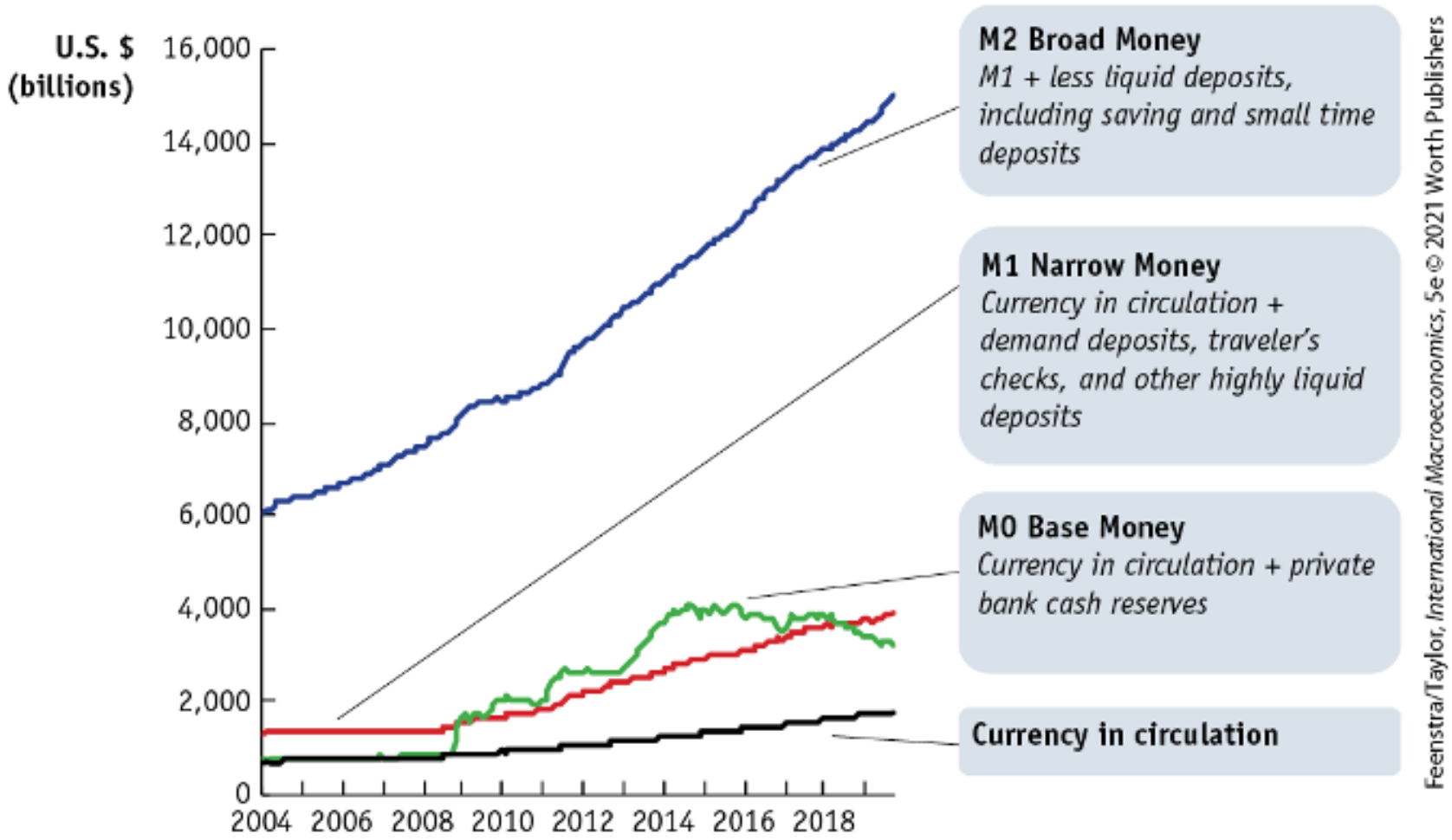
M1 consists of (1) currency in circulation; (2) demand deposits at commercial banks less cash items in the process of collection and Federal Reserve float; and (3) other liquid deposits, consisting of other checkable deposits (OCDs) and savings deposits (including money market deposit accounts).

Broad Money (M2)

M2 consists of M1 plus (1) small-denomination time deposits (in amounts of less than $100,000) less IRA and Keogh balances at depository institutions; and (2) balances in retail MMFs less IRA and Keogh balances.

Note: An adjustment is made in the definitions of M1 and M2 after May 2020.

U.S. Money Stock Measures, 2000 to 2020



U.S. Money Stock H.6 Statistics (w)

Table 1: Money Stock Measures (10)

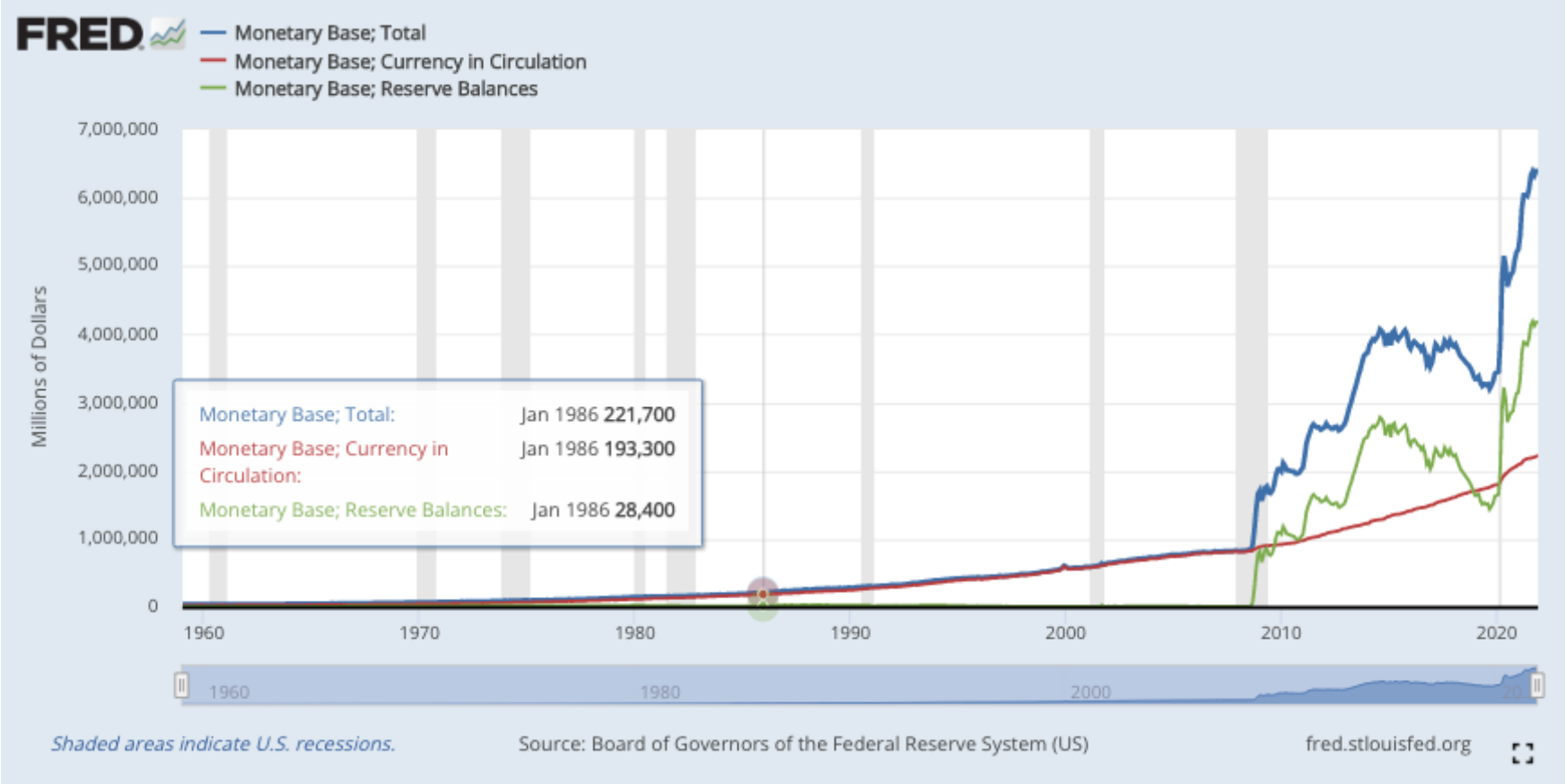
Table 2: Seasonally Adjusted Components of M1 and Non-M1 M2 (6)

Table 3: Not Seasonally Adjusted Components of M1 and Non-M1 M2 (16)

Name	Dec 2021	Nov 2021	Dec 2020	Units
▼ Seasonally Adjusted				
M1	20,553.1	20,345.4	17,812.4	Bil. of $
M2	21,638.1	21,437.0	19,129.5	Bil. of $
▼ Not Seasonally Adjusted				
▼ Monetary base	6,413,300	6,394,800	5,206,500	Mil. of $
Currency in circulation	2,225,300	2,214,300	2,071,600	Mil. of $
Reserve Balances	4,188,000	4,180,600	3,135,000	Mil. of $
M1	20,669.2	20,333.4	17,949.8	Bil. of $
M2	21,767.3	21,426.1	19,278.7	Bil. of $
▼ Memorandum: Reserves				
Total reserves	4,188.0	4,180.6	3,135.0	Bil. of $
Total borrowings from the Federal Reserve	38.0831	45.3176	58.6846	Bil. of $
Nonborrowed Reserves	4,149,900	4,135,300	3,076,300	Mil. of $

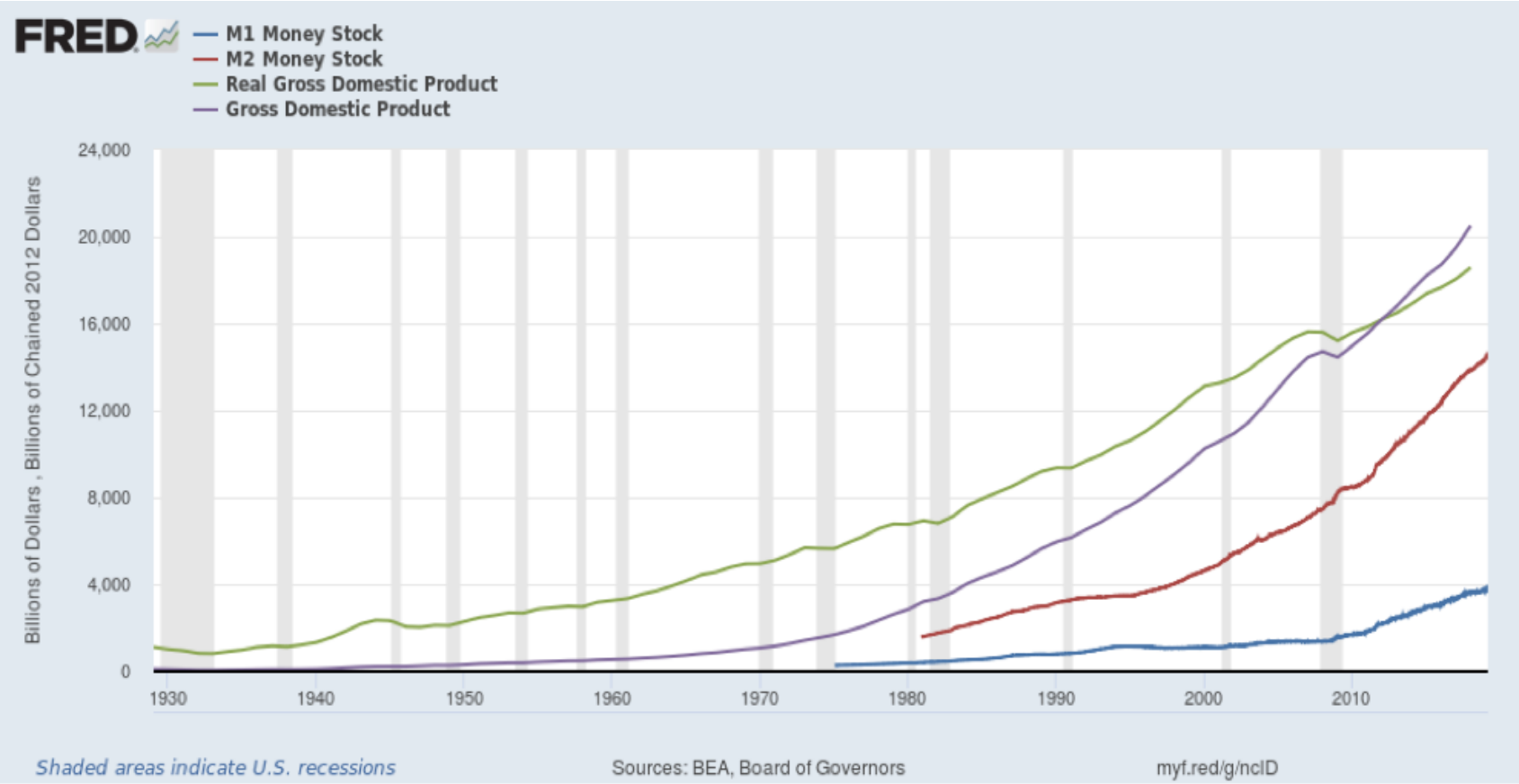
Source: FRED - H.6 Money Stock Measures, Release Tables.
https://fred.stlouisfed.org/release/tables?rid=21

U.S. Monetary Base, 1959-2021

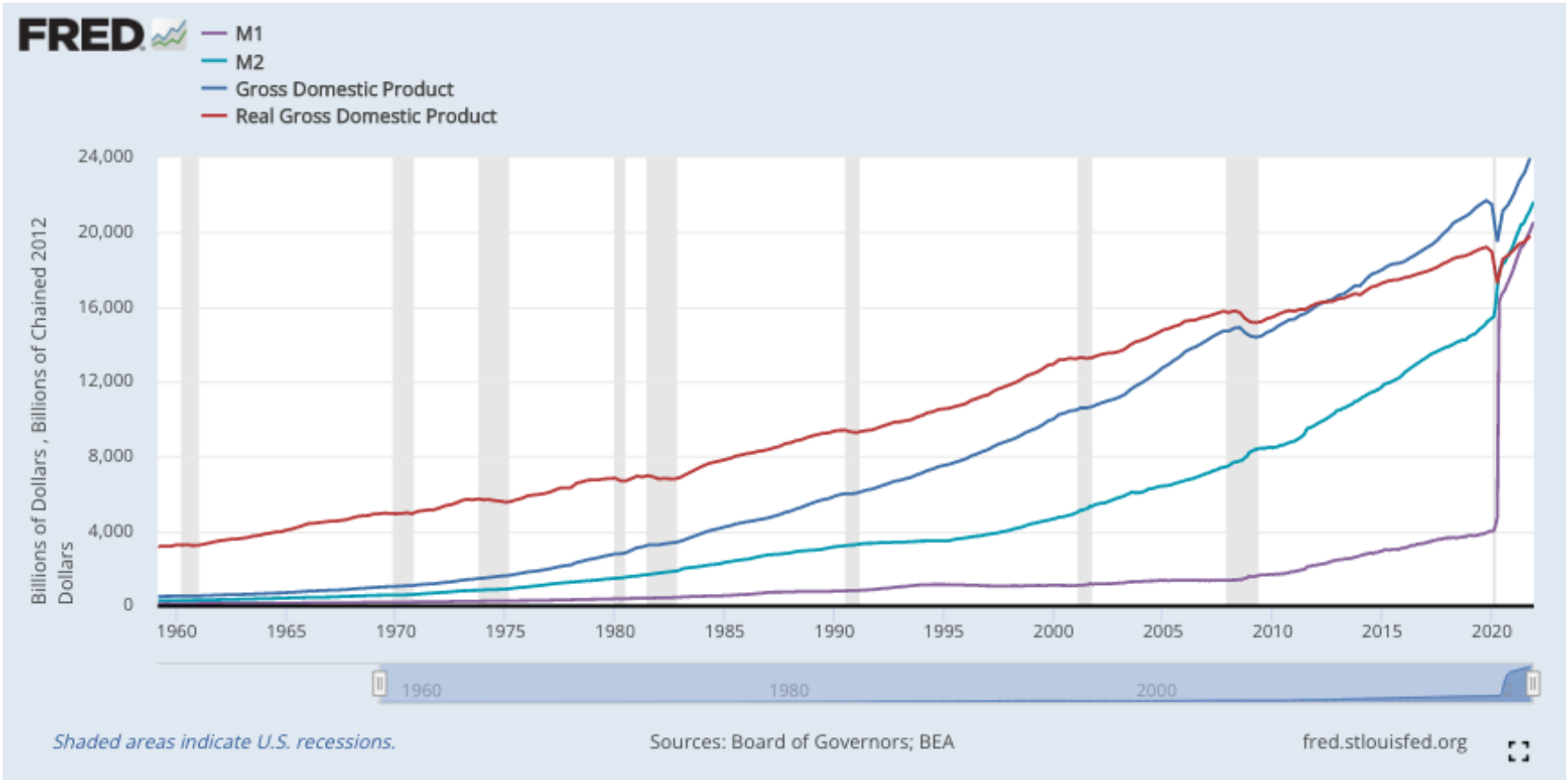


https://fred.stlouisfed.org/series/BOGMBASE

U.S. Money Stocks and National Income, 1930-2018



U.S. Money Stocks and National Income, 1960-2021



U.S. Money Stock Measures (in $B), 2020-2021

	Seasonally adjusted		Not seasonally adjusted							
			Monetary base					Memorandum: Reserves		
Date	M1 [1]	M2 [2]	Currency in circulation [3]	Reserve balances [4]	Monetary base [5]	M1 [1]	M2 [2]	Total reserves [6]	Total ($M) borrowings [7]	Nonborrowed reserves [8]
Aug. 2020	16,887.0	18,378.5	2,007.6	2,799.7	4,807.4	16,869.1	18,346.5	2,799.7	83,125.6	2,716.6
Sept. 2020	17,156.8	18,601.6	2,027.5	2,852.8	4,880.3	17,136.8	18,569.7	2,852.8	78,387.1	2,774.4
Oct. 2020	17,346.8	18,747.9	2,040.5	2,876.6	4,917.1	17,321.1	18,717.1	2,876.6	74,058.7	2,802.6
Nov. 2020	17,589.1	18,958.7	2,058.3	3,034.7	5,093.0	17,642.1	19,009.4	3,034.7	66,597.5	2,968.1
Dec. 2020	17,812.4	19,129.5	2,071.6	3,135.0	5,206.5	17,949.8	19,278.7	3,135.0	58,684.6	3,076.3
Jan. 2021	18,100.9	19,393.4	2,094.2	3,153.8	5,248.0	18,092.5	19,409.6	3,153.8	52,590.8	3,101.2
Feb. 2021	18,389.5	19,665.5	2,100.9	3,345.9	5,446.8	18,276.9	19,567.1	3,345.9	53,475.8	3,292.5
Mar. 2021	18,669.4	19,913.4	2,117.8	3,721.3	5,839.0	18,740.1	19,996.1	3,721.3	57,950.3	3,663.3
Apr. 2021	18,927.5	20,138.8	2,154.8	3,887.3	6,042.1	19,078.2	20,294.4	3,887.3	66,805.2	3,820.5
May 2021	19,209.0	20,402.7	2,169.5	3,872.4	6,041.9	19,159.8	20,342.1	3,872.4	80,781.7	3,791.6
June 2021	19,255.7	20,429.4	2,179.0	3,848.1	6,027.0	19,310.3	20,471.9	3,848.1	87,746.0	3,760.3
July 2021	19,420.0	20,578.8	2,186.3	3,943.9	6,130.2	19,464.0	20,609.0	3,943.9	87,621.1	3,856.3
Aug. 2021	19,696.7	20,834.1	2,188.6	4,140.1	6,328.7	19,689.5	20,812.3	4,140.1	80,766.7	4,059.3
Sept. 2021	19,876.9	20,996.9	2,195.7	4,193.2	6,388.9	19,889.9	20,997.6	4,193.2	68,567.7	4,124.6
Oct. 2021	20,082.9	21,186.8	2,202.9	4,128.1	6,331.0	20,077.7	21,177.9	4,128.1	54,558.8	4,073.5
Nov. 2021	20,345.4	21,437.0	2,214.3	4,180.6	6,394.8	20,333.4	21,426.1	4,180.6	45,317.6	4,135.3
Dec. 2021	20,553.1	21,638.1	2,225.3	4,188.0	6,413.3	20,669.2	21,767.3	4,188.0	38,083.1	4,149.9

https://www.federalreserve.gov/releases/h6/current/default.htm

M1 and M2 (Non-M1) Components

Date	M1			Non-M1 M2	
	Currency [1]	Demand deposits [2]	Other liquid deposits [3]	Small-denomination time deposits [4]	Retail money market funds [5]
Aug. 2020	1,911.1	2,261.9	12,714.0	378.8	1,112.7
Sept. 2020	1,927.9	2,386.1	12,842.8	348.6	1,096.3
Oct. 2020	1,944.1	2,418.5	12,984.2	316.4	1,084.7
Nov. 2020	1,956.8	2,788.0	12,844.2	280.9	1,088.8
Dec. 2020	1,969.3	3,318.2	12,524.8	251.5	1,065.6
Jan. 2021	1,992.6	3,461.3	12,647.0	229.7	1,062.8
Feb. 2021	2,006.9	3,678.5	12,704.1	206.3	1,069.7
Mar. 2021	2,018.0	3,798.3	12,853.1	185.7	1,058.3
Apr. 2021	2,050.7	3,765.6	13,111.2	164.5	1,046.9
May 2021	2,065.0	3,999.8	13,144.2	152.0	1,041.8
June 2021	2,079.4	4,213.9	12,962.5	141.0	1,032.7
July 2021	2,089.4	4,343.7	12,986.8	130.1	1,028.8
Aug. 2021	2,093.5	4,487.8	13,115.4	118.9	1,018.5
Sept. 2021	2,099.5	4,516.5	13,260.9	108.6	1,011.4
Oct. 2021	2,105.4	4,641.7	13,335.8	100.5	1,003.4
Nov. 2021	2,114.6	4,766.1	13,464.7	93.7	997.9
Dec. 2021	2,124.5	4,827.1	13,601.5	84.9	1,000.1

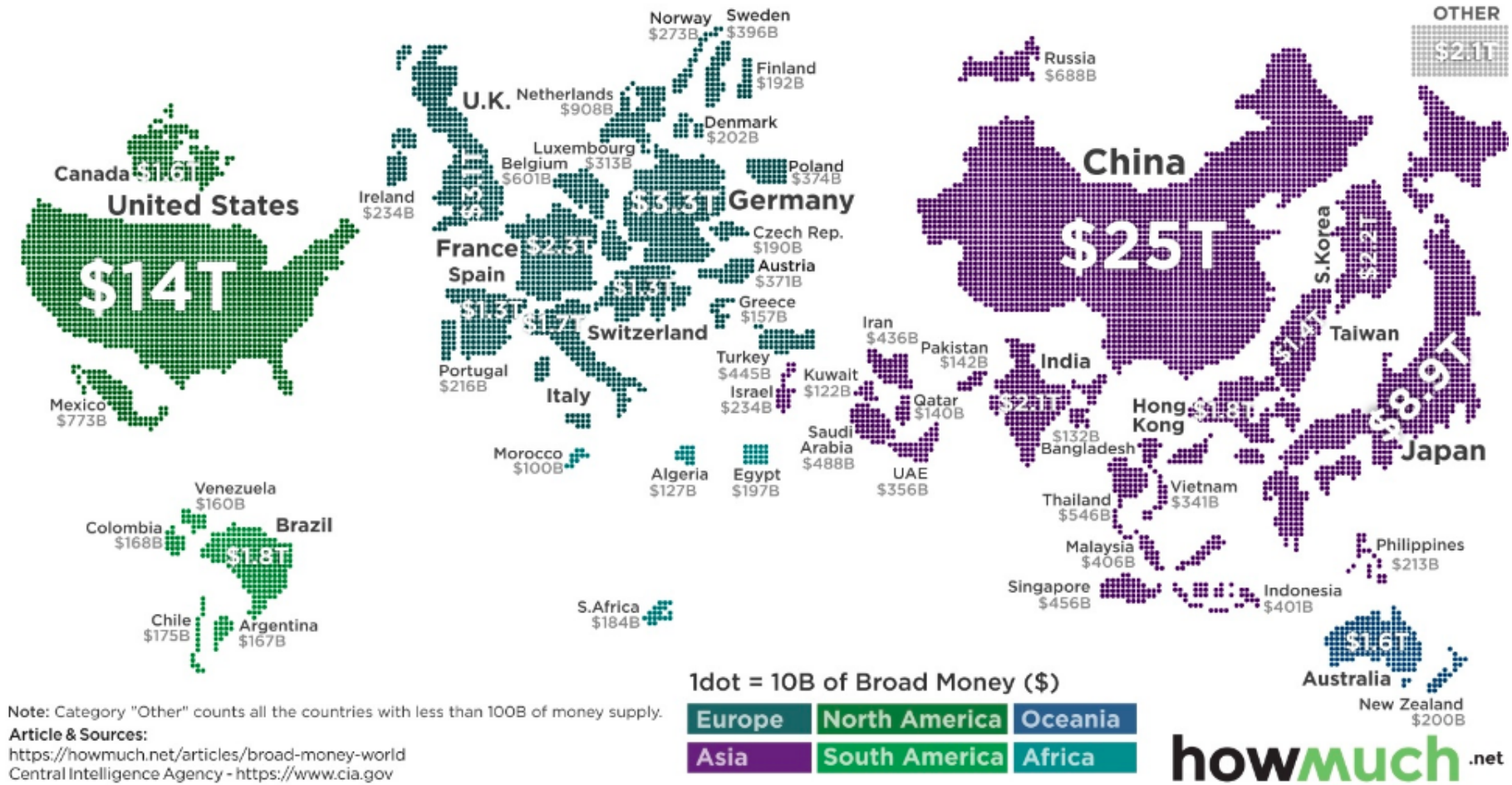
Note: Seasonally Adjusted Components of M1 and Non-M1 M2. Billions of dollars.
`https://www.federalreserve.gov/releases/h6/current/default.htm`

M1 and M2 (Non-M1) Components

Date	M1			Non-M1 M2		Memorandum: IRA and Keogh accounts		
	Currency [1]	Demand deposits [2]	Other liquid deposits [3]	Small-denomination time deposits [4]	Retail money market funds [5]	At depository institutions	At money market funds	Total
Aug. 2020	1,908.8	2,274.1	12,686.2	381.7	1,095.6	577.9	375.8	953.7
Sept. 2020	1,929.2	2,387.4	12,820.1	350.4	1,082.6	585.9	380.5	966.4
Oct. 2020	1,944.1	2,427.4	12,949.7	315.2	1,080.7	592.9	382.8	975.7
Nov. 2020	1,957.9	2,753.0	12,931.2	277.0	1,090.2	598.7	382.5	981.2
Dec. 2020	1,973.8	3,356.3	12,619.7	248.3	1,080.6	604.7	382.1	986.8
Jan. 2021	1,988.3	3,368.1	12,736.1	228.0	1,089.1	606.6	380.2	986.9
Feb. 2021	1,999.3	3,527.8	12,749.7	205.2	1,085.1	604.4	376.9	981.4
Mar. 2021	2,019.9	3,762.7	12,957.5	184.7	1,071.3	602.3	373.6	975.9
Apr. 2021	2,053.6	3,849.5	13,175.1	165.1	1,051.1	599.5	369.9	969.4
May 2021	2,068.7	4,037.8	13,053.3	152.6	1,029.7	596.0	365.9	962.0
June 2021	2,080.7	4,296.7	12,932.9	142.6	1,019.1	592.5	361.9	954.4
July 2021	2,087.1	4,429.3	12,947.6	131.6	1,013.4	590.6 e	363.3 e	953.9 e
Aug. 2021	2,091.3	4,503.5	13,094.8	120.0	1,002.8	590.6 e	371.2 e	961.9 e
Sept. 2021	2,098.9	4,524.8	13,266.2	109.2	998.5	590.6 e	379.1 e	969.7 e
Oct. 2021	2,106.5	4,651.3	13,319.8	100.3	1,000.0	590.6 e	383.0 e	973.6 e
Nov. 2021	2,116.4	4,709.2	13,507.8	92.6	1,000.1	590.6 e	383.0 e	973.6 e
Dec. 2021	2,129.6	4,878.2	13,661.4	84.0	1,014.1	590.6 e	383.0 e	973.6 e

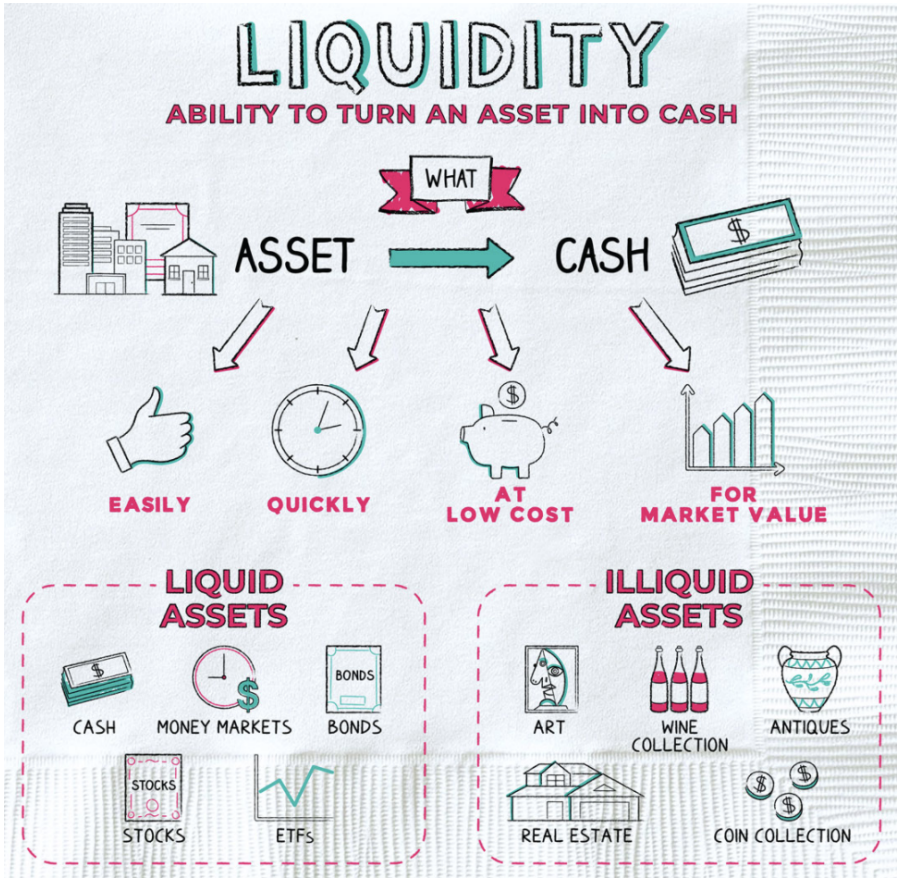
Note: Not Seasonally Adjusted Components of M1 and Non-M1 M2. Billions of dollars.
`https://www.federalreserve.gov/releases/h6/current/default.htm`

Global Money Stock in Circulation, 2019 (w)



https://howmuch.net/articles/broad-money-world-2019

Money, Asset, and Liquidity (w)



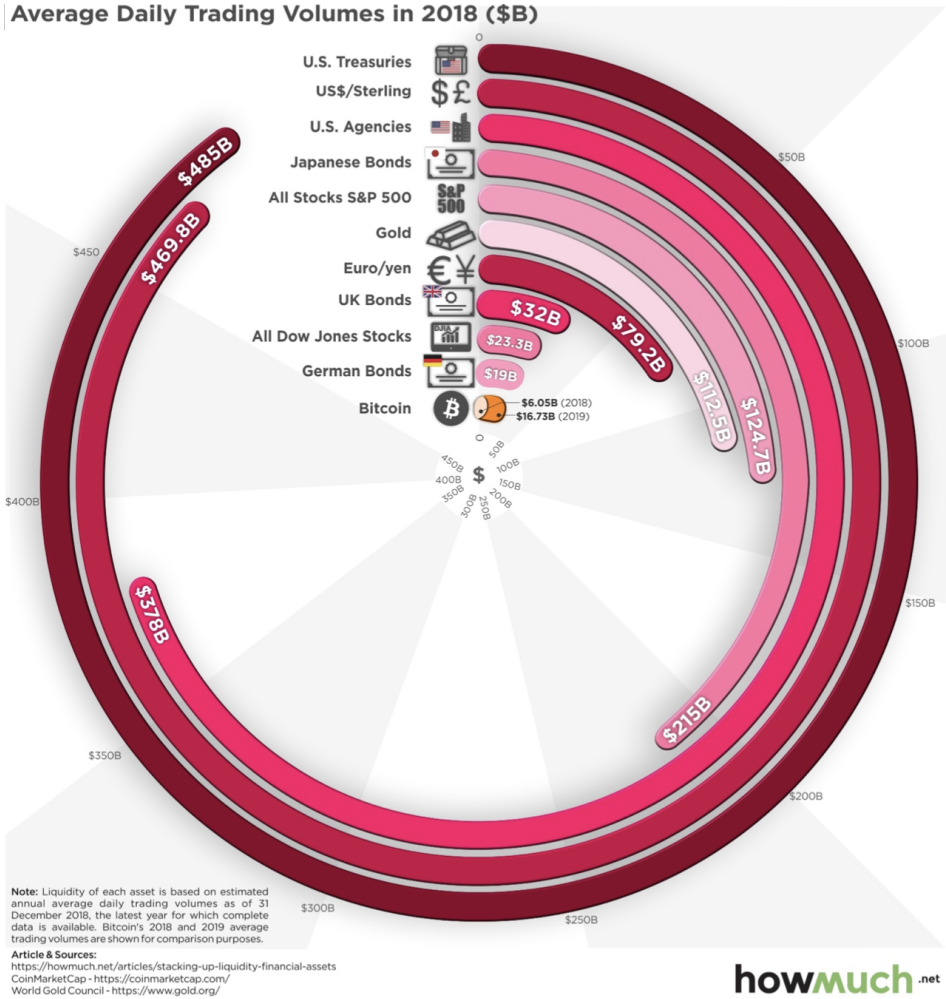
https://napkinfinance.com/napkin/liquidity/

Assets are liquid if they can be exchanged for cash:

- Easily and quickly
- At little or no transaction cost
- At their fair market values, i.e., without having to entice a buyer with a big discount

Liquidity refers to the ease with which an asset, or security, can be converted into ready cash without affecting its market price. Cash (money) is the most liquid asset because you can easily turn it into other assets.
Source: Investopedia.

Global Financial Assets Trading Liquidity (w)



1. U.S. treasuries are by far the most liquid class of assets, averaging some $485B per day in 2018.
2. Gold remains a highly liquid asset even in the age of fiat and crypto, topping $112.5B in 2018.
3. Bitcoin's average daily liquidity surged from 2018 to 2019, rising from $6.05B to $16.73B.
4. Despite its volatility, bitcoin sees almost as much daily liquidity as German bonds ($16.7B vs $19B).

CNBC: Money and Financial Innovation

Watch the videos below to be amazed by the financial innovations in the recent years and consider their impacts on our world of money, more specifically, the measurements of money and challenges to monetary policy.

- 201703 What is Blockchain? | CNBC 4:52 (w)
- 201806 What is Fintech? | CNBC 3:47 (w)
- 201901 How Robinhood Makes Money | CNBC 9:00 (w)
- 201904 How Venmo Makes Money | CNBC 11:29 (w)
- 201910 How Square Makes Money | CNBC 13:40 (w)
- 201910 Why Facebook's Libra is in Trouble | CNBC 14:51 (w)

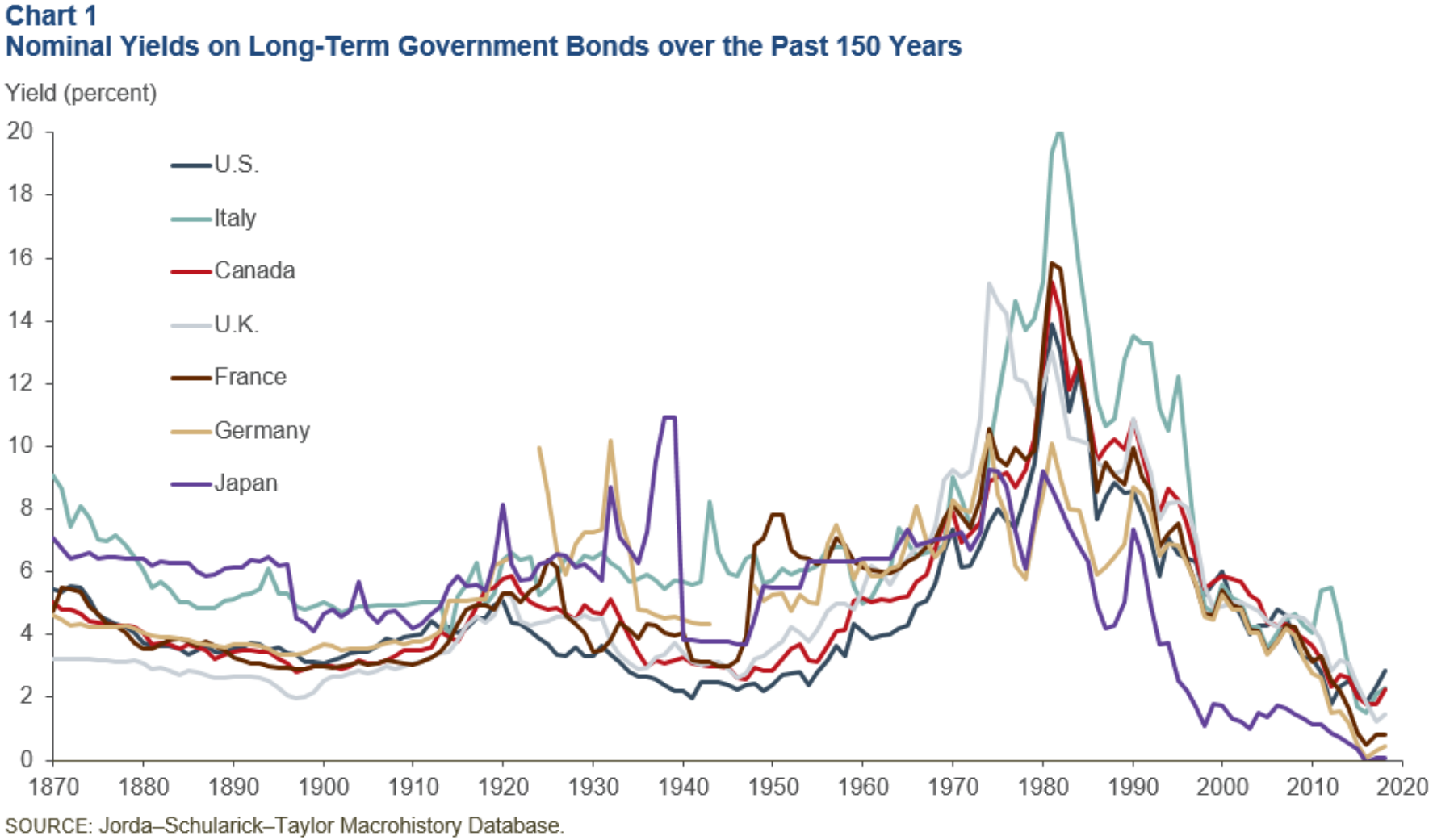
What Does the Bible say about Money? (w)

Bible Verses about Money (w) (w)

- 1 out of 10 verses in the Gospels deal with money
- 16 out of 38 of Jesus' parables deal with money and possessions
- Nearly 25% of Jesus' words in the NT deal with biblical stewardship
- There are more than 2,000 scriptures on tithing in the Bible, money, and possessions in the Bible, which is twice as many as faith and prayer combined.
- When it comes to breaking down what the Bible has to say about money, there are nine principles about money students can learn:
  1) God owns everything; 2) Money is a tool; 3) Worship with your money; 4) Get that money; 5) Fight for contentment; 6) Kill greed in your heart; 7) Be mindful of debt; 8) Manage your finances;
  9) Mo' money, mo' problems.

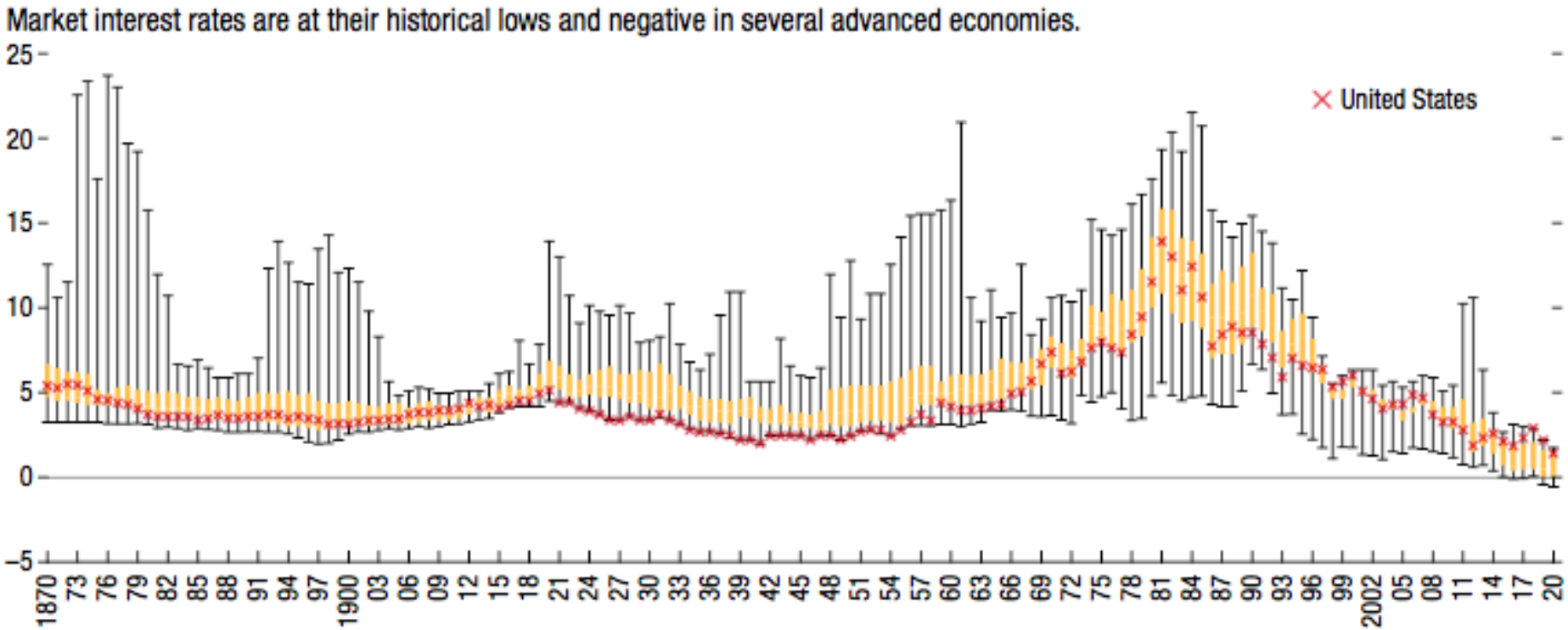
Outline

Historical Long-Term Interest Rates 1870-2018



https://www.dallasfed.org/news/speeches/kaplan/2018/rsk181024.aspx

Historical Trends in Global Interest Rates1870-2020



Sources: Jordà-Schularick-Taylor Macrohistory database (Jordà and others 2019); and IMF staff calculations.
Note: The sample includes Australia, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and the United States. The figure shows the interquartile range (yellow bars) and the 10th and 90th percentiles (whiskers). Red markers signify the United States. Data for 2020 are through the end of March.

Note: 10-Year Government Bond Yields

U.S. Interest Rate Statistics H.15

- The Board of Federal Reserve System publishes the H.15 statistics on daily interest rates for selected U.S. Treasury and private money market and capital market instruments.
- Money Market Rates (less than 1 year): Federal Funds, Commercial Paper, Certificates of Deposit, Eurodollar Deposits, Bank Prime Loans, U.S. Government Treasury Bills.
- Capital Market Rates (equal or over 1 year): Interest Rate Swaps, U.S. Government Treasury Notes and Bonds, Corporate Bonds, Municipal Bonds, Residential Mortgage Loans.
- Current and historical H.15 data, along with weekly, monthly, and annual averages, are available on the Board's Data Download Program (DDP). Weekly, monthly and annual rates are averages of business days unless otherwise noted. `https://www.federalreserve.gov/datadownload/Choose.aspx?rel=H15)`
- The H.15 statistics contains pivotal information on the U.S. interest rate structures. `https://www.federalreserve.gov/releases/h15/`

U.S. Interest Rate Risk Structure: H.15 Statistics (w)

Instruments	2021 Feb 25	2021 Feb 26	2021 Mar 1	2021 Mar 2	2021 Mar 3
Federal funds (effective) 1 2 3	0.07	0.07	0.07	0.07	0.07
Commercial Paper 3 4 5 6					
Nonfinancial					
1-month	0.06	0.06	0.06	0.06	0.06
2-month	0.07	0.07	0.06	0.06	0.06
3-month	0.08	0.08	0.07	0.06	0.07
Financial					
1-month	n.a.	0.09	0.07	0.08	n.a.
2-month	n.a.	n.a.	n.a.	n.a.	n.a.
3-month	0.12	0.15	0.10	0.11	0.17
Bank prime loan 2 3 7	3.25	3.25	3.25	3.25	3.25
Discount window primary credit 2 8	0.25	0.25	0.25	0.25	0.25
U.S. government securities					
Treasury bills (secondary market) 3 4					
4-week	0.04	0.04	0.03	0.04	0.04
3-month	0.04	0.04	0.05	0.04	0.05
6-month	0.06	0.05	0.07	0.06	0.07
1-year	0.09	0.08	0.08	0.08	0.08

https://www.federalreserve.gov/releases/h15/

U.S. Interest Rate Term Structure: H.15 Statistics (w)

Instruments	2021 Feb 25	2021 Feb 26	2021 Mar 1	2021 Mar 2	2021 Mar 3
Treasury constant maturities					
Nominal 9					
1-month	0.04	0.04	0.03	0.04	0.04
3-month	0.04	0.04	0.05	0.04	0.05
6-month	0.06	0.05	0.07	0.06	0.07
1-year	0.09	0.08	0.08	0.08	0.08
2-year	0.17	0.14	0.13	0.13	0.14
3-year	0.34	0.30	0.27	0.26	0.29
5-year	0.81	0.75	0.71	0.67	0.73
7-year	1.23	1.15	1.12	1.08	1.14
10-year	1.54	1.44	1.45	1.42	1.47
20-year	2.25	2.08	2.11	2.09	2.12
30-year	2.33	2.17	2.23	2.21	2.25
Inflation indexed 10					
5-year	-1.53	-1.64	-1.69	-1.76	-1.72
7-year	-1.06	-1.16	-1.19	-1.26	-1.21
10-year	-0.60	-0.71	-0.71	-0.78	-0.74
20-year	-0.03	-0.18	-0.14	-0.18	-0.17
30-year	0.22	0.06	0.12	0.08	0.10
Inflation-indexed long-term average 11	0.05	-0.09	-0.03	-0.07	-0.05

https://www.federalreserve.gov/releases/h15/

Time Value and Interest Rate

$$\boxed{FV = PV \times (1 + i)}$$

- What is the value of \$100 next year, if the market interest rate is 1%?
- PV is the present value of a financial asset, i stands for interest rate.
- FV is the future value of the financial asset bearing interest over time.

$$\boxed{PV = FV \div (1 + i)}$$

- What is the value today for next year's \$100, if $i = 1\%$?
- How much shall we deposit today in order to withdraw \$100 next year?
- How much we can borrow today if we have to pay back \$100 next year?

Future Value and Simple Interest

$$\boxed{FV = PV \times i \times T}$$

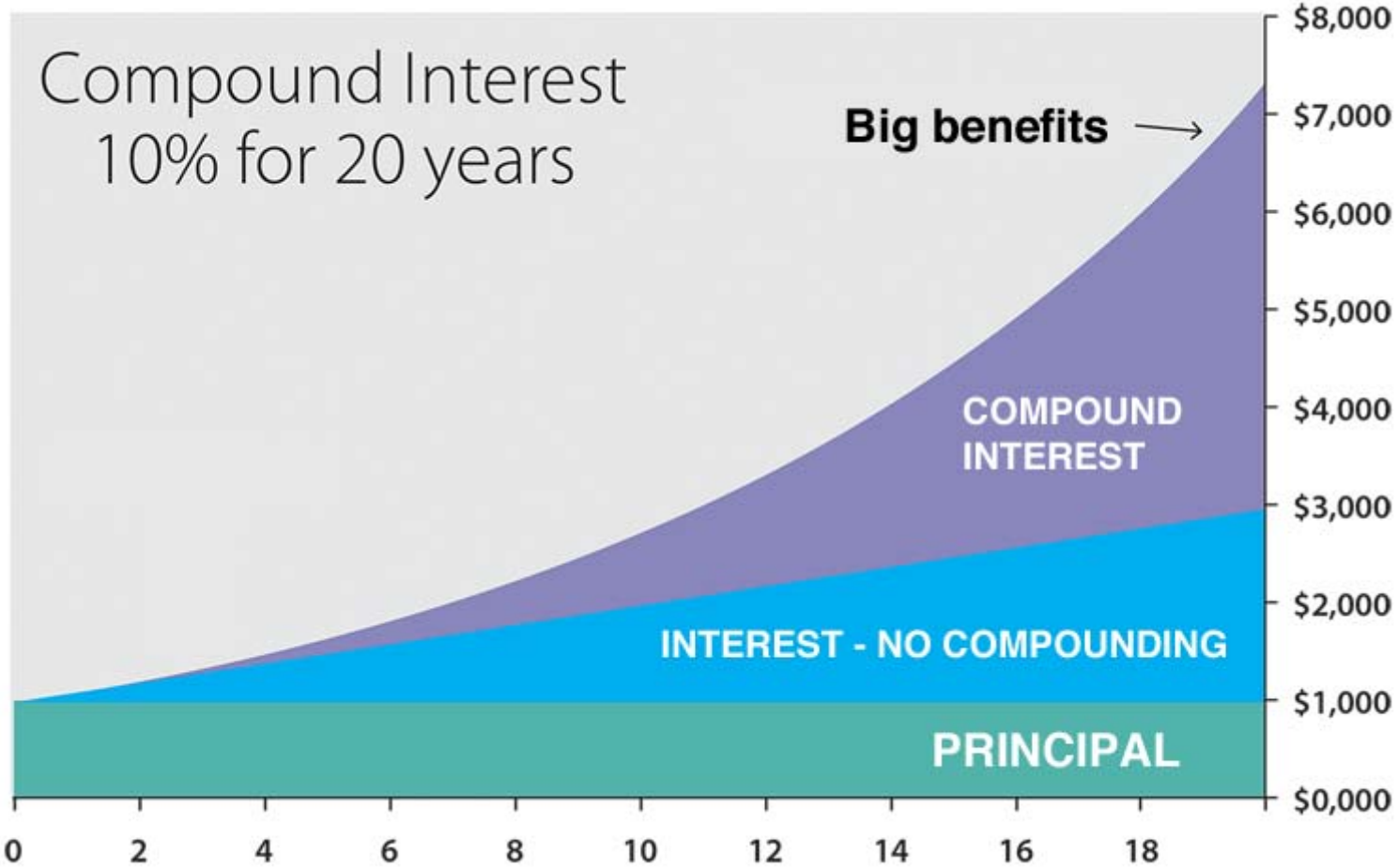
- Suppose the market interest rate is 1% and remains the same.
- Simple interest pays a fixed amount of interest year over year.
- The value of \$100 in one year: $FV_1 = 100 + 100 \times 1\% = \$101$
- The value of \$100 in two years: $FV_2 = 100 + 1 + 1 = \$102$
- .....
- The value of \$100 in T years: $FV_T = 100 + 1 + ... + 1 = \$100 + 1 \times T$
- Conclusion: A financial asset with simple interest grows in linear value.

Future Value and Compound Interest

$$\boxed{FV = PV \times (1+i)^T}$$

- Suppose the market interest rate is 1% and remains the same.
- Compound interest pays interest year over year on earlier interest paid.
- The value of \$100 in one year: $FV_1 = 100 + 100 \times 1\% = PV \times (1+i)$
- The value of \$100 in two years: $FV_2 = FV_1 + FV_1 \times 1\% = FV_1 \times (1+i)$
- The value of \$100 in three year: $FV_3 = FV_2 + FV_2 \times 1\% = FV_2 \times (1+i)$
- .....
- The value of \$100 in T years: $FV_T = FV_{T-1} \times (1+i) = PV \times (1+i)^T$
- Conclusion: A financial asset with compound interest grows exponentially.

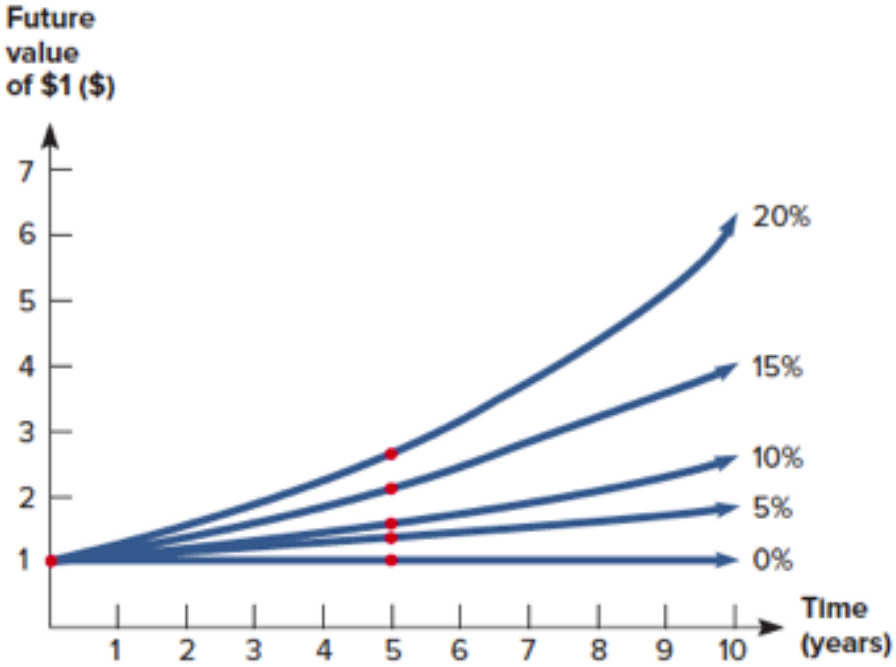
The Effect of Compound Interest (w)



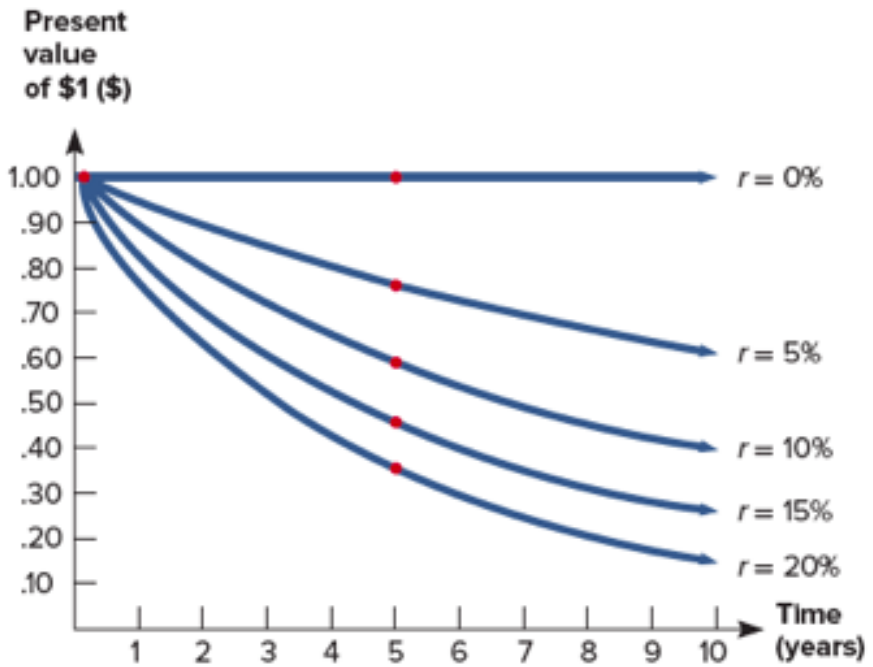
https://www.thecalculatorsite.com/articles/finance/compound-interest-formula.php

Future Value v.s. Present Value

$FV = (1+i)^T$ (Compounding)



$PV = (1+i)^{-T}$ (Discounting)



Source: Ross (2021). FV rises with the compound rate i and the time horizon. For the same future value, PV falls with the discount rate i and time horizon.

Credit Market and Interest Rate

- Credit (loanable funds) is essential for the efficient allocation of incomes in the economy. The relevant price in he credit market is the interest rate (in real terms). In a world without inflation and other risks, the interest rate is the price of borrowing or lending, reflecting the economic trade-off between the present and future incomes that borrowers and savers face.
- Firms, households, and governments use the credit market for borrowing. The credit demand summarizes the relationship between the quantity of credit demanded by borrowers and the interest rate cost. The credit demand curve results from the optimizing behavior of the borrowers.
- Savors/lenders trade off consumption today for consumption in the future, taking into account of the reward (earned interest) for delaying consumption. The credit supply summarizes the relationship between the quantity of credit supplied and the interest rate.
- The intersection of the credit demand curve and the credit supply curve is the credit market equilibrium. At the equilibrium interest rate, the quantity of credit demanded is equal to the quantity of credit supplied.

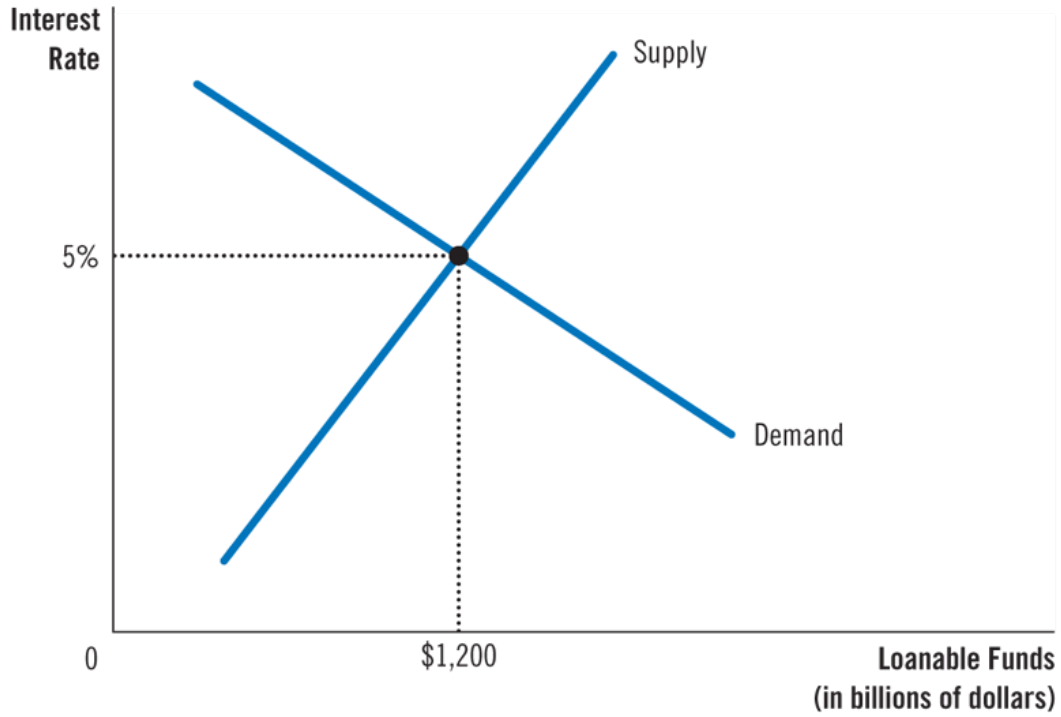
Source: Acemoglu, Laibso, and List (2022) CH10, Macroeconomics, 3e, Pearson.

Credit (Loanable Funds) Market Equilibrium $S(i) = I(i)$

FIGURE 1

The Market for Loanable Funds

The interest rate in the economy adjusts to balance the supply and demand for loanable funds. The supply of loanable funds comes from national saving, including both private saving and public saving. The demand for loanable funds comes from firms and households that want to borrow for purposes of investment. Here the equilibrium interest rate is 5 percent, and $1,200 billion of loanable funds are supplied and demanded.



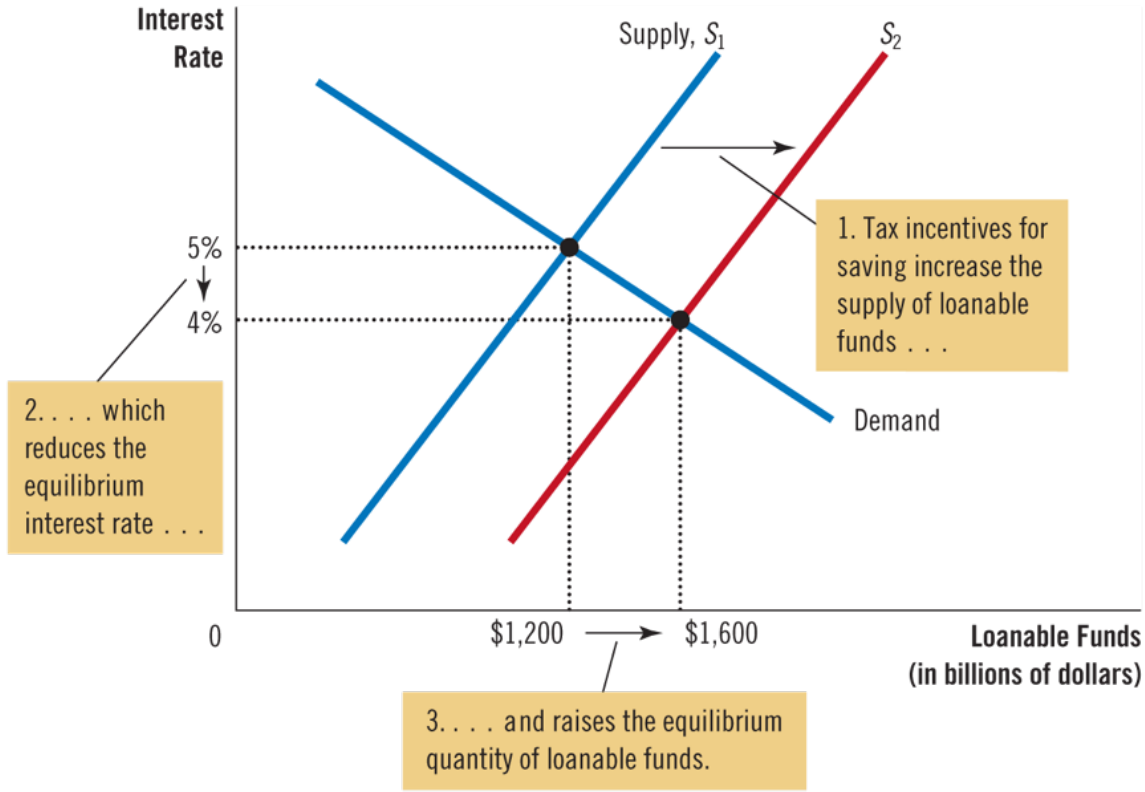
Source: N. G. Mankiw (2021) CH26, Principles of Economics, 9e, Cengage.

Saving Increases Supply of Credits (Funds)

FIGURE 2

Saving Incentives Increase the Supply of Loanable Funds

A change in the tax laws to encourage Americans to save more would shift the supply of loanable funds to the right from S_1 to S_2. As a result, the equilibrium interest rate would fall, and the lower interest rate would stimulate investment. Here the equilibrium interest rate falls from 5 percent to 4 percent, and the equilibrium quantity of loanable funds saved and invested rises from $1,200 billion to $1,600 billion.



Source: N. G. Mankiw (2021) CH26, Principles of Economics, 9e, Cengage.

Investment Increases Demand for Credits (Funds)

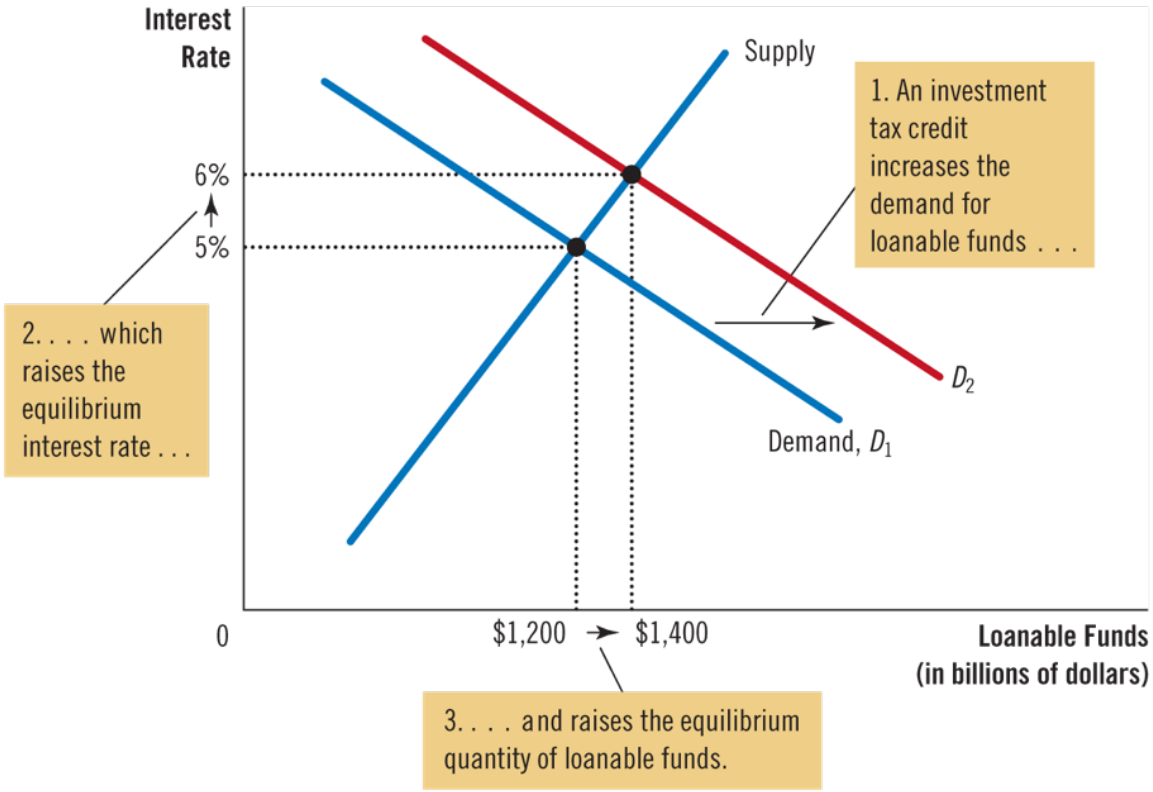


FIGURE 3

Investment Incentives Increase the Demand for Loanable Funds

If the passage of an investment tax credit encouraged firms to invest more, the demand for loanable funds would increase. As a result, the equilibrium interest rate would rise, and the higher interest rate would stimulate saving. Here, when the demand curve shifts from D_1 to D_2, the equilibrium interest rate rises from 5 percent to 6 percent, and the equilibrium quantity of loanable funds saved and invested rises from $1,200 billion to $1,400 billion.

Source: N. G. Mankiw (2021) CH26, Principles of Economics, 9e, Cengage.

National Income, Saving and Investment

In a closed economy, national income identity implies that investment I must always be financed by saving S, and both are determined by the interest rate.

- $Y = C + I + G \Rightarrow I = Y - C - G$
- Add and subtract government tax T inside
- $Y - C - G = Y - C - T + T - G = (Y - C - T) + (T - G)$
- Private sector saving $= Y - C - T = S_{private}$
- Public sector saving $= T - G = S_{public}$
- $S = (Y - C - T) + (T - G) = S_{private} + S_{public}$
- National saving is equal to investment ($S = I$) in equilibrium.

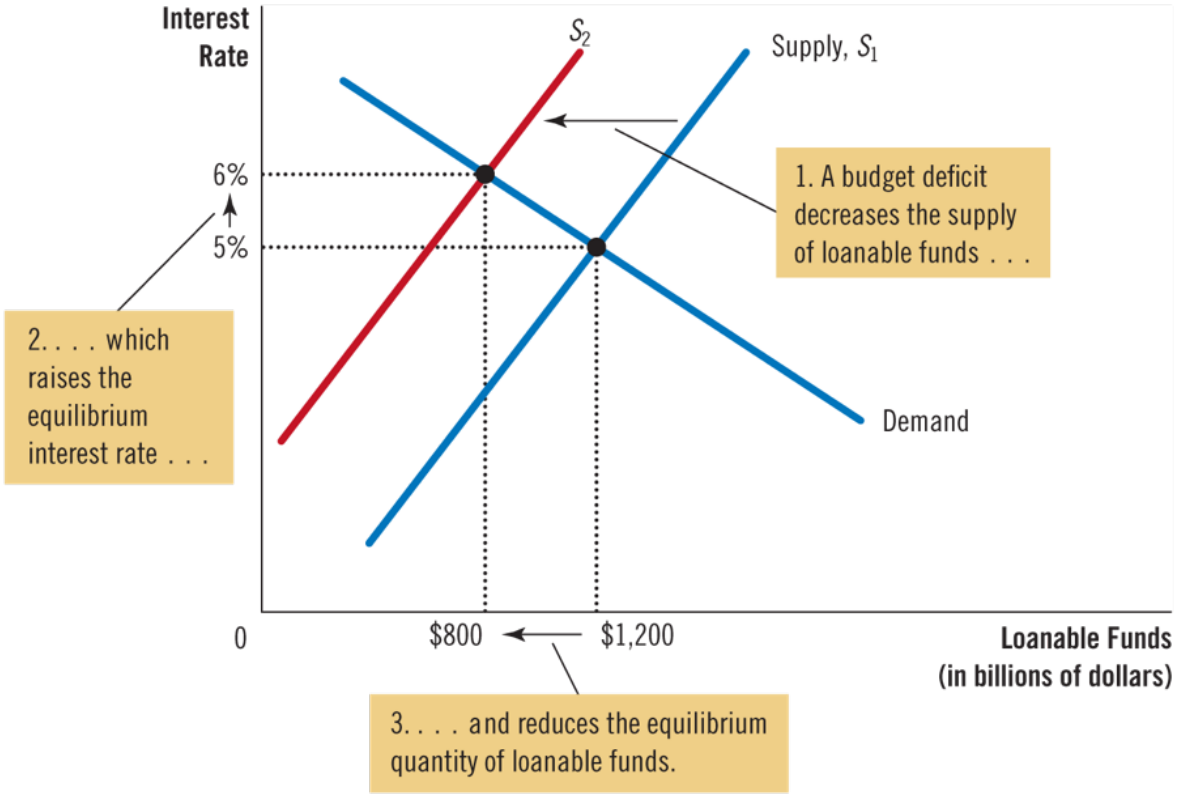
In the loanable funds market for borrowing and lending activities, saving provides supply of fund whereas investment induces demand for fund. Market equilibrium is reached at the interest rate such that saving equals investment.

Public Debt Decreases National Savings

FIGURE 4

The Effect of a Government Budget Deficit

When the government spends more than it receives in tax revenue, the resulting budget deficit lowers national saving. The supply of loanable funds decreases, and the equilibrium interest rate rises. Thus, when the government borrows to finance its budget deficit, it crowds out households and firms that otherwise would borrow to finance investment. Here, when the supply curve shifts from S_1 to S_2, the equilibrium interest rate rises from 5 percent to 6 percent, and the equilibrium quantity of loanable funds saved and invested falls from $1,200 billion to $800 billion.



Source: N. G. Mankiw (2021) CH26, Principles of Economics, 9e, Cengage.

What Determine Interest (Rate)?

The nature of interest had been mysterious and contentious in history. According to Wikipedia, in many historical societies including ancient Christian, Jewish, and many modern Islamic societies, usury meant the charging of interest of any kind and was considered wrong, or was made illegal.Religious and legal practices aside, why does interest exist ever on earth? Consider the following questions:

1. Which money do you prefer, $100 today or $100 one year after?
2. Which do you prefer, an apple today or the same apple next month?
3. Are the answers fundamentally different across space over time?
4. Why does interest exist? What determine its size?

Usury `https://en.wikipedia.org/wiki/Usury`
Charging interest `https://www.openbible.info/topics/charging_interest`

Irving Fisher (1930) The Theory of Interest

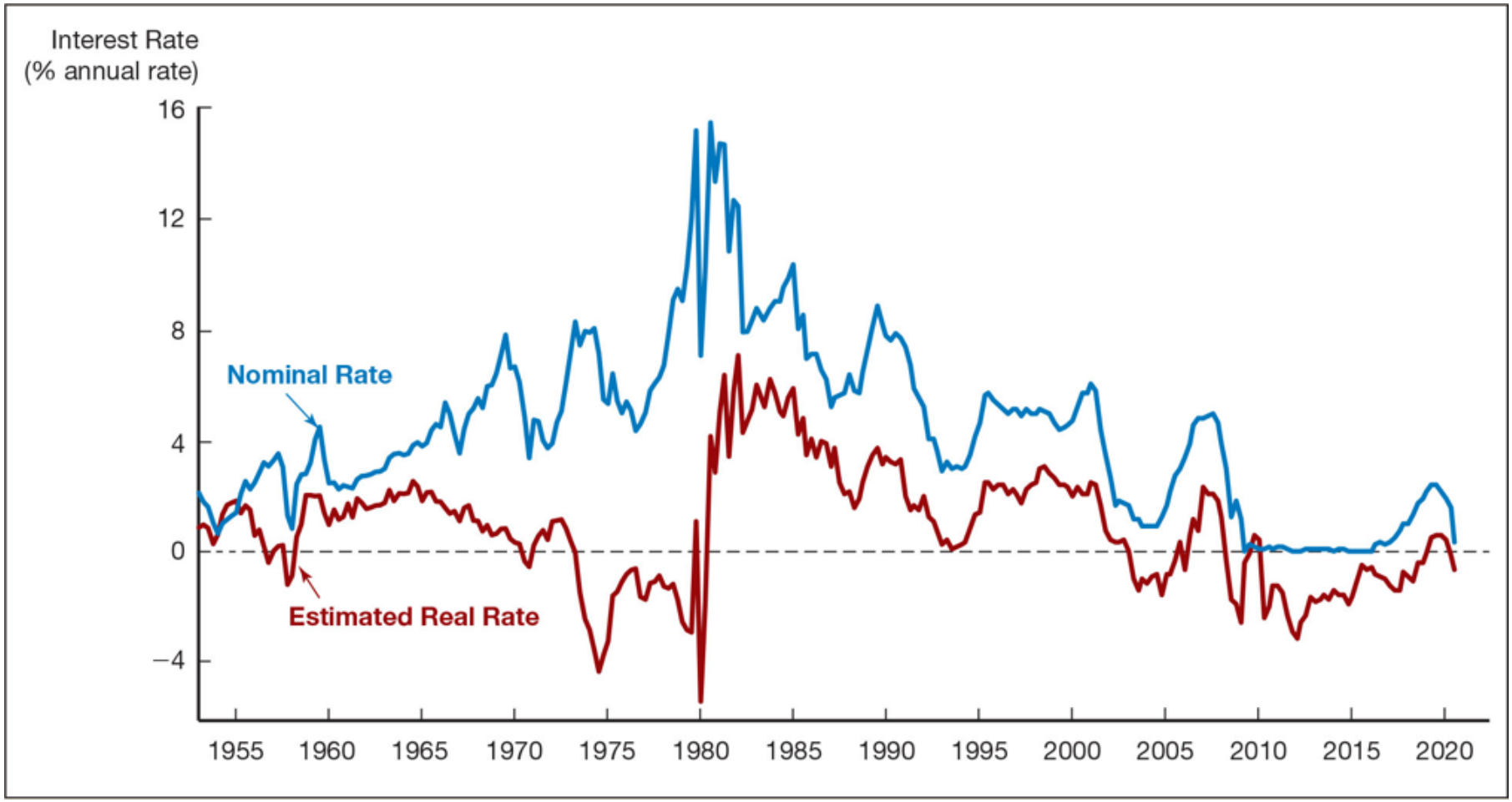
1. Income is the alpha and omega of economic life.
2. Investment is the balancing of consumption over time.
3. Capital generates income. Income is derived from capital.
4. The value of capital is derived from the value of income.
5. Interest is paid for immediate consumption at the cost of future consumption, the size of which is determined by consumption impatience and investment opportunity.
6. Interest (rate) is the (percentage) cost of borrowing and return to lending.
7. Nominal interest rate equals real interest rate plus a risk premium.
8. The price, or the present value, of an asset is the discounted sum of all its expected future cash flows, adjusting for risks.
9. Market interest rates and asset prices are ex-ante risk signals.

Fisher Equation: Nominal and Real Interest Rates

$$\boxed{i \approx r + \pi^e}$$

- Nominal and real interest rates differ because of monetary effects.
- The real interest rate is the rate of interest an investor expects to receive after allowing for the change in monetary value. It equals nominal rate minus expected future inflation rate.
- In other words, since inflation impairs the value of money, the nominal interest rate the bank offered should compensate for expected future inflation that prevails in the contracting period.
- Notice that Fisher's theory of interest is pure in the sense that no other risk is involved and expected inflation rate π^e is an ex-ante estimate.
- To recap, in a world without money and risk, the real rate of interest is determined by consumption impatience and investment opportunity.

Nominal and Real Interest Rates, 1953-2020

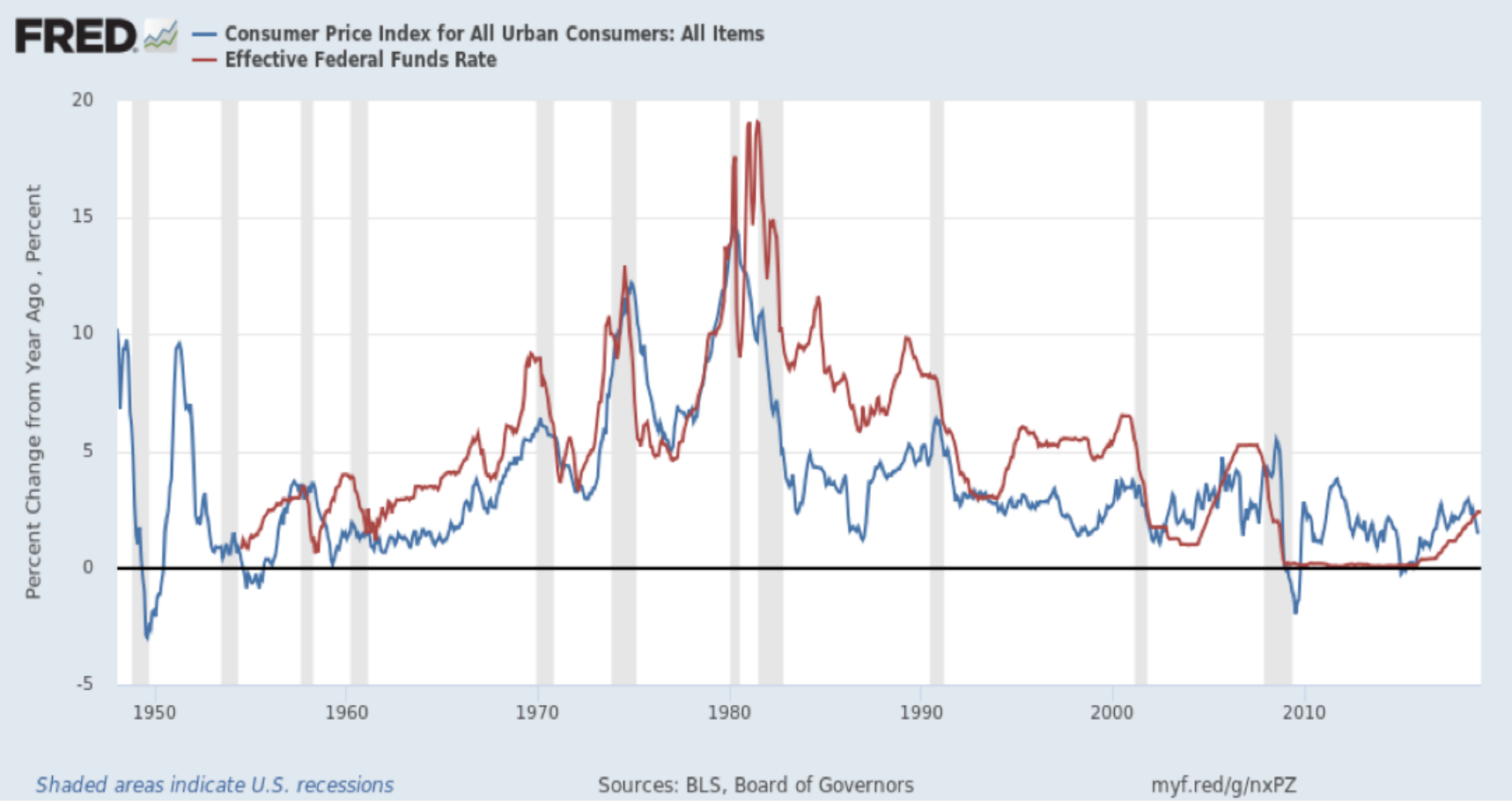


Note: The nominal interest rate is measured by the bond yield of the three-month Treasury bill.
Source: Mishkin (2022) CH4.

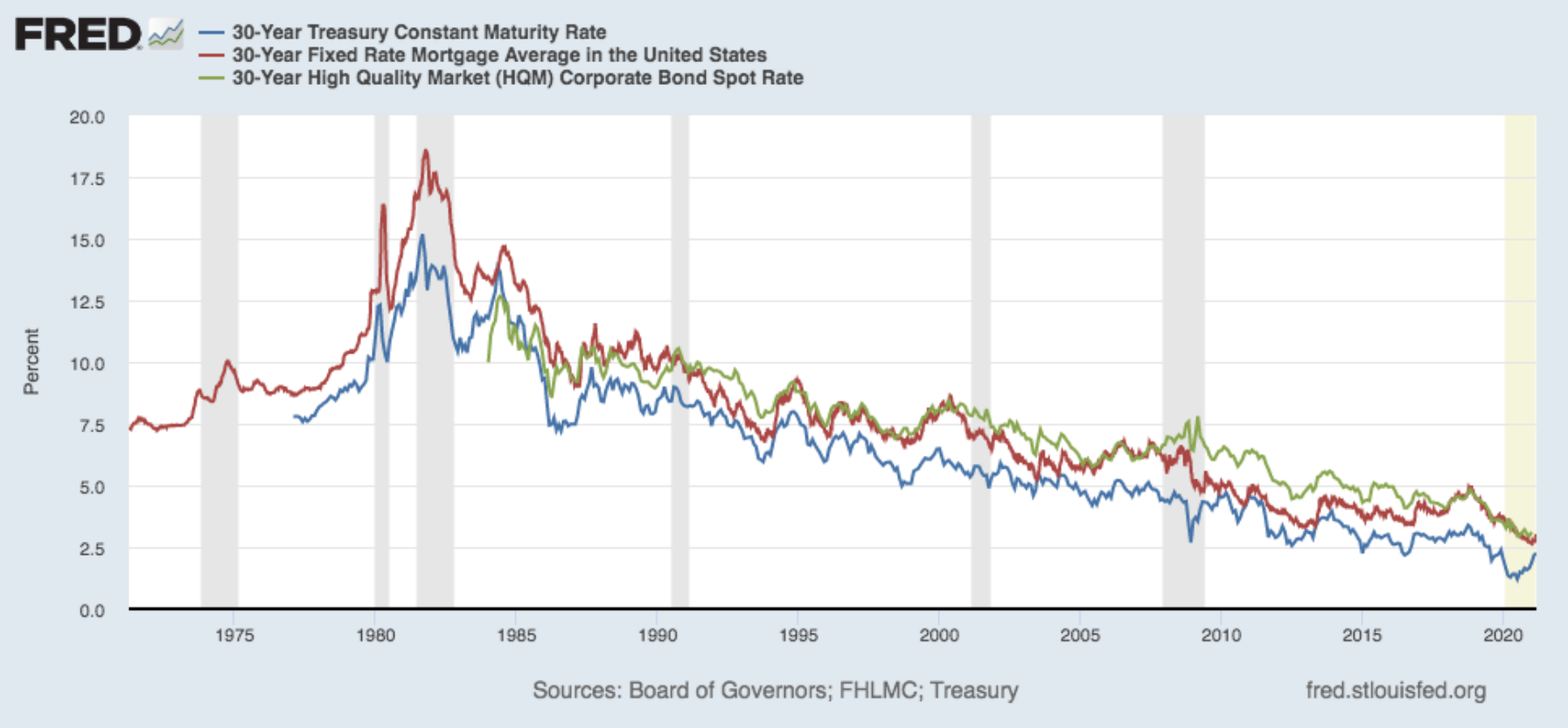
Fisher Equation: Derivation and Application

- But, why is Fisher equation an approximation?
- Assuming no transaction cost, deposit 1 dollar in a bank for one year shall earn enough interest to maintain market real return and offset the adverse impact of future inflation.
- No arbitrage equilibrium condition: $(1+i) = (1+r)(1+\pi^e)$.
- Fisher equation: $i = r + \pi^e + r\pi^e \approx r + \pi^e$ if $r \approx \pi^e \approx 0.00$.
- Application: Impute the inflation rate
  - N_t: Nominal GDP in year t, so is N_{t-1} defined
  - R_t: Real GDP in year t, so is R_{t-1} defined
  - $D_t = N_t/R_t$: GDP deflator in year t
  - Real GDP growth equation: $R_t = R_{t-1}(1+g)$
  - Nominal GDP growth rate: $N_t = N_{t-1}(1+g)(1+\pi)$
  - Solve for $\pi_t = \frac{N_t/R_t}{N_{t-1}/R_{t-1}} - 1 = \frac{D_t}{D_{t-1}} - 1 = \frac{D_t - D_{t-1}}{D_{t-1}}$

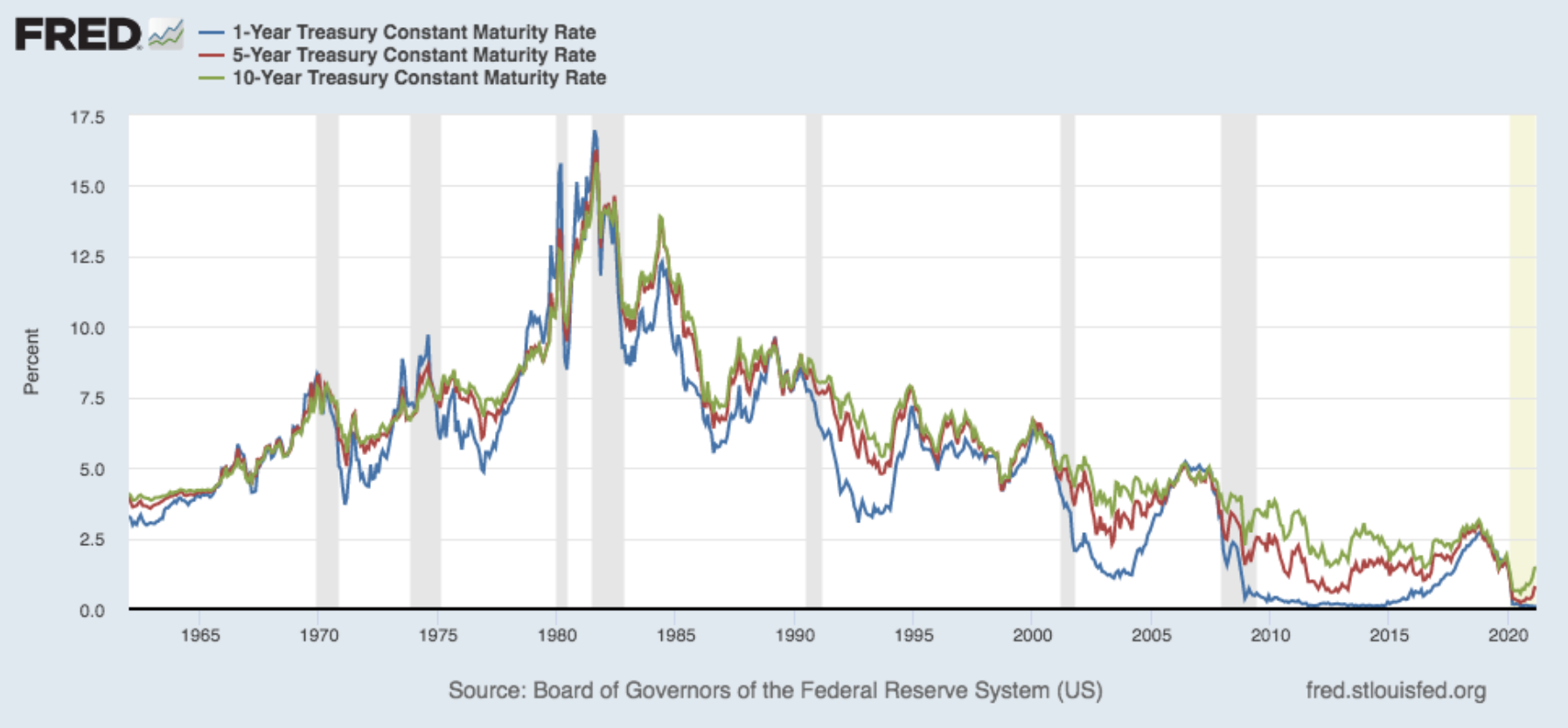
U.S. Interest Rate and Inflation Rate



U.S. Interest Rate Risk Structure



U.S. Interest Rate Term Structure



Fisher Equation: Extensions on Risk Premia

The nominal rate of interest is the real rate of interest plus a risk premium(s) that the market or the consensus of investors requires on the financial asset.

$$\boxed{NR = RR + IP + DP + MP + LP + CP + ... + PP}$$

- NR is the nominal interest rate
- RR the real rate of interest
- IP the inflation premium
- DP the default premium
- MP the maturity premium
- LP the liquidity premium
- CP the currency premium
- PP the political risk premium

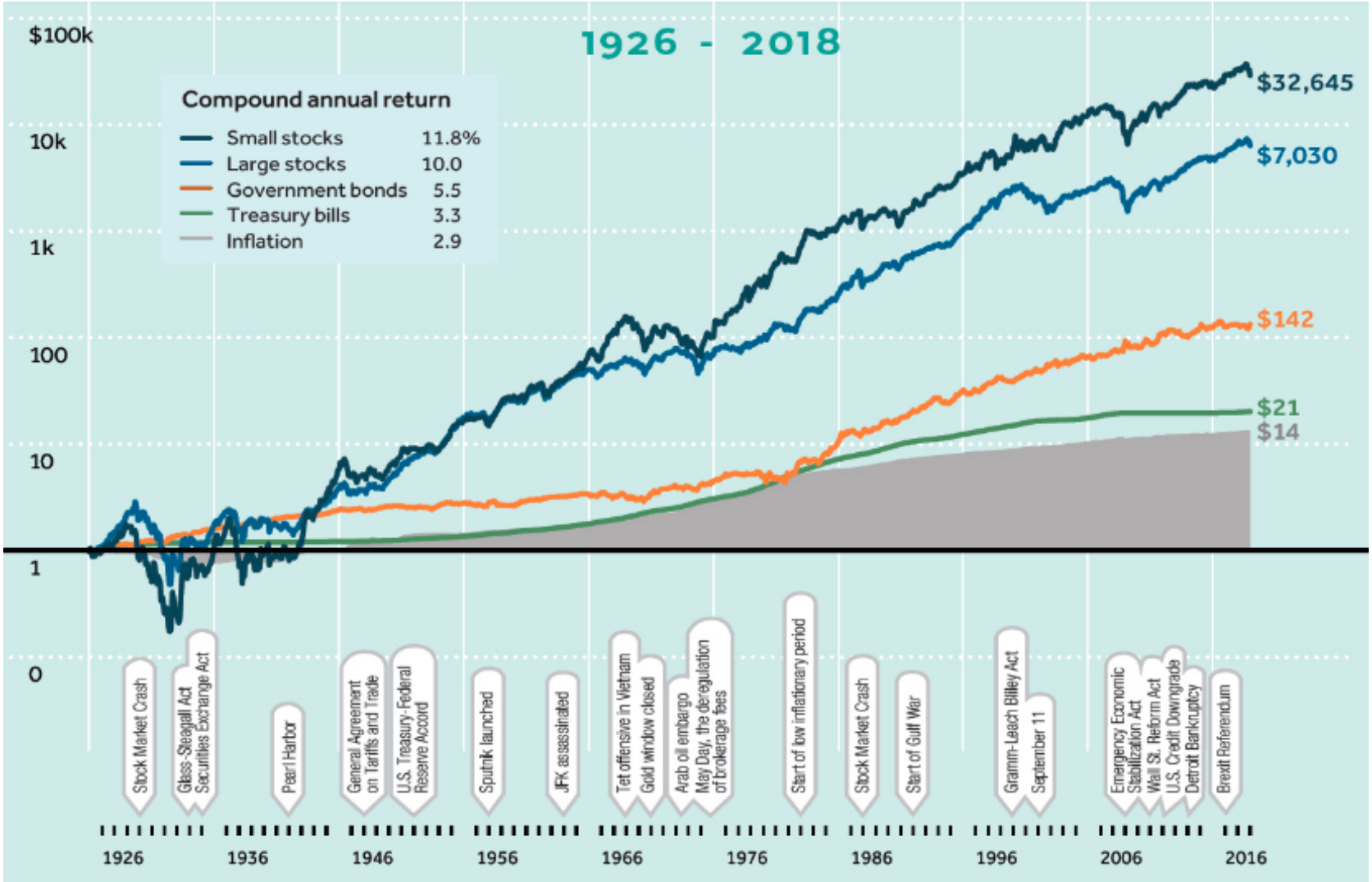
Financial Markets and Assets: Classification

Financial market is an institution where financial assets are exchanged.

1. By Nature
   - Debt market
   - Equity market
2. By Maturity
   - Money market
   - Capital market
3. By Seasoning
   - Primary market
   - Secondary market

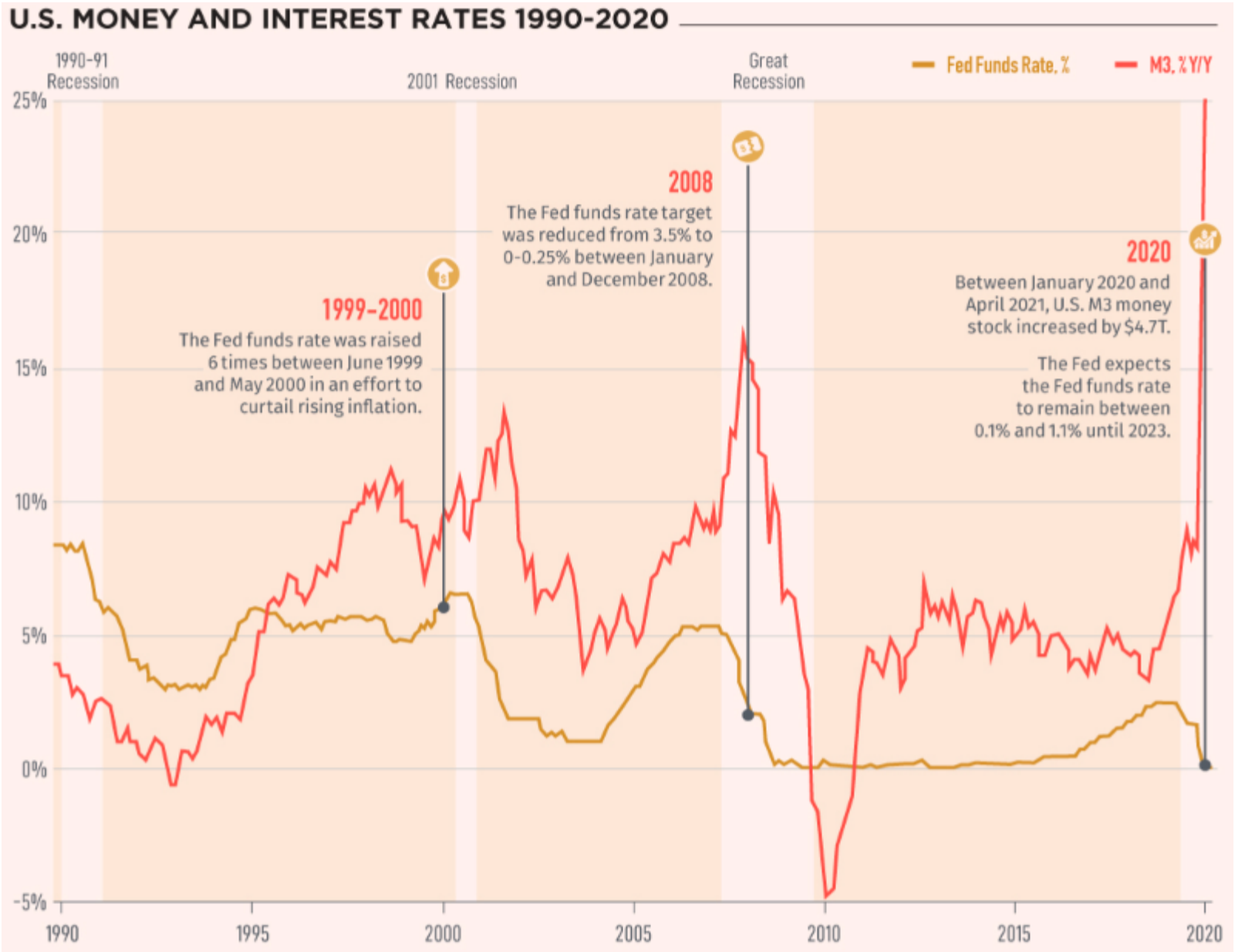
1. By Delivery
   - Cash (spot) market
   - Derivatives market
2. By Organization
   - Auction market
   - Over-the-counter market
3. By Trading System
   - Order-driven market
   - Ouote-driven market

U.S. Long-Term Asset Returns (w)



https://graycelladvisors.com/smallcap/

Outline



https://elements.visualcapitalist.com/30-years-of-u-s-money-supply-and-interest-rates/

Monetary World v.s. Real World

- Money is a standardized medium of exchange and a metric of exchange value. Interest is most commonly expressed in monetary units.
- Fisher's theory of interest applies more generally even to a world without money. In a world where there is no money, interest still exists because of time preference and investment opportunity.
- Interest rate, in real terms, measures the percentage rate an individual would like to pay to obtain immediate income at the cost of future income. Or, the willingness to invest considering opportunities available.
- Introducing money into our society, all goods and services (or real income) are measured in terms of currency unit.
- Therefore, as a standardized metric of exchange value, the money itself becomes vital for the inter-termporal exchange of income or trade.

Nominal v.s. Real Variables

In economics, nominal value is expressed in monetary terms (in units of a currency). By contrast, real value adjusts nominal value to remove the effects of price level change in the economy. More fundamentally, a real variable is measured in terms of the quantity of goods and services. The five most pivotal real variables in macroeconomics and finance are:

1. Real income (NI/P): goods and services produced in a period.
2. Real wage (W/P): the amount of goods and services that the monetary or nominal wage can afford.
3. Real money balance (M/P): the purchasing power of money in terms of the amount of goods and services.
4. Real exchange rate ($RE = E * P_F / P_H$): the amount of domestic goods and services that a foreign currency can purchase.
5. Real interest rate ($r = i - \pi$): the rate of return for goods and services, which equals nominal interest rate minus inflation rate.

Classical Views of Money

- According to the classical theory, all markets fro goods continuously clear and relative prices flexibly adjust to ensure the equilibrium is attained. The economy is always in full resource allocation and employment except for the transitory deviations as a result of real disturbances.
- In such an economy, the role of money is simple: it serves as the numeraire, that is a commodity whose unit is used in order to express prices and values, but whose own value remains unaffected by this role. It also facilitates the exchange of goods as Jevons (1875) pointed out that the use of money satisfied double coincidence of wants.
- However, it does not influence the determination of relative prices, real interest rates, the equilibrium quantities of commodities, and thus aggregate real income.
- Money is "neutral" with no consequences for real economic magnitudes. Its role as a store of value is perceived as limited under the classical assumption of perfect information and negligible transaction costs.

Source: Sriram (1999).

Quantity Theory of Money: MV=PY

The quantity theory brings forth a direct and proportional relationship between the quantity of money and the price level. This relationship was developed in the classical equilibrium framework by two alternative but equivalent expressions. Money demand theories have evolved over time.
In general, it is demand for real money balances (Sriram, 1999).

1. M – money in circulation
2. V – transaction velocity
3. P – aggregate price level
4. Y – real output or income

Transaction equation is derived from the role of money as a means or medium of exchange. Irving Fisher (1911) concentrated on institutional details of the payment mechanism behind money demand in his analysis, Cambridge economists focused on motives for holding money by individuals.

Quantity Theory of Money: Earlier Formulations

Fisher's "equation of exchange" (1911): $M_S V_T = P_T T$

- The quantity of money in circulation M_S is related to the volume of transactions T and the price level of articles trade P_T in a given period through a proportionality factor V_T called "transaction velocity."
- This equation is not an identity rather an equilibrium condition. Money is held simply to facilitate transactions and has no intrinsic utility.

Pigou (1971) and Marshall (1923): the cash balance approach $M_D = kPY$

- The quantity of money is related to nominal income and money demand determines the effect of money supply on the price level.
- Cambridge economists pointed out the role of wealth and the interest rate in determining the demand for money.
- The emphasis the Cambridge formulation places on the demand for money influences both the Keynesian and the Monetarist theories.

Source: Sriram (1999).

Keynesian Theory of Money Demand

When classical and neoclassical analyzed the money demand primarily in terms of money in exchange, Keynes focused on the motives that lead people to hold money. His significant contribution to the money demand theory hinges on the role the speculative motive plays.

1. Transactions motive. Keynes accepted the quantity theory view that, money as a medium of exchange, the transactions component is proportional to the level of income.
2. Precautionary motive. Keynes recognized that people hold money as a cushion against unexpected wants. He argued that the precautionary money balances people want to hold would be proportional to income.
3. Speculative motive. Keynes believed people choose to hold money as a store of wealth, which he called the speculative motive. The speculative demand for money is the liquidity preference Keynes referred to.

Recall that the opportunity cost of holding money is the interest forgone.

Source: Mishkin (2022) The Economics of Money, Banking, and Financial Markets, 13e, Pearson.

Keynesian Theory of Liquidity Preference

- The store-of-value function is emphasized in the speculative motive of the demand for money. Individuals can hold their wealth either in money or in bonds. The price they are willing to pay for bonds depends on the interest rate (bond yields) as the prospective buyers would wish to earn.
- The rate of interest was formally introduced in the money demand function where the demand for real money balances is a function of real income and interest rate. $M_D = L(P, Y, i)$ or $M_D/P = L(Y, i)$
- The major implication of the Keynesian analysis is that when the interest rate is very low, everyone will expect it to rise in the future, and hence, prefers to hold money whatever is supplied.
- At this stage, the aggregate demand for money become perfectly elastic with respect to the interest rate. The economy falls into a situation called "liquidity trap" in which the interest elasticity of money demand can be infinitely at low levels of interest rate.

Source: Sriram (1999).

Money Supply in the U.S.

- The U.S. money supply comprises currency—dollar bills and coins issued by the Federal Reserve System and the U.S. Treasury—and various kinds of deposits held by the public at commercial banks and other depository institutions such as thrifts and credit unions.
- Because money is used in virtually all economic transactions, it has a powerful effect on economic activity. An increase in the supply of money works both through lowering interest rates, which spurs investment, and through putting more money in the hands of consumers, making them feel wealthier, and thus stimulating spending.
- Federal Reserve policy is the most important determinant of the money supply. The Federal Reserve affects the money supply by affecting its most important component, bank deposits.
- In a simplified equilibrium model, money supply is assumed perfectly inelastic to the interest rate, fully determined by the monetary policy. Hence, it is exogenous (independent of the market interest rate).

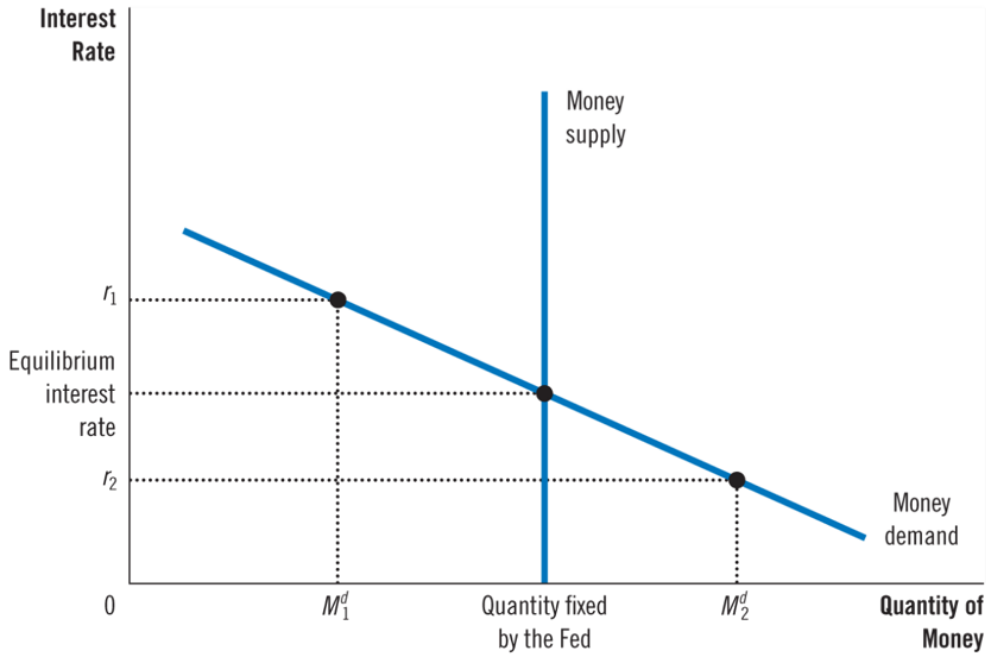
Source: Anna J. Schwartz, Money Supply. https://www.econlib.org/library/Enc/MoneySupply.html

Money Market Equilibrium $M_D = L(P, Y, i) = M_S$

FIGURE 1

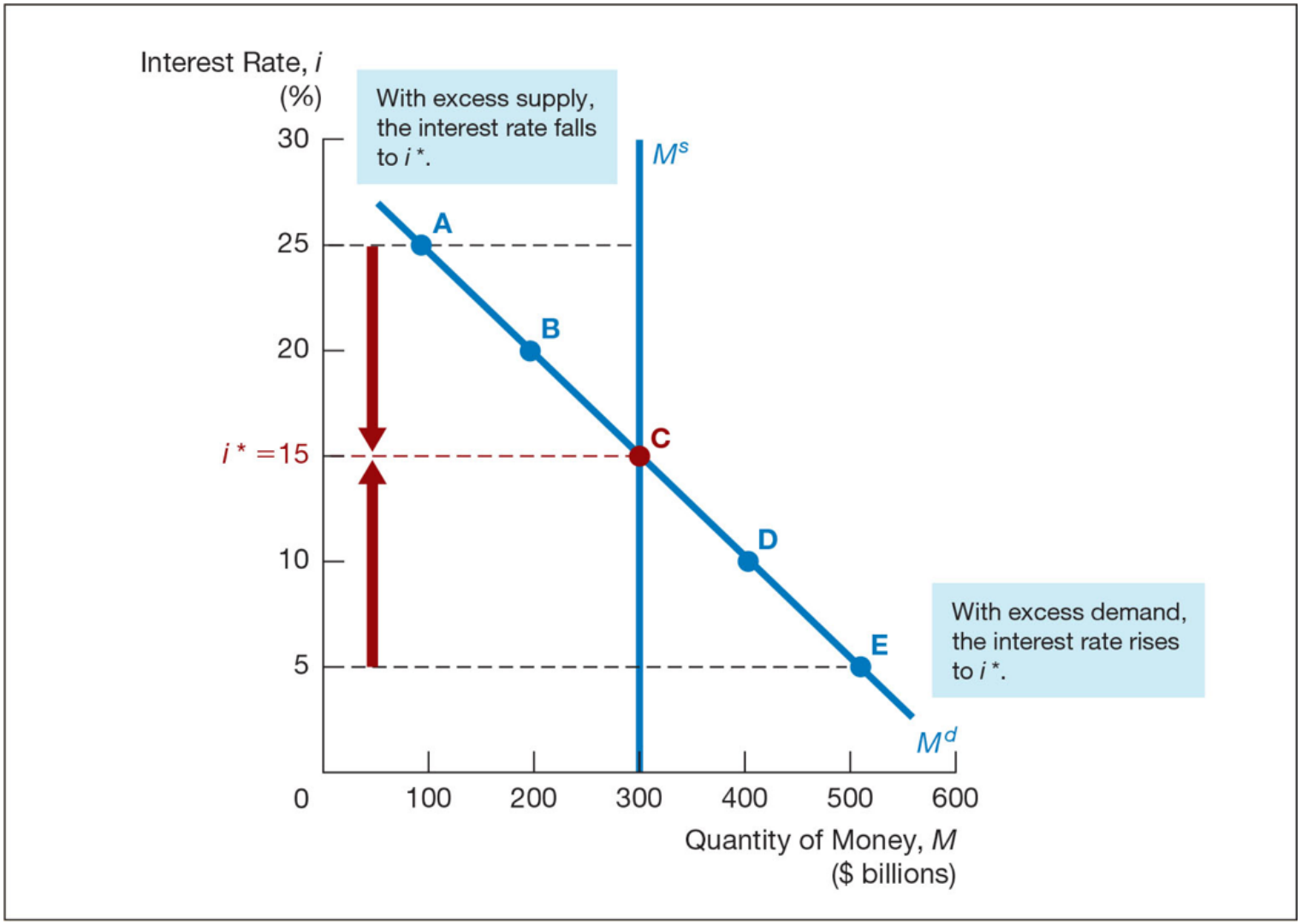
Equilibrium in the Money Market

According to the theory of liquidity preference, the interest rate adjusts to bring the quantity of money supplied and the quantity of money demanded into balance. If the interest rate is above the equilibrium level (such as at r_1), the quantity of money people want to hold (M_1^d) is less than the quantity the Fed has created, and this surplus of money puts downward pressure on the interest rate. Conversely, if the interest rate is below the equilibrium level (such as at r_2), the quantity of money people want to hold (M_2^d) exceeds the quantity the Fed has created, and this shortage of money puts upward pressure on the interest rate. Thus, the forces of supply and demand in the market for money push the interest rate toward the equilibrium interest rate, at which people are content holding the quantity of money the Fed has created.



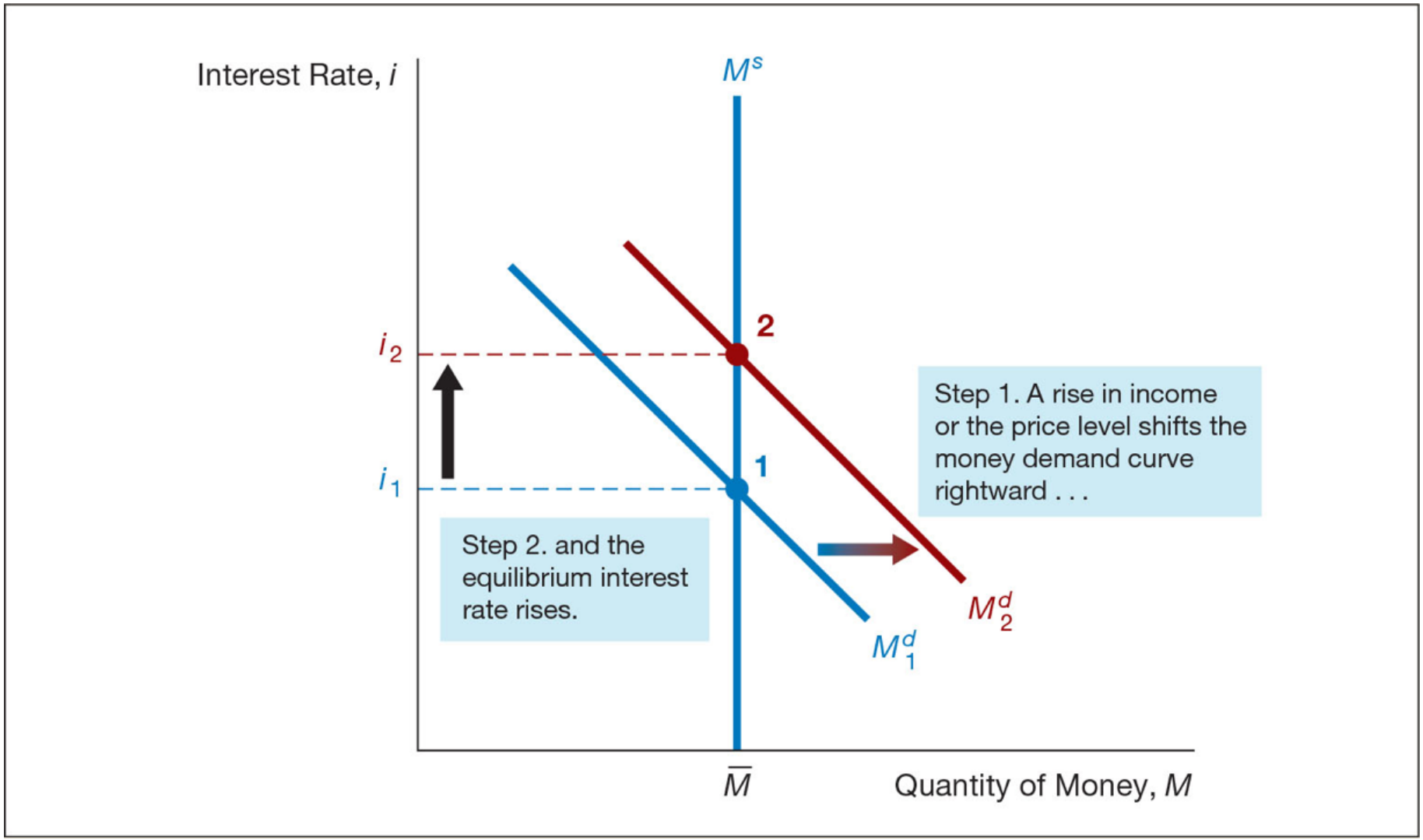
Source: Mankiw (2022).

Money Market Equilibrium Adjustment



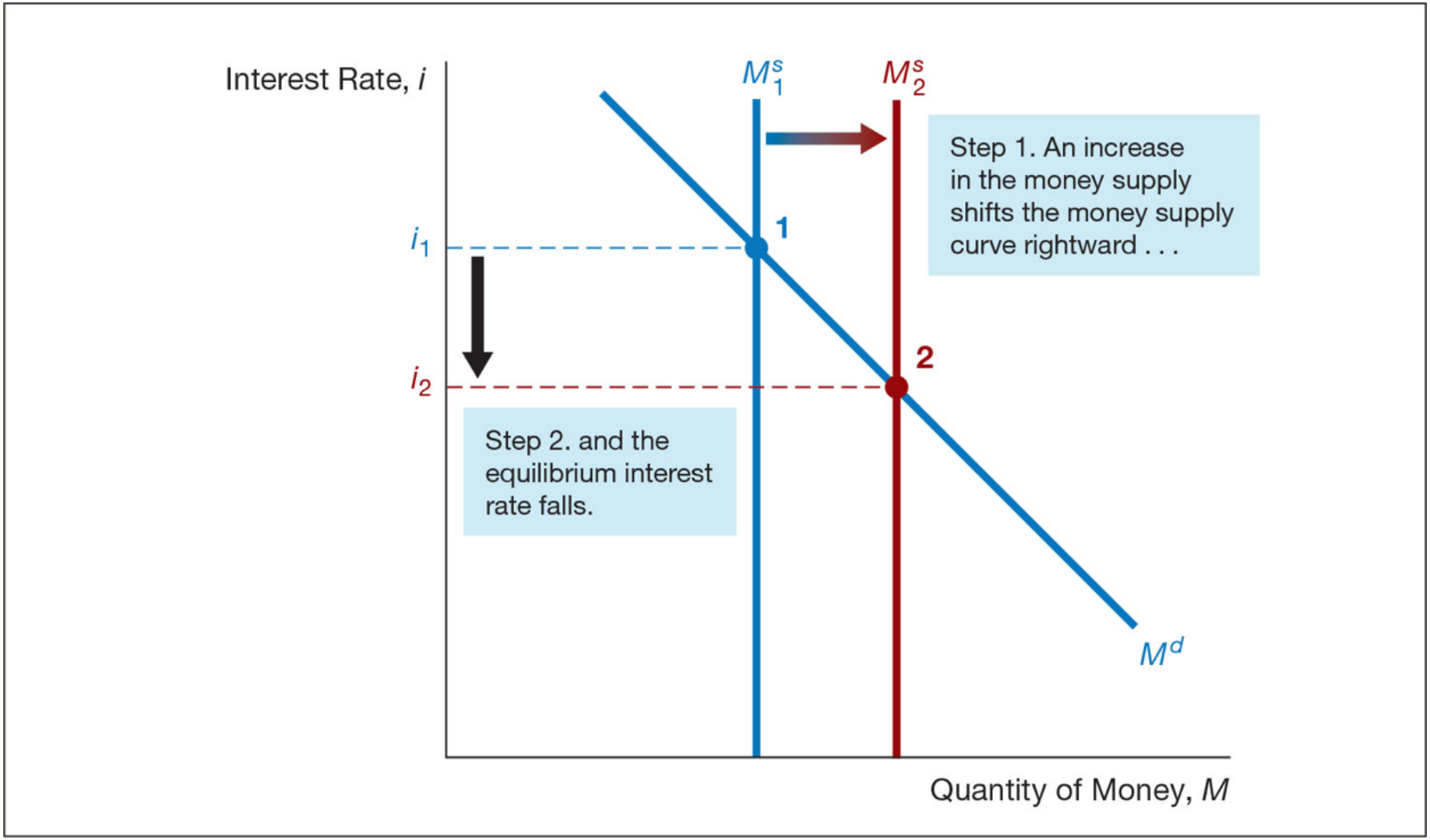
Source: Mishkin (2022) The Economics of Money, Banking, and Financial Markets, 13e, Pearson.

Increase in Money Demand



Source: Mishkin (2022) The Economics of Money, Banking, and Financial Markets, 13e, Pearson.

Increase in Money Supply



Source: Mishkin (2022) The Economics of Money, Banking, and Financial Markets, 13e, Pearson.

Interest Rate and Liquidity Trap

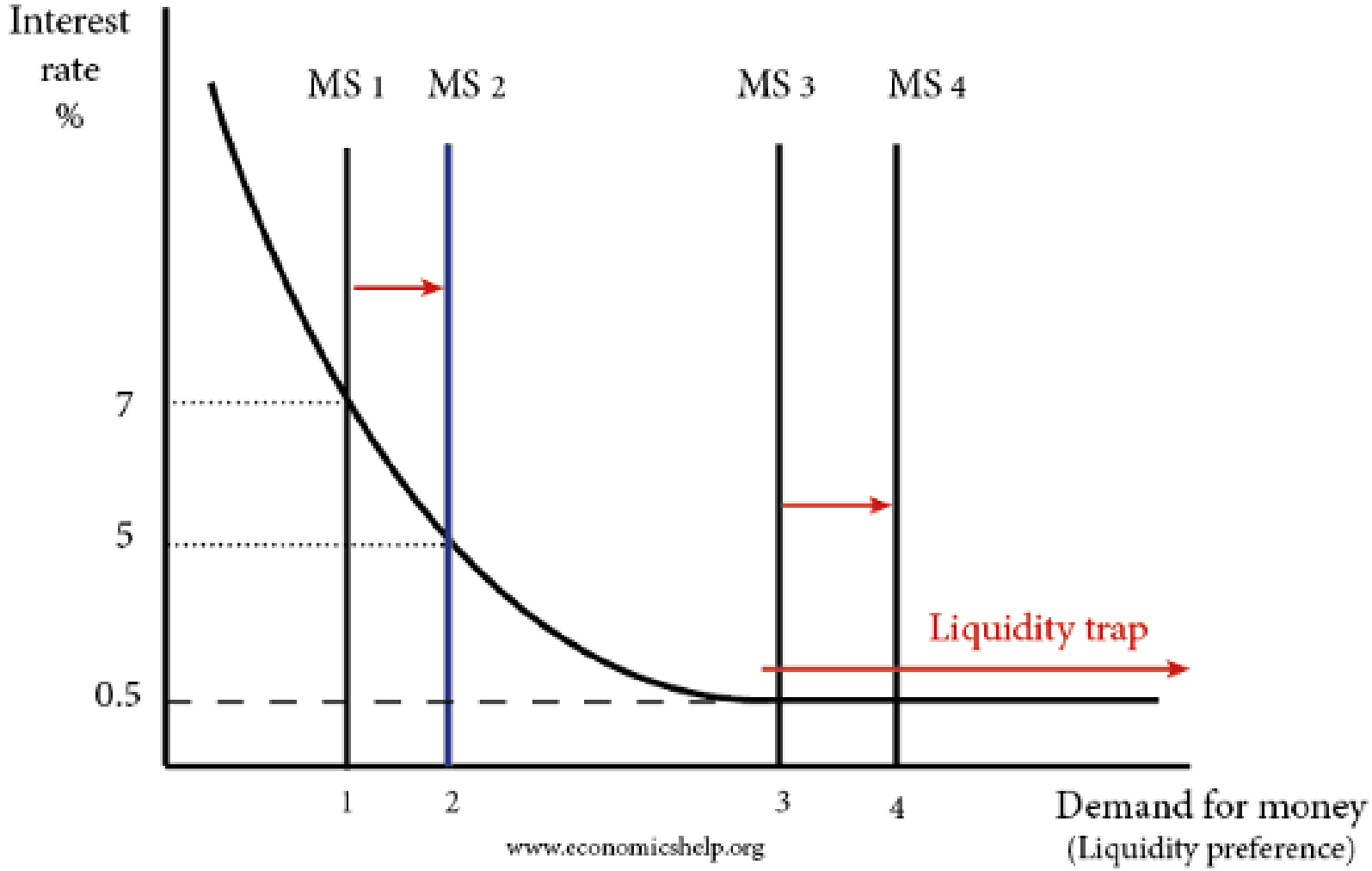
Liquidity traps occur when low interest rates and high cash balance fail to increase Aggregate Demand in an economy which is in a downturn. This can occur due to several factors:

1. Troubled banks were risk averse due to their lack of liquidity making them reluctant to grant loans and loans may come with a risk premium attributed to it. On the policy side, a bank may also be required to hold onto more capital which further reduces the number of loans granted.
2. Worsening household confidence implied little incentive to consume any goods in the economy. If all households were to save, then all of goods and services in the economy would become impoverished. Keynes advocates that households saved as little as possible and instead increased spending.
3. Firms and households may be pre-occupied trying to cutting existing debt instead of planning on creating any more debt.

Keynes warned against these ideas and suggested these were contributing factors to the Great Depression, since there were little reaction to the reductions in interest rates.

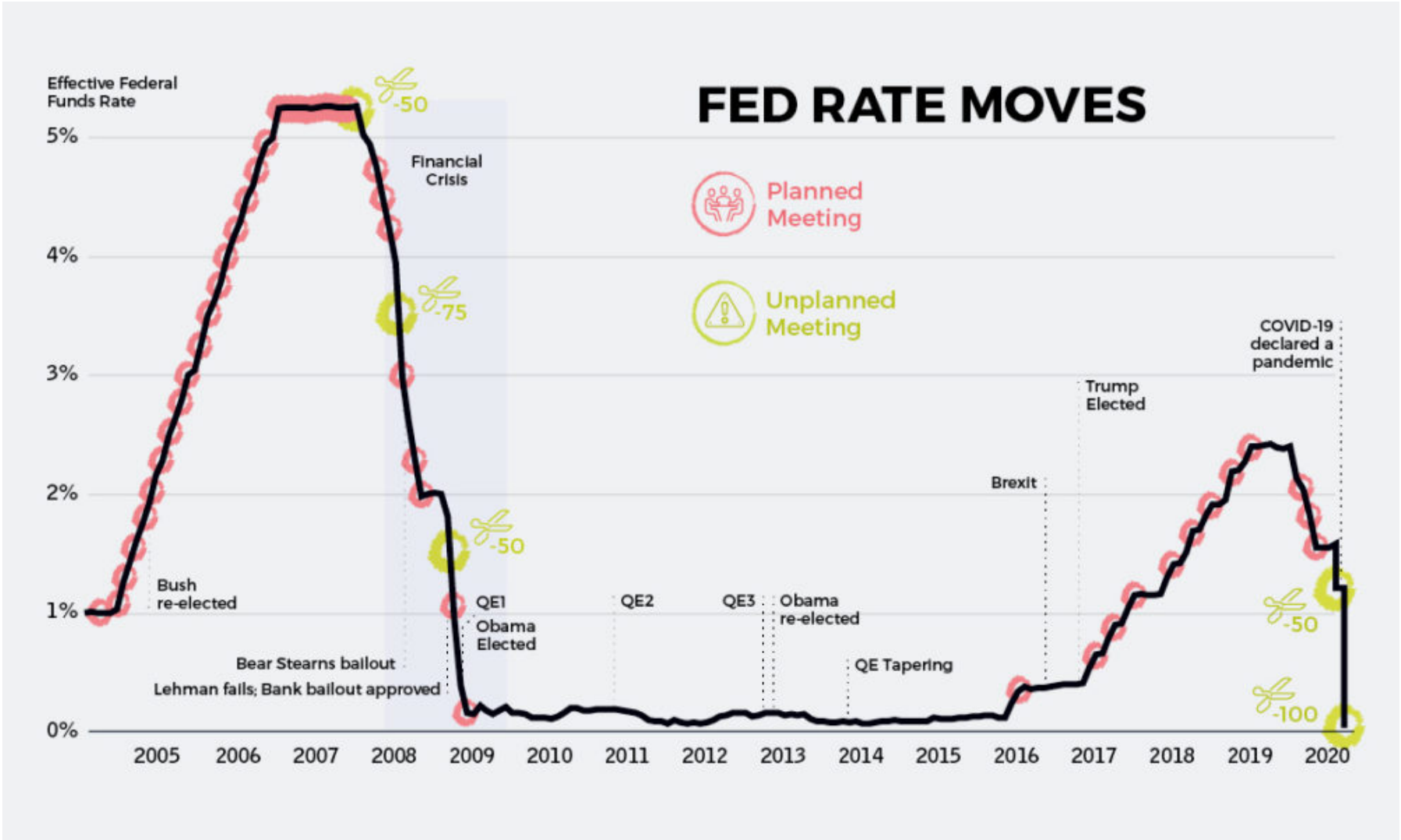
https://medium.com/geekculture/keynesian-economcics-8cdc614e33c

Interest Rate and Liquidity Trap



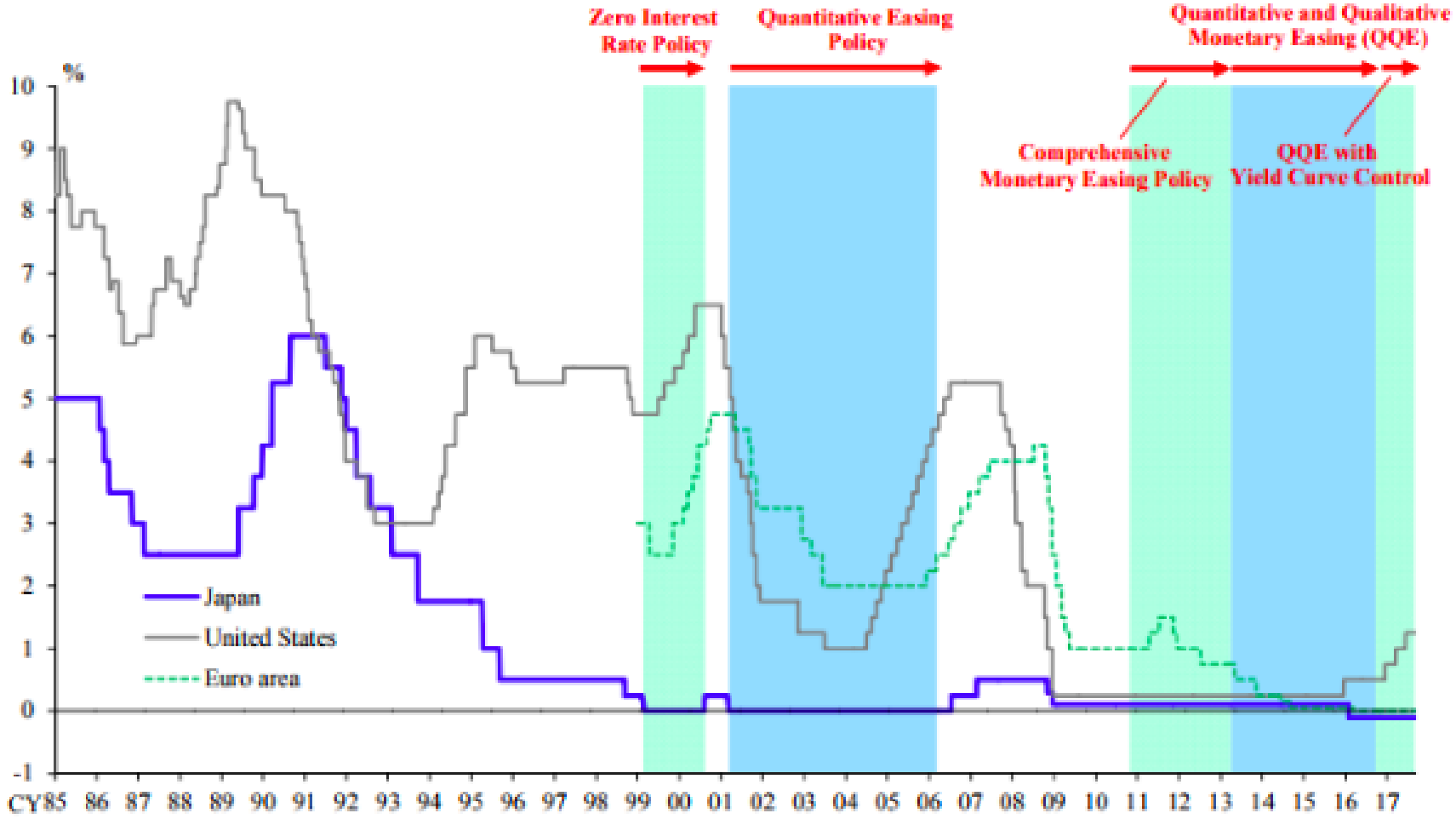
https://medium.com/geekculture/keynesian-economics-8cdc614e33c

Federal Funds Rate, 2005-2020



https://www.visualcapitalist.com/chart-the-downward-spiral-in-interest-rates/

Policy Interest Rates in JP, US, EU



Note: For Japan, for the period when no target interest rate was adopted, figures for the policy rate are the interest rate applied on excess reserves.
Sources: Bank of Japan; Federal Reserve; European Central Bank; Haver; Bloomberg.

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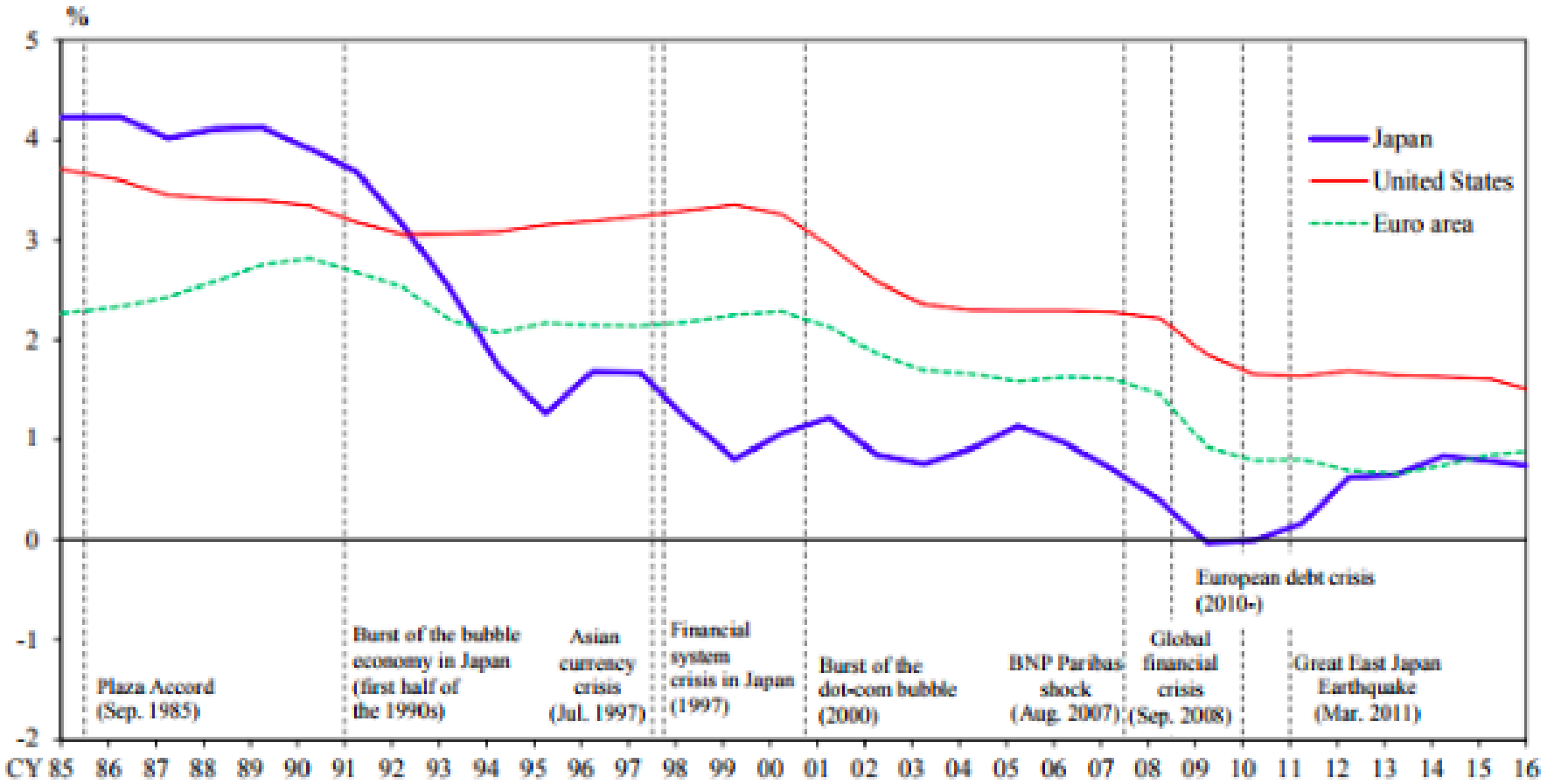
Source: Nakaso (2017) `https://www.bis.org/review/r171020d.htm`

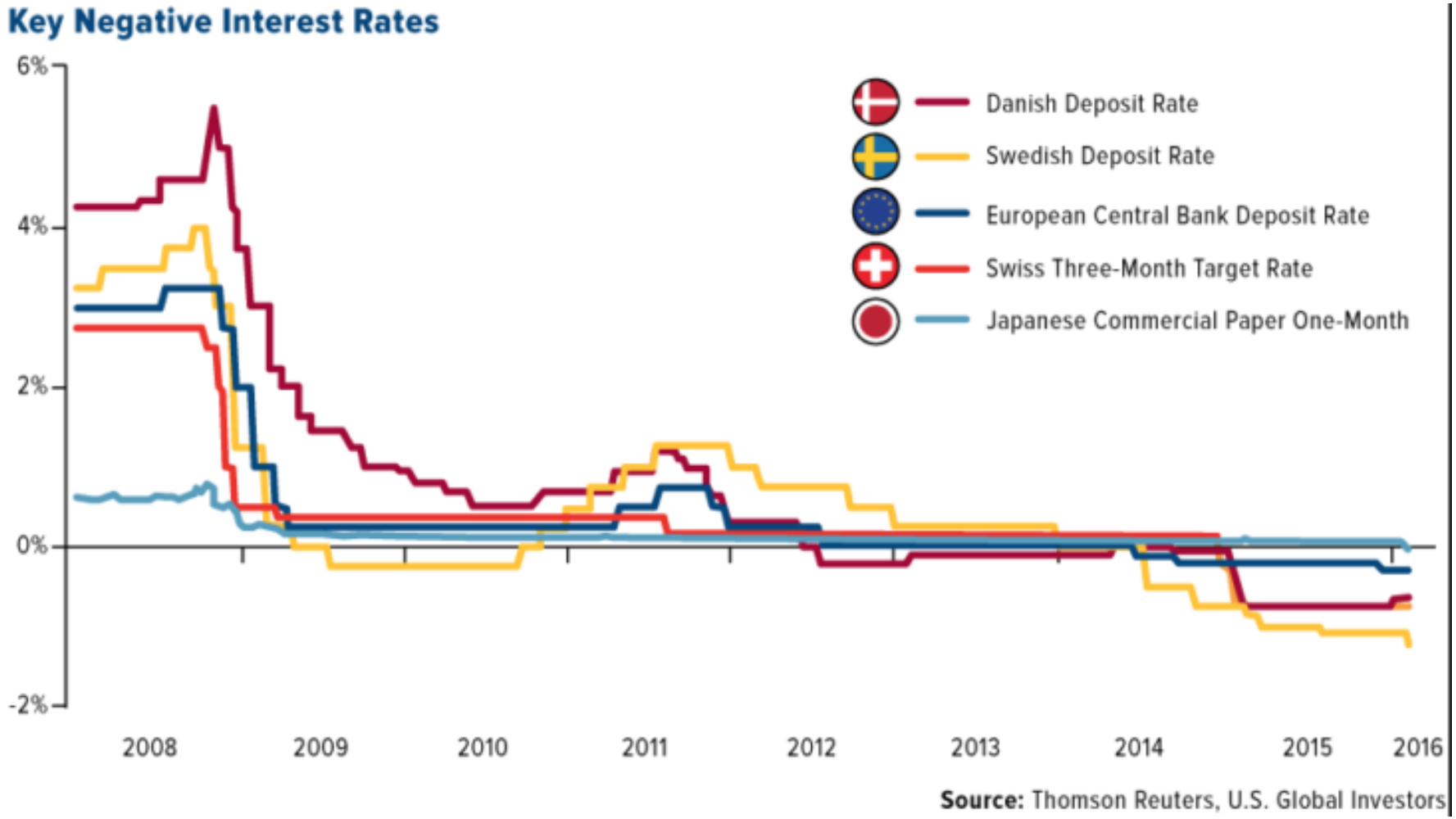
Potential Economic Growth in JP, US, EU



Note: The figure for Japan is based on BOJ staff estimations (fiscal year based). Figures for the United States and the euro area are based on the OECD estimations.
Sources: Bank of Japan; OECD.

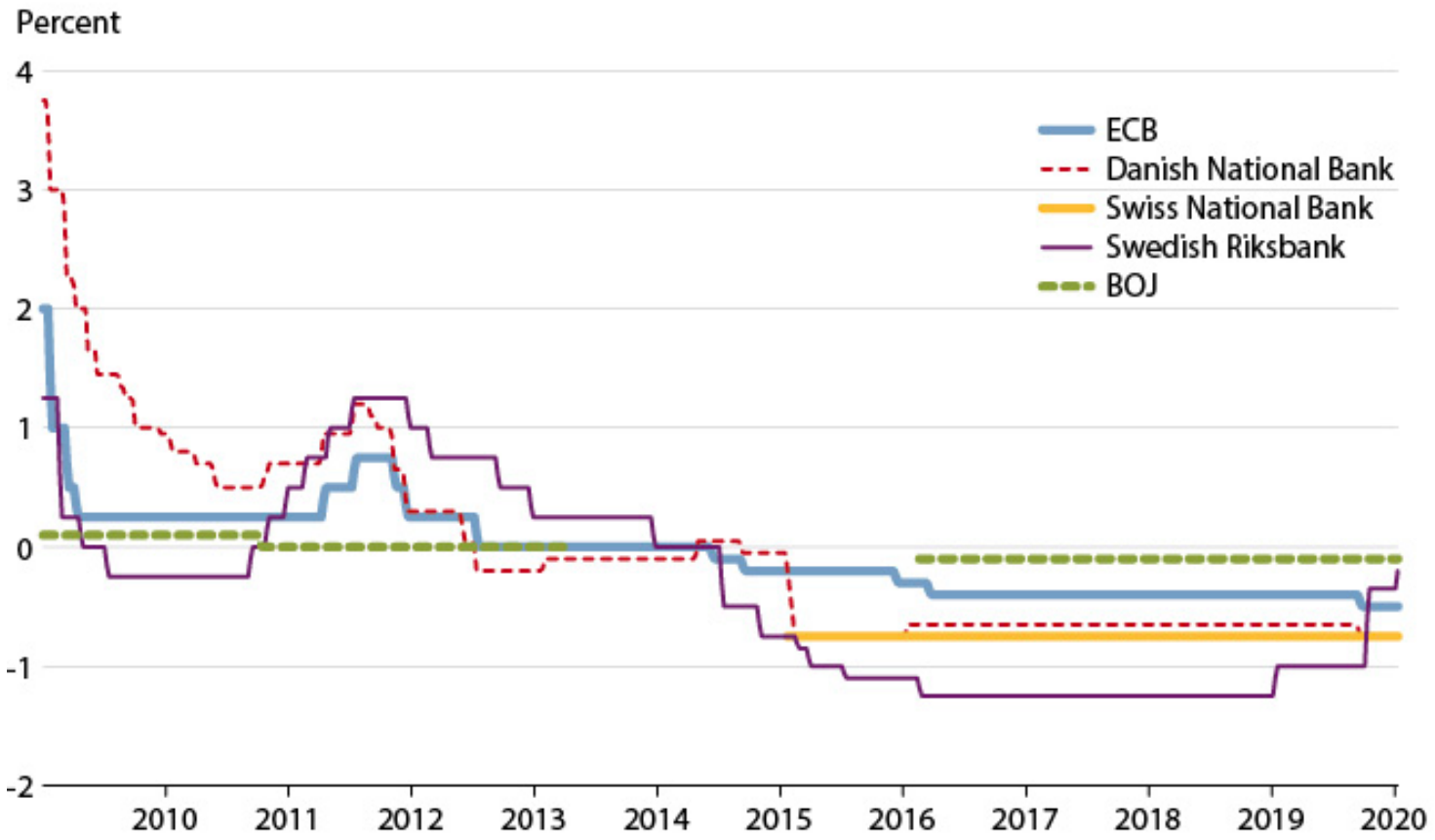
Source: Nakaso (2017) `https://www.bis.org/review/r171020d.htm`

Negative Interest Rates, 2008-2016



https://www.econlib.org/negative-interest-rates-and-negative-ioer/

Negative Interest Rates, 2009-2020



NOTE: The BOJ line plots the uncollateralized overnight call rate lower limit (January 2009-April 2013) and the deposit facility policy rate (February 2016-present). Between April 2013 and February 2016, the BOJ did not set a target deposit rate. The ECB line plots the deposit facility rate. The Danish National Bank line plots the rate of interest on certificates of deposit. The Swiss National Bank line plots the rate of interest on sight deposits. The Swedish Riksbank line plots the deposit rate.
SOURCE: The BOJ, ECB, Danish National Bank, Swiss National Bank, and Swedish Riksbank.

https://research.stlouisfed.org/publications/economic-synopses/2020/02/28/negative-u-s-interest-rates

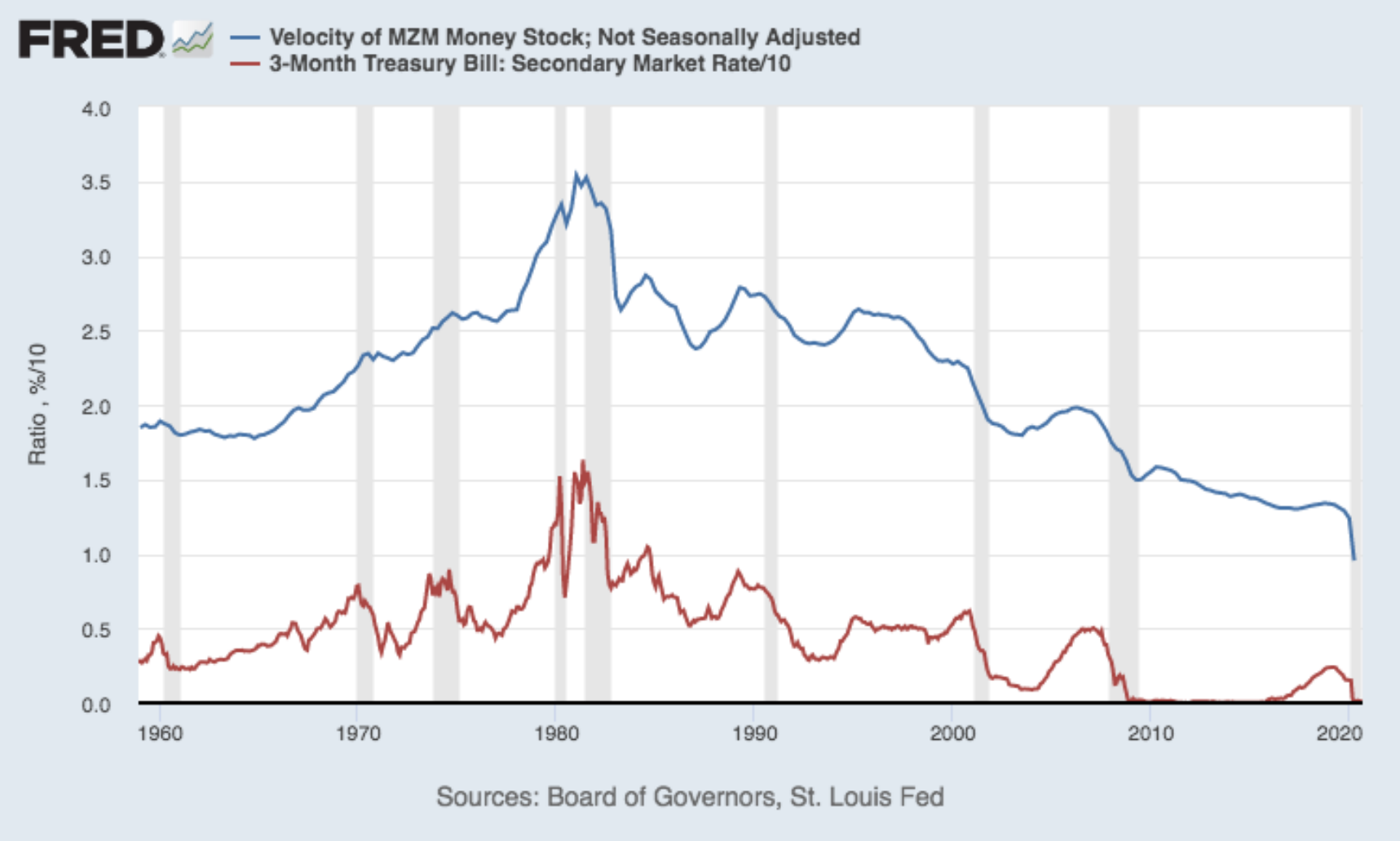
Money Velocity and Interest Rate

$$\boxed{M_D = L(P, Y, i) \quad \& \quad V = PY/M = Y/L(Y, i)}$$

- According to Keynes, the demand for real money balance is negatively related to the nominal interest rate and positively to real income.
- Later, Keynesian economists expanded the analysis and showed that interest rates play a more important role in money demand than even Keynes supposed. They demonstrated that even the transactions and precautionary demands would be negatively related to the interest rate.
- When interest rate $i$goes up, real money balance $M_D/P = L(i, Y)$ declines, and therefore velocity rises. Because interest rates undergo substantial fluctuations, Keynesian theories of money demand indicate that velocity undergoes substantial fluctuations as well.
- Thus, Keynesian theories cast doubt on the classical view that nominal income is determined primarily by movements in the quantity of money.

Mishkin (2022) The Economics of Money, Banking, and Financial Markets, 13e, Pearson.

Money Velocity and Interest Rate (w)



Textbook References

N. G. Mankiw (2021) Principles of Economics, 9e, Cengage

Olivier Blanchard (2021) Macroeconomics, 8e, Pearson

Acemoglu, Laibso, and List (2022) Macroeconomics, 3e, Pearson

Bade and Parkin (2021) Foundations of Macroeconomics, 9e, Pearson

Abel, Bernanke, and Croushore (2020) Macroeconomics, 10e, Pearson

Roger Leroy Miller (2021) Economics Today Macro View, 20e, Pearson

Goolsbee, Levitt, and Syverson (2020) Microeconomics, 3e, Worth

Kennedy and Pray (2017) Macroeconomic Essentials, 4e, MIT

Fredrick Mishkin (2022) The Economics of Money, Banking, and Financial Markets, 13e, Pearson.

Web References

Fisher Irving (1930) The Theory of Interest: As Determined by Impatience to Spend Income and Opportunity to Invest It. (w)

Anna J. Schwartz, Money Supply. Economics and Liberty.
`https://www.econlib.org/library/Enc/MoneySupply.html`

Subramanian Sriram (1999) Survey of literature on demand for money: theoretical and empirical work with special reference to error-correction models. IMF working paper. (w)

Hiroshi Nakaso: Evolving monetary policy - the Bank of Japan's experience. Central Bankers' Speeches.
`https://www.bis.org/review/r171020d.htm`