

EC210 MACROECONOMIC PRINCIPLES

2: Low and high inflation

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Lent term 2020

Long rates



"I've called you in here to keep you in the loop, as we've made some very long-term investments."

LONGER INTEREST RATES

- Focus on government zero-coupon 2-year bonds
 - pay $q^{(2)}$ today, get $\mathbf{\$1}$ in 2 years.
- Exclude (other classes may teach you):
 - corporate bonds: default risk.
 - equity: payoff risk.
 - coupons: bond pays every year.
 - indexed bonds: payment depends on some variable like inflation.

COMPARING BONDS

- Return on (short) one-year bond

$$I/q_t^{(1)}$$

- Return on (long) two-year bond

$$I/q_t^{(2)}$$

- Return on long sequence of short bonds

$$(I/q_t^{(1)}) (I/q_{t+1}^{(1)})$$

- **Assumption:** investors are risk neutral, care only about expected return. Equate expected return

$$I/q_t^{(2)} = (I/q_t^{(1)}) (I/q_{t+1}^{(1)e})$$

YIELDS

- Yield to maturity (or interest rate): constant annual rate that equals return on the bond

$$I + i_t = I/q_t^{(I)}$$

$$(I + i_t^{(2)})^2 = I/q_t^{(2)}$$

- From expectations hypothesis:

$$(I + i_t^{(2)})^2 = (I + i_t^{(I)}) (I + i_{t+I}^{(I)e})$$

- Simple approximation

$$2 i_t^{(2)} \approx i_t^{(I)} + i_{t+I}^{(I)e}$$

TERM SPREAD

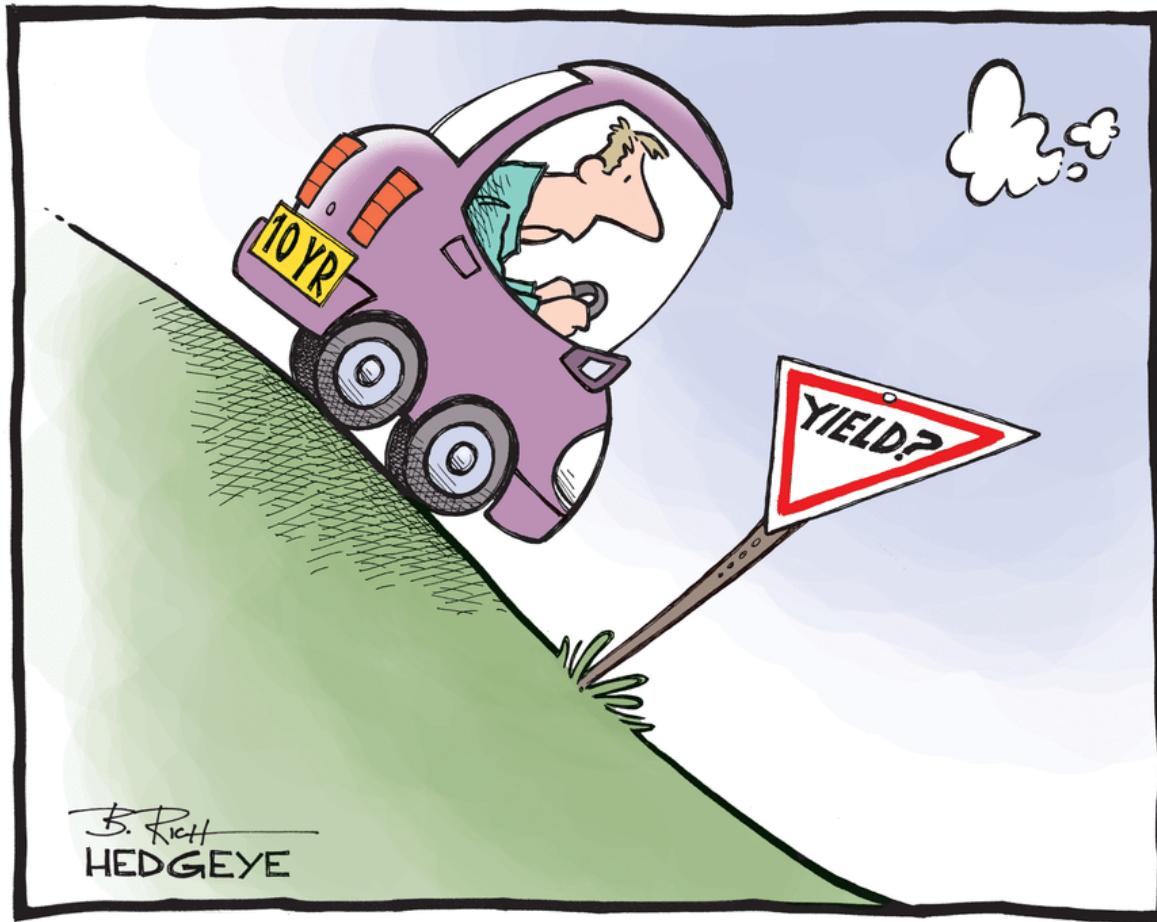
$$2i_t^{(2)} = i_t^{(1)} + i_{t+1}^{(1)}e$$
$$\Rightarrow 2(i_t^{(2)} - i_t^{(1)}) = i_{t+1}^{(1)}e - i_t^{(1)}$$

- Difference between long and short rates tells you market's expected path for short rate
- Positive (negative) spread:
 - long-term rates are higher (lower) than short-term rates (left-hand side)
 - markets expect short-term rates to rise (fall) in the future (right-hand side)

U.S. TERM SPREAD



Yield curve



LONGER INTEREST RATES

- N-year bonds, pay $q^{(n)}$ today, get £I in N years.
- Expected return on N one-year bonds and one N-year bond must then be the same.

$$I/q_t^{(n)} = (I/q_t^{(1)}) (I/q_{t+1}^{(1)e}) \dots (I/q_{t+n-1}^{(1)e})$$

- In terms of yields

$$(1+i_t^{(N)})^N = (1+i_t^{(1)}) (1+i_{t+1}^{(1)e}) \dots (1+i_{t+N-1}^{(1)e})$$

$$i_t^{(N)} \approx (i_t^{(1)} + i_{t+1}^{(1)e} + \dots + i_{t+N-1}^{(1)e}) / N$$

YIELD CURVE

- Sometimes called the term structure

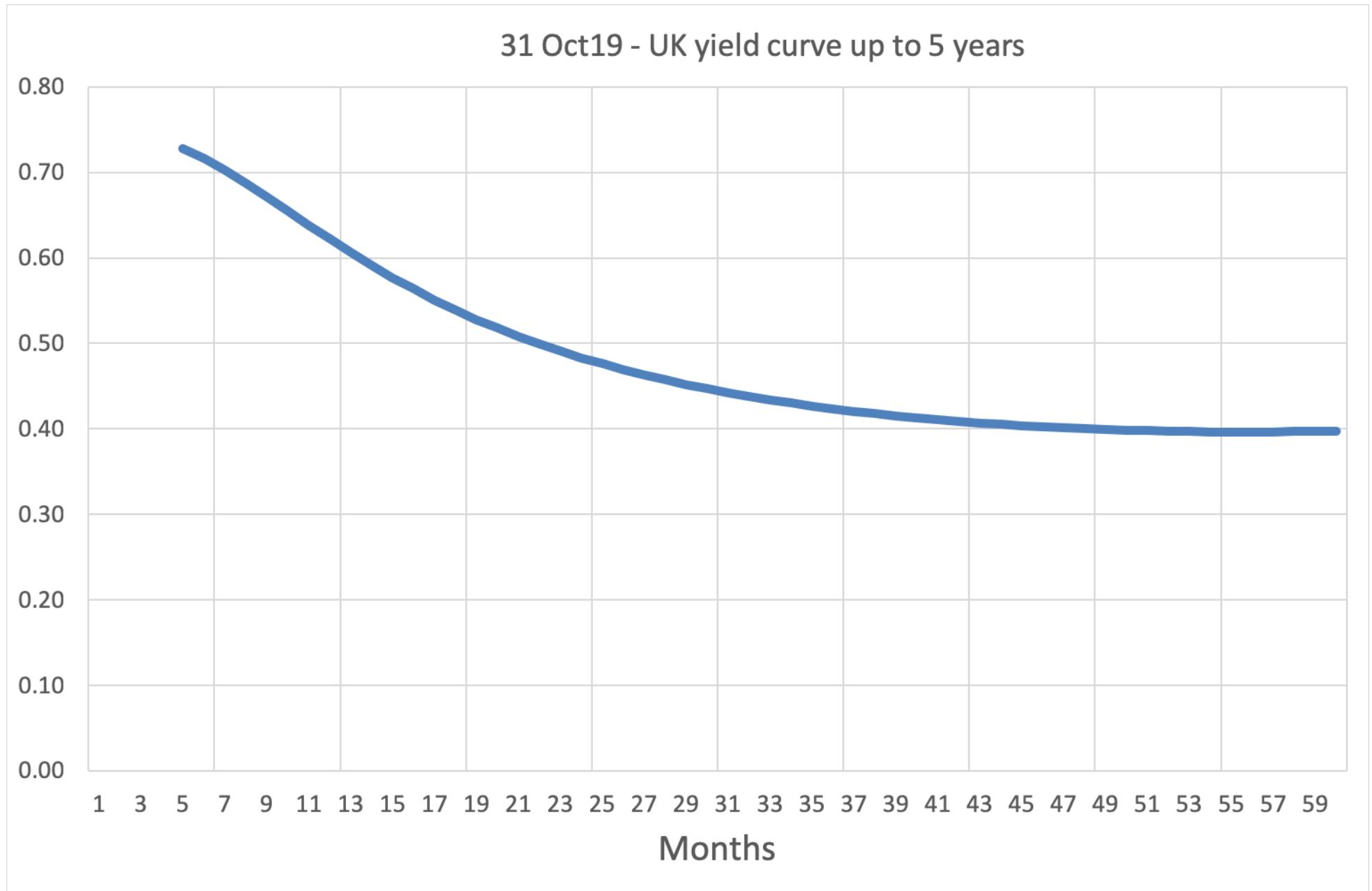
$$\{i_t^{(1)}, i_t^{(2)}, \dots, i_t^{(N)}\}$$

- Again CB only sets short-term rates, but because it can control **whole** path of these (aka forward curve) it can influence the **entire yield curve**

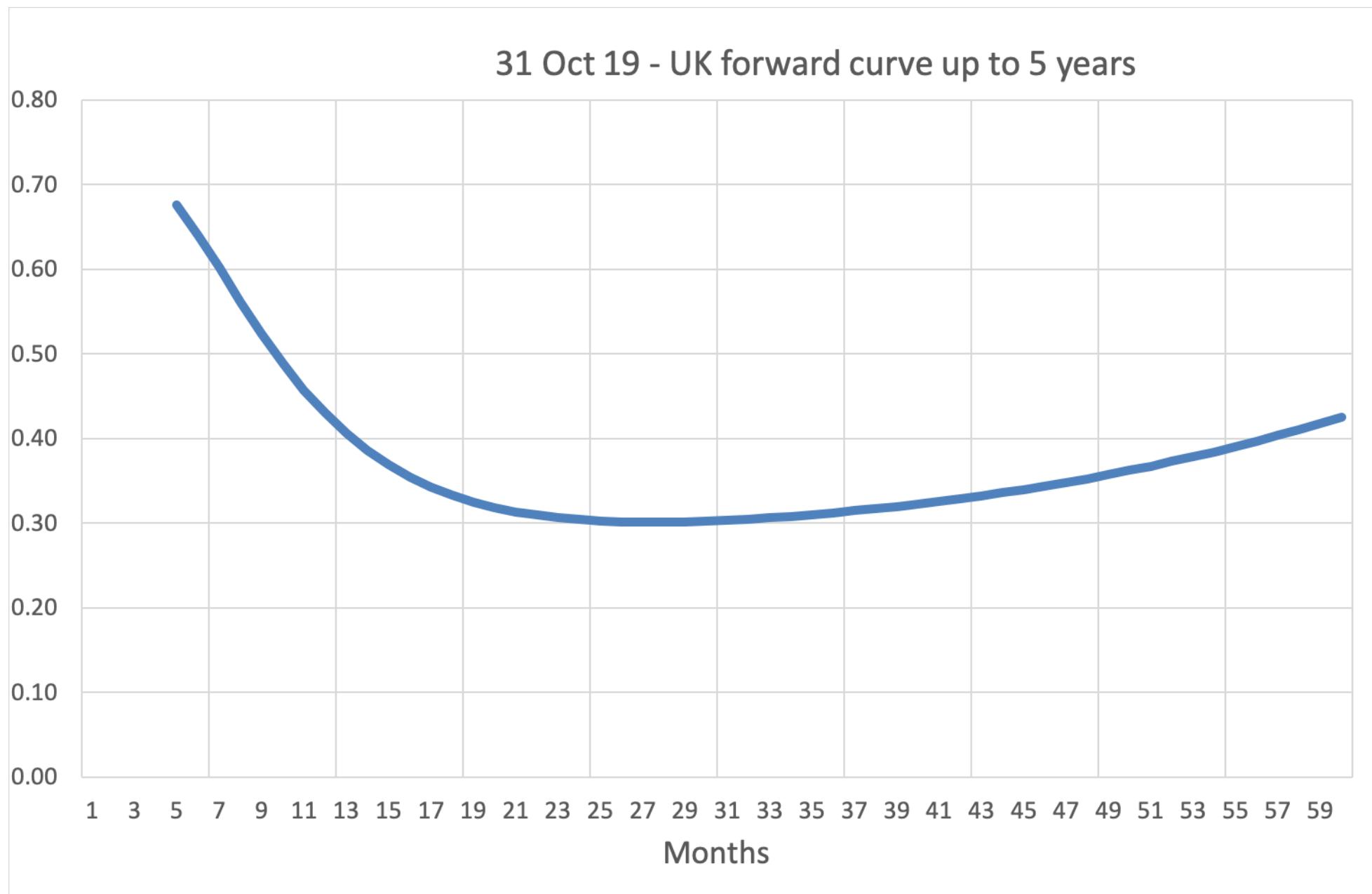
$$\{i_t^{(1)}, i_{t+1}^{(1)e}, \dots, i_{t+N-1}^{(1)e}\} \implies \{i_t^{(1)}, i_t^{(2)}, \dots, i_t^{(N)}\}$$

- Term spread is slope of yield curve

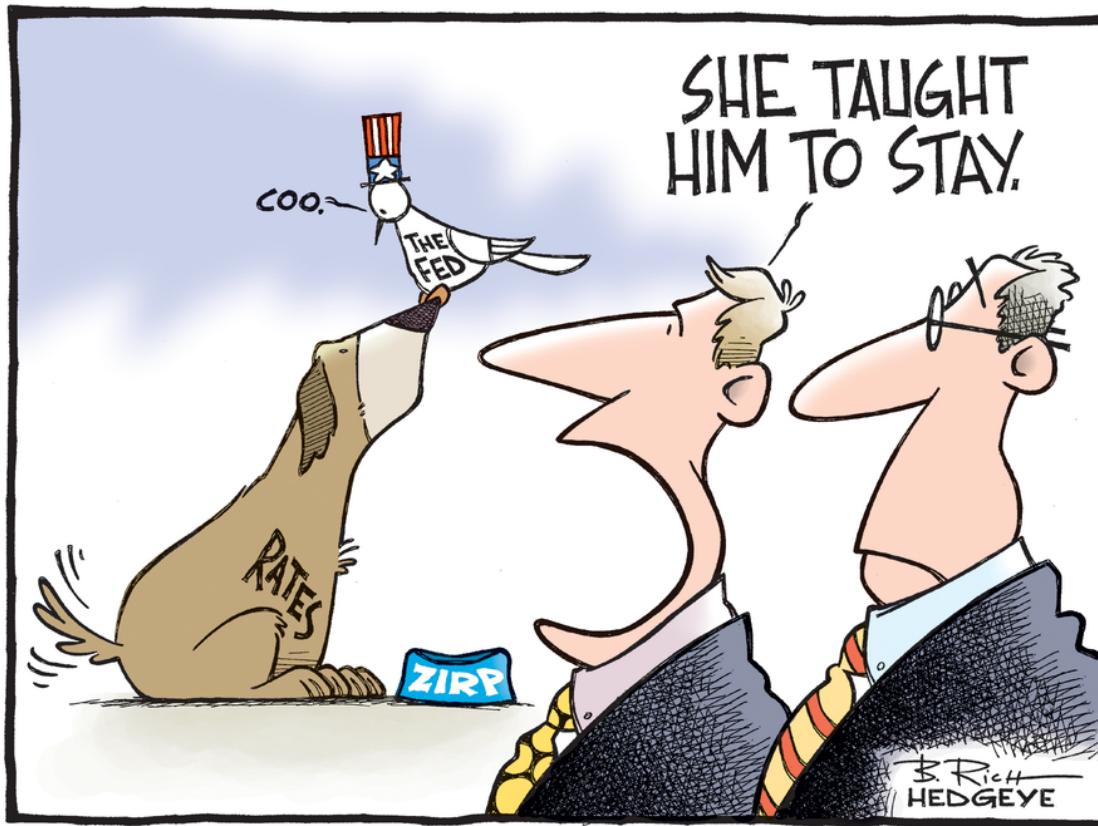
YIELD CURVE RECENTLY



FORWARD CURVE



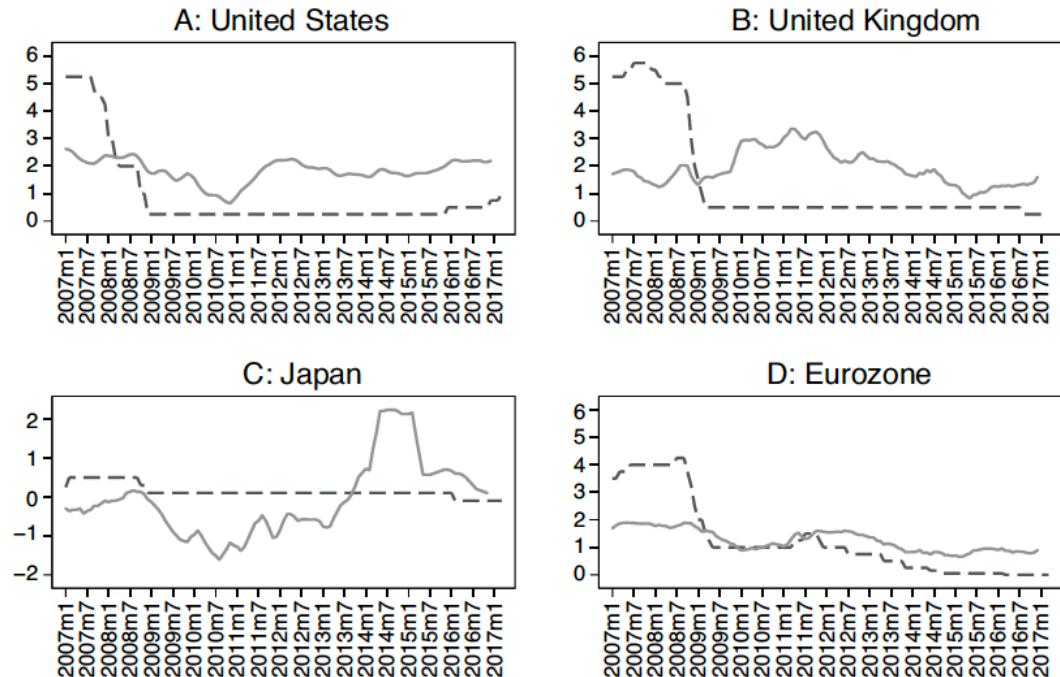
Forward guidance



CENTRAL BANKS GOING LONG

- For many investments and savings decisions, the relevant rates are those in months and years
- Central banks want to lower these long-term interest rates in order to maximize stimulus.
- Especially when short rates hit zero

Figure 1.7 Inflation and policy interest rates, 2007-2016

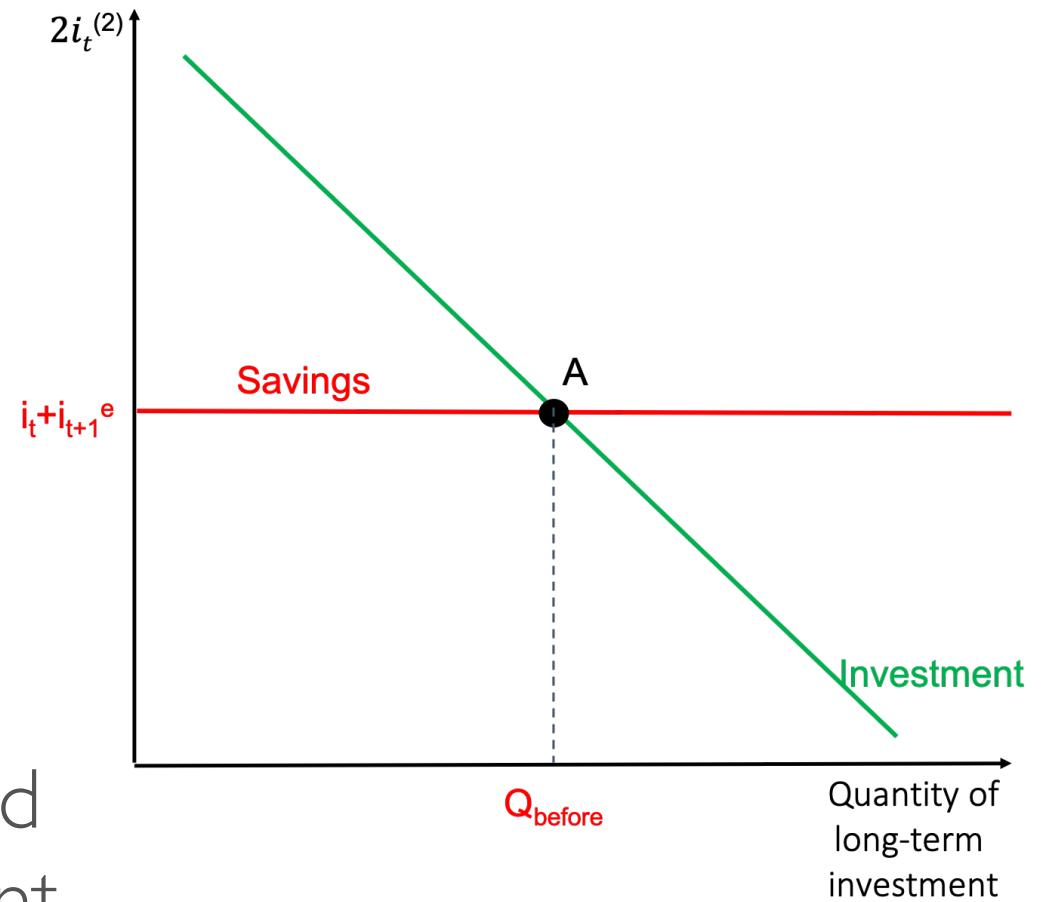


Notes: The solid grey lines plot core inflation and the black dashed lines the policy rate (overnight interbank rate when the policy rate is not available).

Source: Miles, Panizza, Reis, Uribe (2016)

SAVINGS AND INVESTMENT

- For many investments and savings decisions, the relevant rates are those in months and years.
- Under efficient financial markets, supply of two-period savings is the horizontal line at $i_t + i_{t+1}^e$
- Downward sloping demand for funds for real investment



FORWARD GUIDANCE

- Announce future short-term interest rate plans.
- Through arbitrage this affects expected returns, and so affect long-term yields today

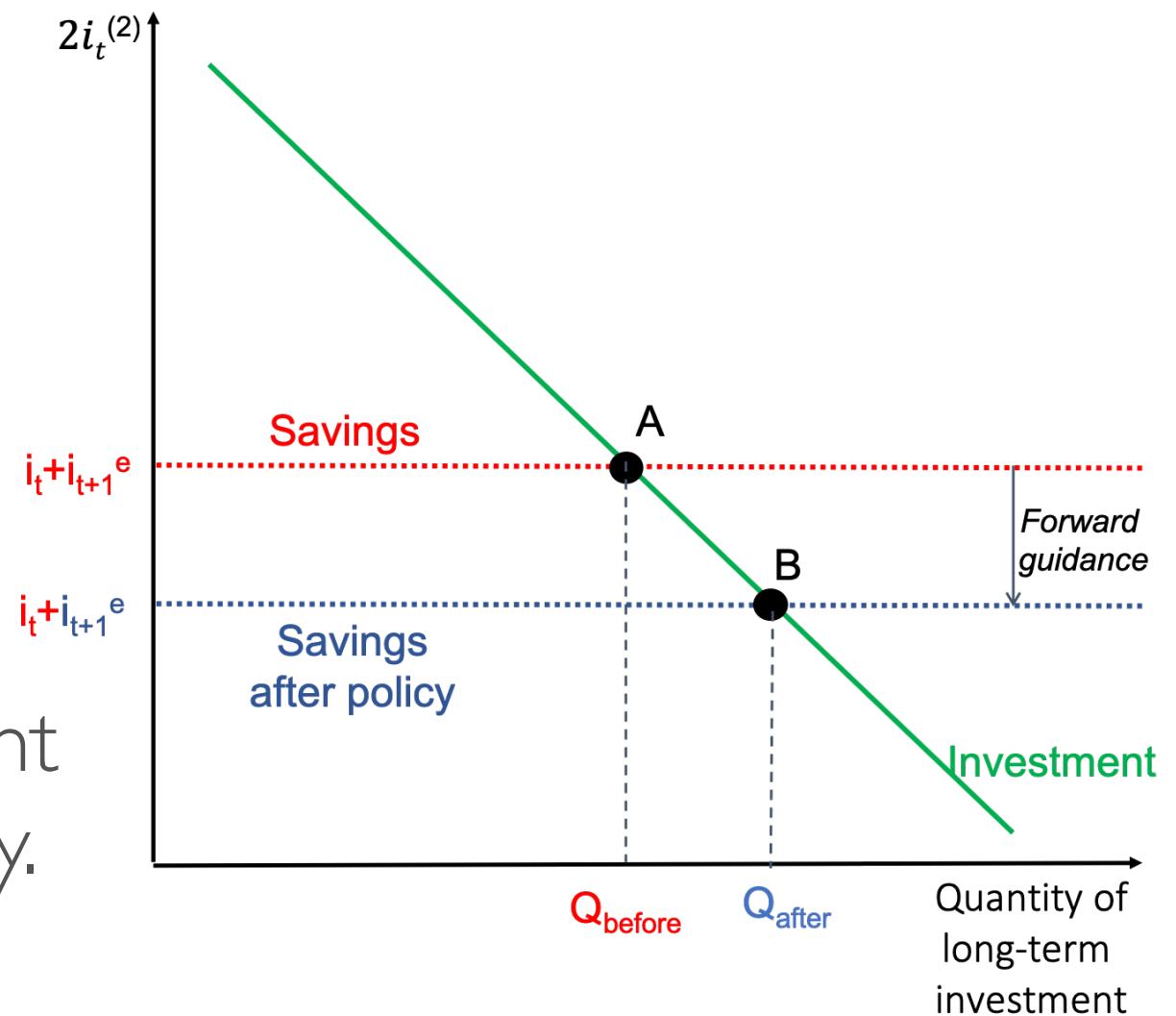
$$2 i_t^{(2)} \approx i_t^{(1)} + i_{t+1}^{(1)e}$$

- Even though CB only sets short-term rates, because it can control **whole** path of these short term rates, it can influence long-term rates:

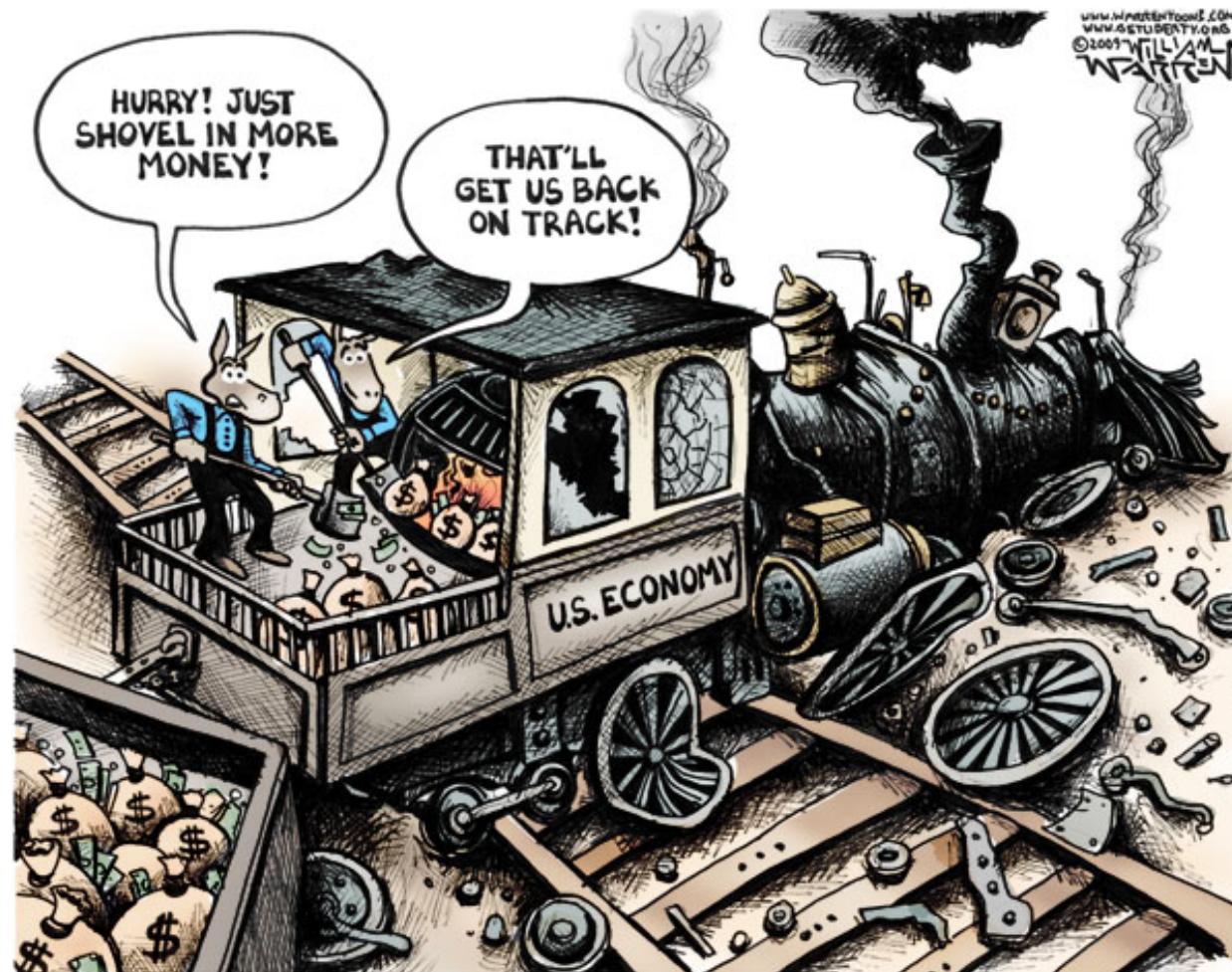
$$\{i_t^{(1)}, i_{t+1}^{(1)e}\} \implies \{i_t^{(1)}, i_t^{(2)}\}$$

EFFECTIVENESS

- Lower i_{t+1}^e perceived by investors.
- Shifts the demand curve downwards
- Increases investment stimulates economy.

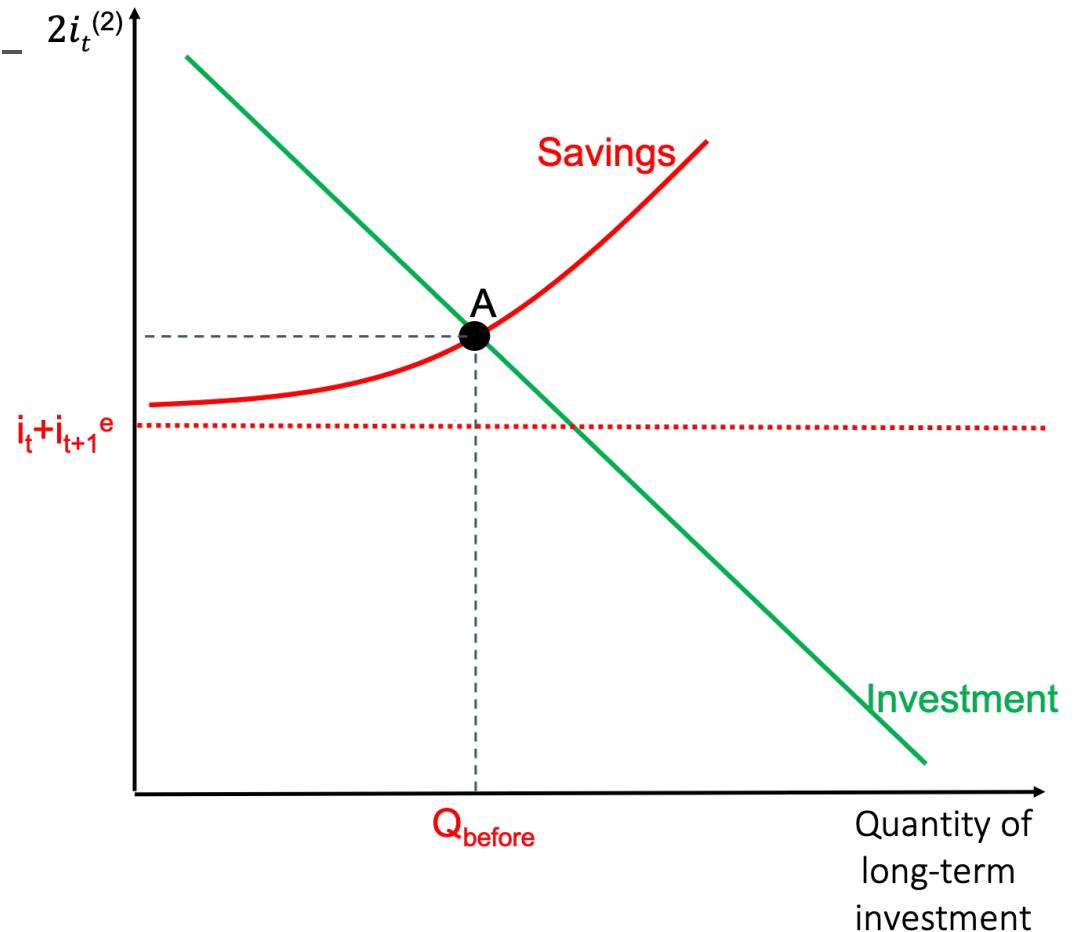


Quantitative easing



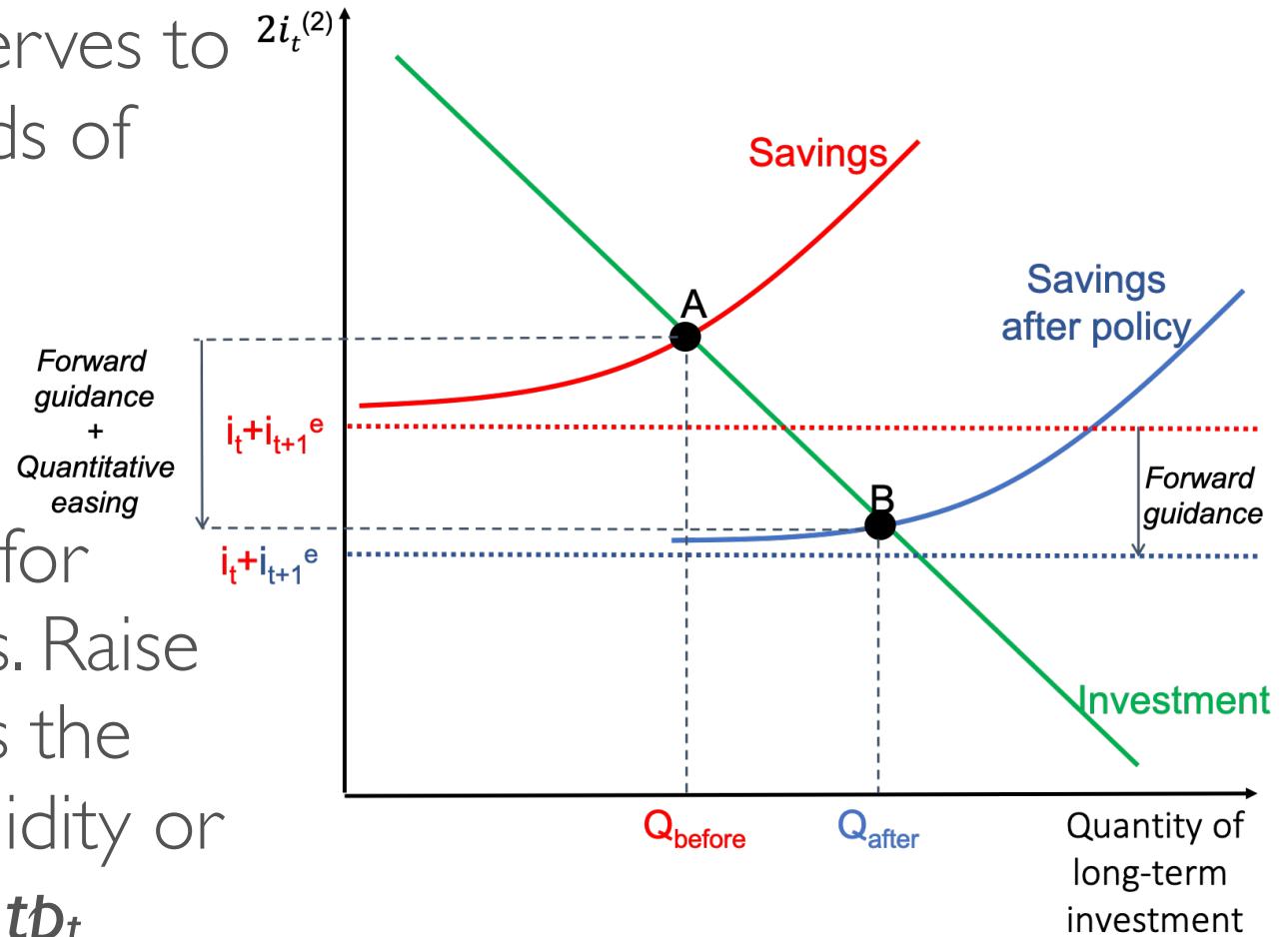
IMPERFECT FINANCIAL MARKETS

- Investors require term premium tp_t to compensate for the risk of holding two-period bonds
- This is shown as the red upwards sloping savings curve
- At equilibrium A:
- $2i_t^{(2)} \approx i_t^{(1)} + i_{t+1}^{(1)e} + tp_t$



QUANTITATIVE EASING

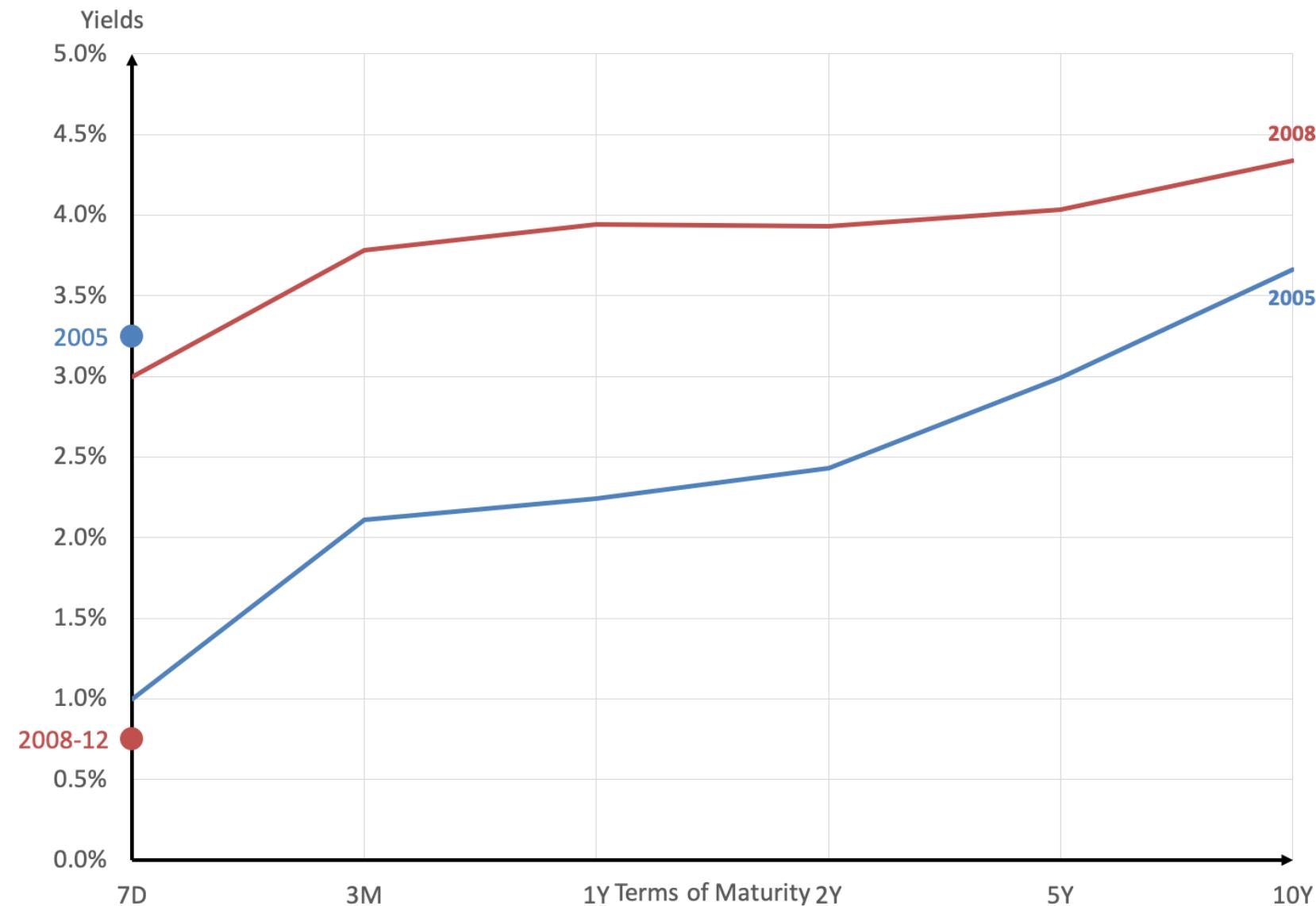
- Use newly issued reserves to buy government bonds of longer maturities.



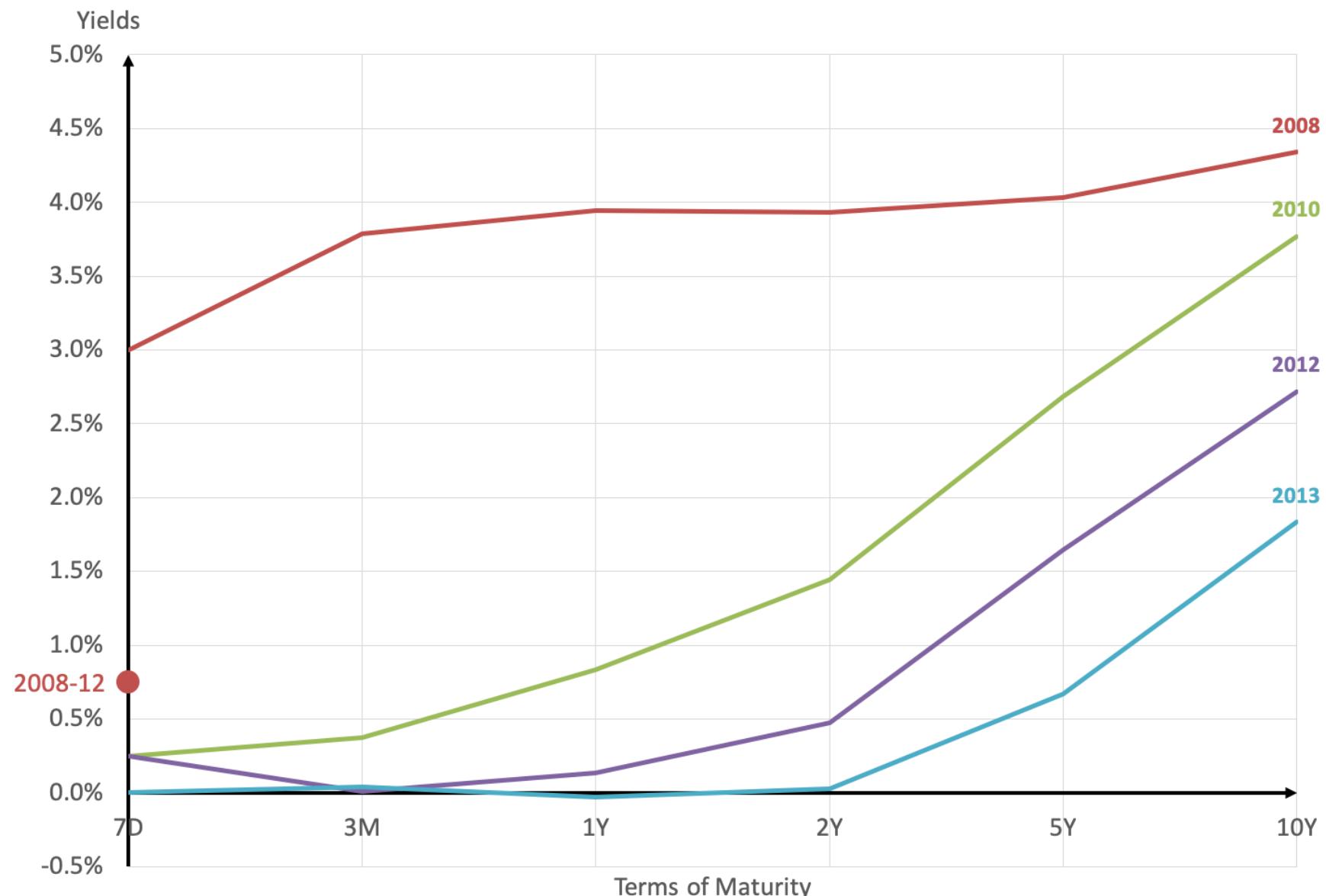
- Increase the demand for longer-maturity bonds. Raise their price and lowers the compensation for liquidity or risk and thus reduces tp_t

- Combines with forward guidance, go to point B

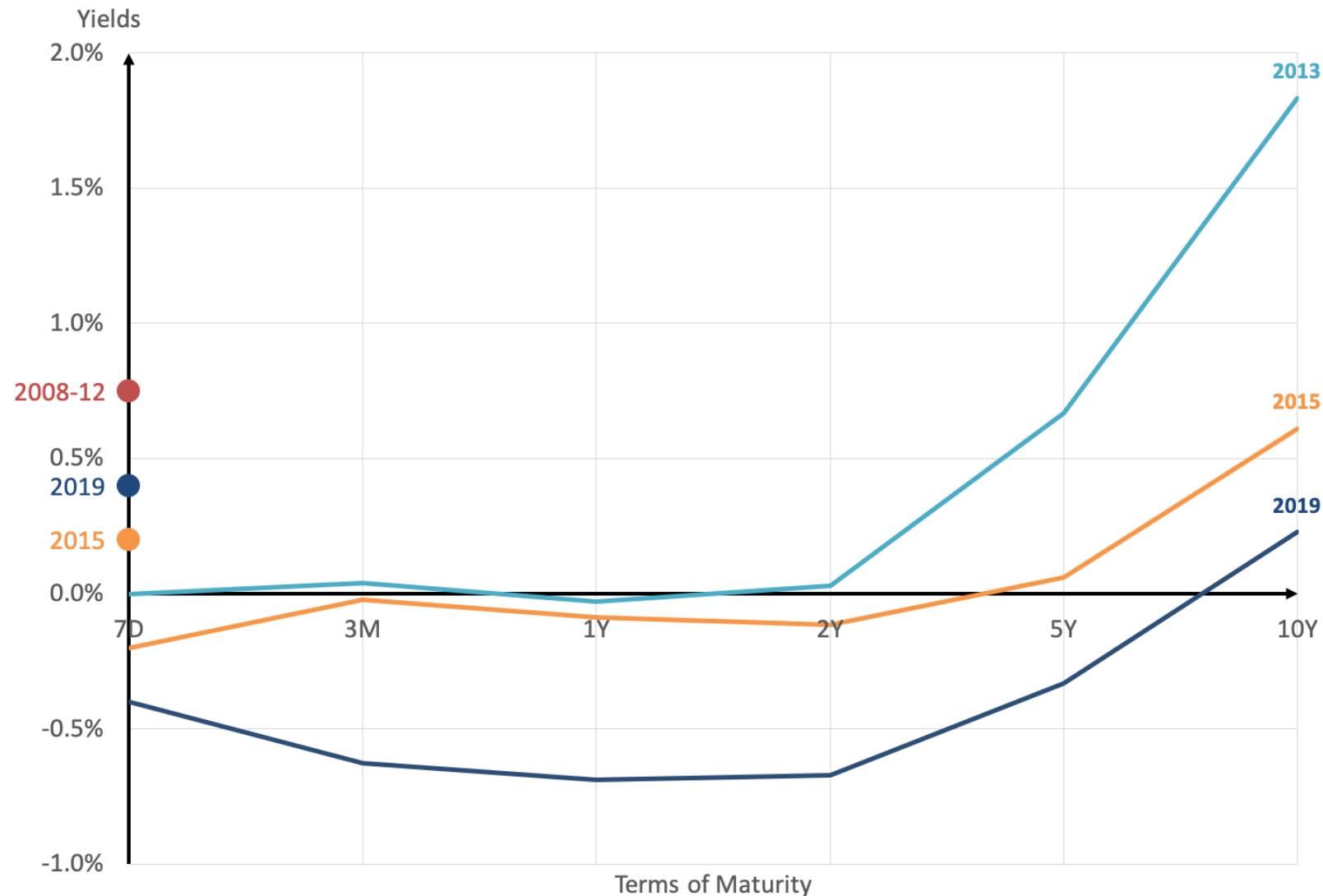
EAYIELD CURVE - CONVENTIONAL



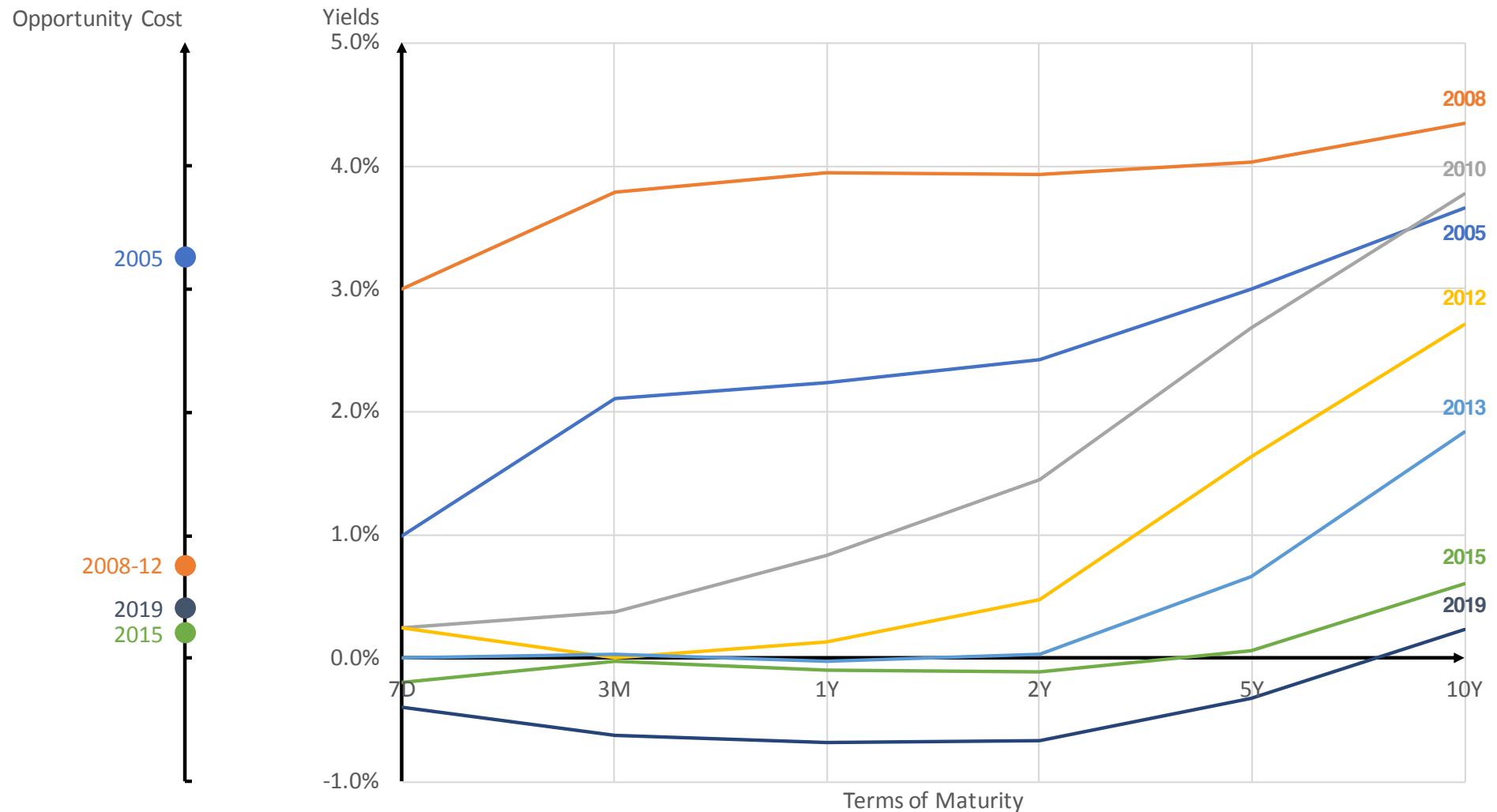
EA YIELD CURVE - FWD GUIDANCE



EA YIELD CURVE - QE



ALTOGETHER



Central bank balance sheet



CLASSIC CB BALANCE SHEET

- Features:
 1. **Assets:** mostly short-term government bonds
 2. **Liabilities:** reserves and currency
 3. **Total size:** quite small

Assets	Liabilities
Short-term govt bonds	Currency
Long-term govt bonds	Reserves
Foreign currency, gold, others	Net worth

CB NET INCOME

$$\begin{aligned}\text{NetIncome} &= i^{\text{assets}} \text{Assets} - i^v \text{Reserves} \\ &\quad - 0 \times \text{Currency} \\ &\approx i(\text{Assets} - \text{Reserves}) \\ &\qquad\qquad\qquad \text{since } i^{\text{assets}} \approx i^v \approx i \\ &\approx i \times \text{Currency} \\ &\qquad\qquad\qquad \text{Assets} = \text{Reserves} + \text{Currency}\end{aligned}$$

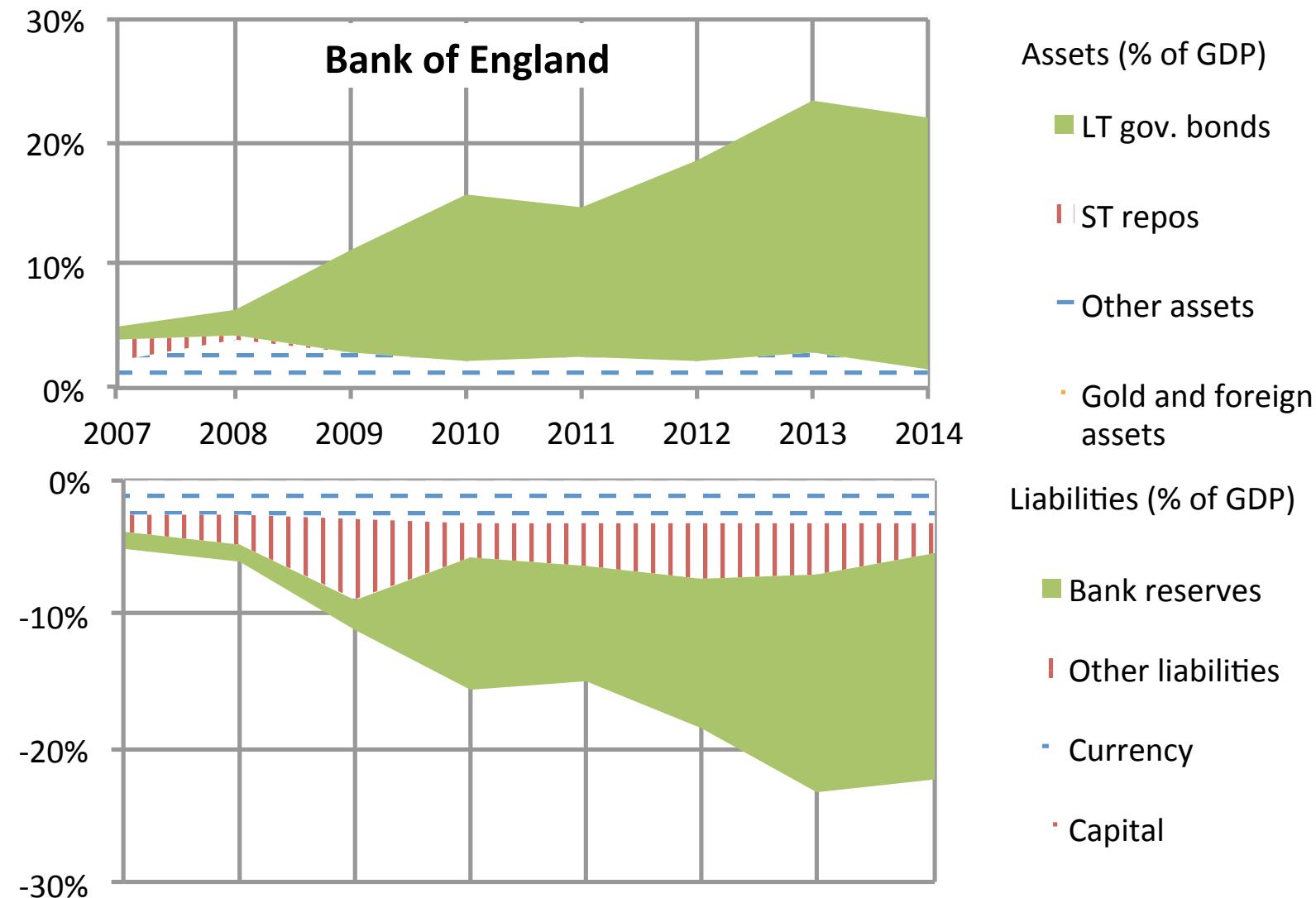
- This is positive and stable (but small)

PAST AND PRESENT

- Today, reserve satiation and quantitative easing
 - 1. **Assets:** long-term government bonds
 - 2. **Liabilities:** currency and reserves
 - 3. **Total size:** very large

Assets	Liabilities
Short-term govt bonds	Currency
Long-term govt bonds	Reserves
Foreign currency, gold, others	Capital

BALANCE SHEET OF CB 2005-15



Source: Reis (2016)

NET INCOME OF CB NOW

$$\text{NetIncome} = i^{(2)} \text{Assets} - i^v \text{Reserves}$$

$$\approx \text{Assets}(i^{(2)} - i) + i \times \text{Currency}$$

$$\text{Reserves} = \text{Assets} - \text{Currency}$$

- Term spread gives extra positive or negative income to central bank. Can be large
- CB can make losses!
- Need **fiscal backing**. Treasury letter of indemnity.

Currency and seignorage



Bernard Schoenbaum The New Yorker Collection/
The Cartoon Bank

“And how would you like your funny money?”

CURRENCY

Properties of currency

- **physical**, hard to seize.
- exchanges one for one with reserves, **unit of account**
- pays **no interest** (zero lower bound on interest rates)
- exchanges are **anonymous**
- **monopoly issuance** by the State
- widely accepted. Serves as: (i) **medium of exchange** to buy goods as it is legal tender, avoiding double coincidence of wants (ii) **store of value** into the future as convenient, durable, and homogeneous.



BIG BILLS

Figure 3.4: Currency-GDP Ratio

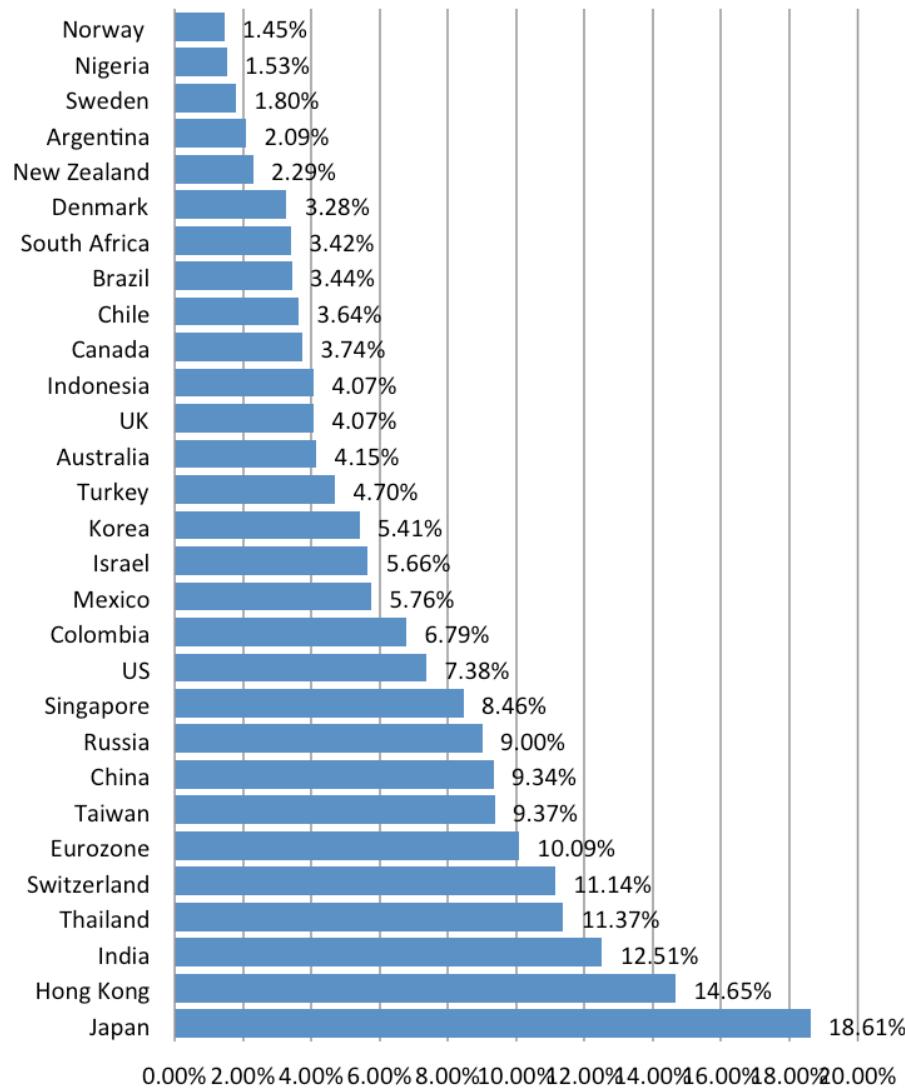
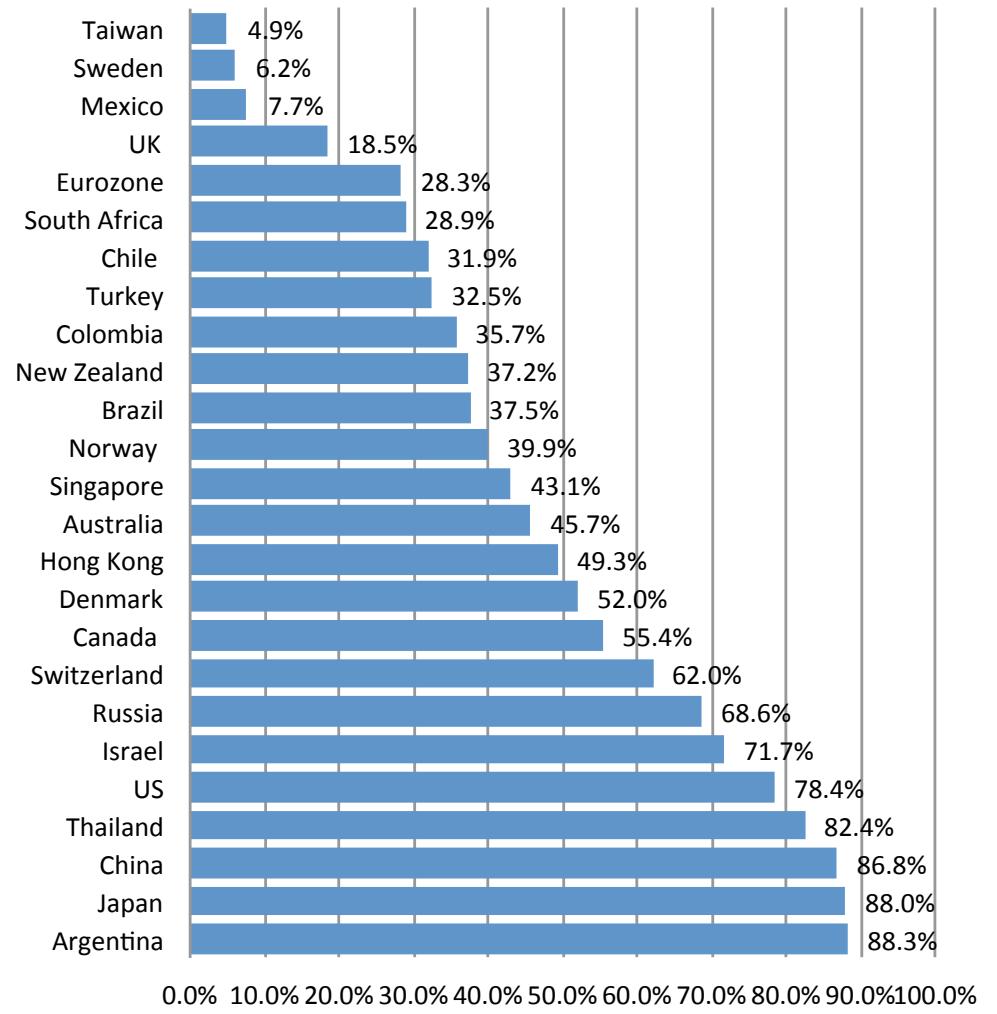


Figure 3.5: Share of Largest Banknote in Total Currency Supply



Source: Rogoff (2016)

NEW CURRENCIES

Abolish paper currency

- Fight crime. But also a form of taxation.
- India's surprise demonetization experience.

Cryptocurrencies (e.g. Bitcoin)

- Mechanism to create money, record transactions in way that cannot be falsified.
- It is anonymous (like currency) its creation is decentralized (like banks' creation of deposits), blockchain database (like database at Bank of England), digital (like reserves)

CB DIGITAL CURRENCY

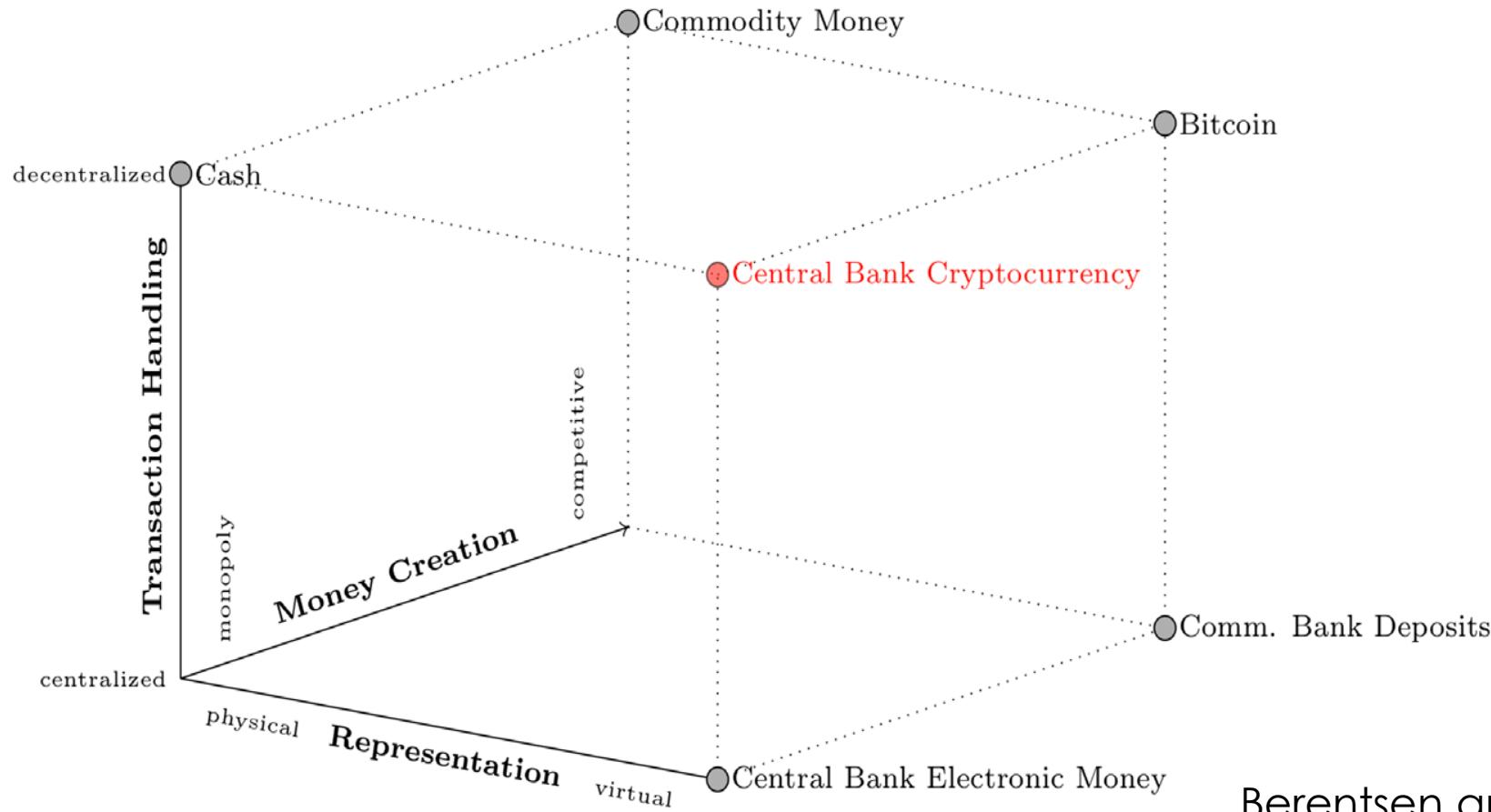
Current net income close to zero

- Because $i=0$

Future of CB issued currency

- Paper banknotes falling, so again no net income
- Central bank digital currency
 - Should you and I have a deposit at the central bank, get a debit card, and use it.
 - Example: Riksbank's Sweden experience.

DIFFERENT CURRENCIES



Berentsen and Schär (2017)

Demand for currency



QUANTITY THEORY

Money as a medium of exchange:

$$M \times V = P \times Y$$

Left-hand side: transactions equal the stock of currency times the number of times it changes hands. V is velocity

Right-hand side: nominal GDP, all sales in economy.

Equal interpreted as proportional.

BACK TO INTEREST RATES

Opportunity cost of currency

$$M \times \underbrace{V(i)}_{(+)} = P \times Y$$

- When accepting money, (may) hold it for a period.
- Could instead earn nominal interest rate on it.
- Higher nominal interest rate, want to get rid of money, velocity increases.
- Remember that CB sets i , and Fisher: $i=r+\pi^e$.

SOME MATHS

- Keep r fixed. Define semi-elasticity of velocity

$$\xi = \frac{\Delta V}{V \Delta \pi^e}$$

- So that can write:

$$\frac{\Delta V}{V} = \left(\frac{\Delta V}{V \Delta \pi^e} \right) \Delta \pi^e = \xi \Delta \pi^e$$

- Then quantity theory:

$$\frac{\Delta M}{M} + \frac{\Delta V}{V} = \frac{\Delta P}{P} + \frac{\Delta Y}{Y}$$

$$\mu + \xi \Delta \pi^e = \pi + g$$

LONG RUN INFLATION

- In long run, stable expectations:

$$\mu = \bar{\pi} + \bar{g}$$

$$\mu = \bar{i} - \bar{r} + \bar{g}$$

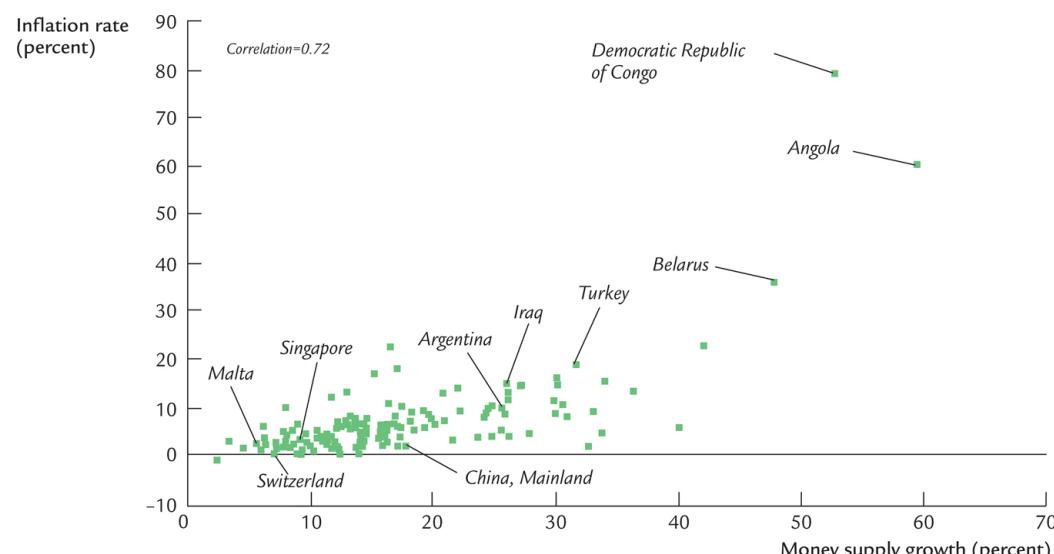


Figure 5.2 International Data on Inflation and Money Growth

Mankiw: Macroeconomics, Ninth Edition
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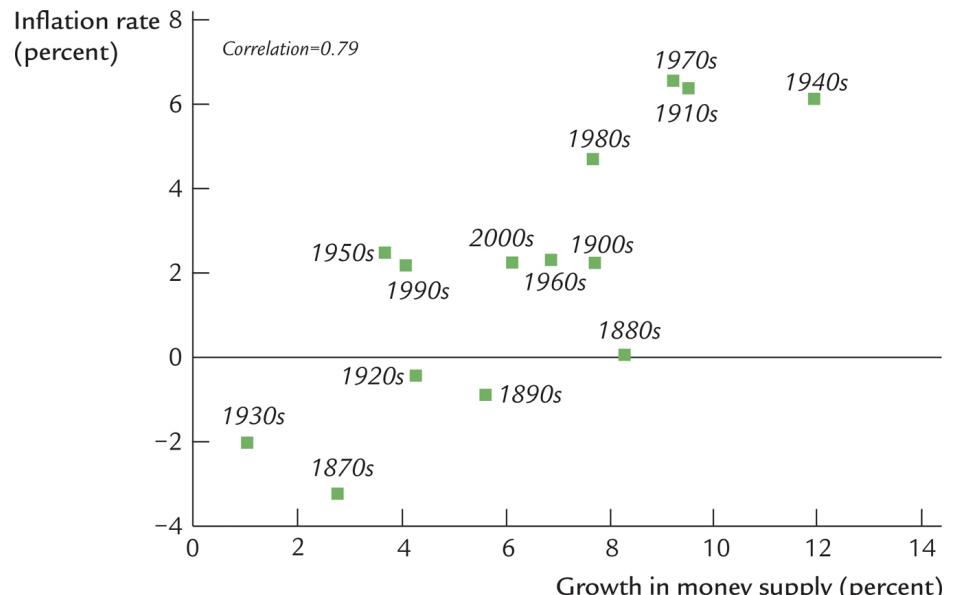


Figure 5.1 Historical Data on U.S. Inflation and Money Growth

Mankiw: Macroeconomics, Ninth Edition
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“Inflation is always and everywhere a monetary phenomenon” Friedman (1976)

DEBATES

Economies are becoming cashless

- Is central bank without currency powerless?
- Not at all, as long as control interest on reserves
- Controls the unit of account, even if not the medium of payment.

Hyperinflations



SEIGNIORAGE

- CB prints currency, cost 0, buys goods with it:

$$\text{seignorage} = \frac{\Delta M}{P}$$

- Link to net income:

$$\begin{aligned}\text{NetIncome} &= i \left(\frac{M}{P} \right) = (\mu + r - g) \left(\frac{M}{P} \right) \\ &\approx \mu \left(\frac{M}{P} \right) = \left(\frac{\Delta M}{M} \right) \left(\frac{M}{P} \right) = \left(\frac{\Delta M}{P} \right)\end{aligned}$$

- Seigniorage is very easy to raise in the short-run.

HYPERINFLATIONS

- Fiscal problems usually at root of hyperinflations.
Governments printing money to pay for expenses.

Table 23-1 Seven Hyperinflations of the 1920s and 1940s

Country	Start	End	P_T/P_0	Average Monthly Inflation Rate (%)	Average Monthly Money Growth (%)
Austria	Oct. 1921	Aug. 1922	70	47	31
Germany	Aug. 1922	Nov. 1923	1.0×10^{10}	322	314
Greece	Nov. 1943	Nov. 1944	4.7×10^6	365	220
Hungary 1	Mar. 1923	Feb. 1924	44	46	33
Hungary 2	Aug. 1945	Jul. 1946	3.8×10^{27}	19,800	12,200
Poland	Jan. 1923	Jan. 1924	699	82	72
Russia	Dec. 1921	Jan. 1924	1.2×10^5	57	49

P_T/P_0 : Price level in the last month of hyperinflation divided by the price level in the first month.

Source: Philip Cagan, "The Monetary Dynamics of Hyperinflation," in Milton Friedman ed., *Studies in the Quantity Theory of Money* (University of Chicago Press, 1956), Table 1

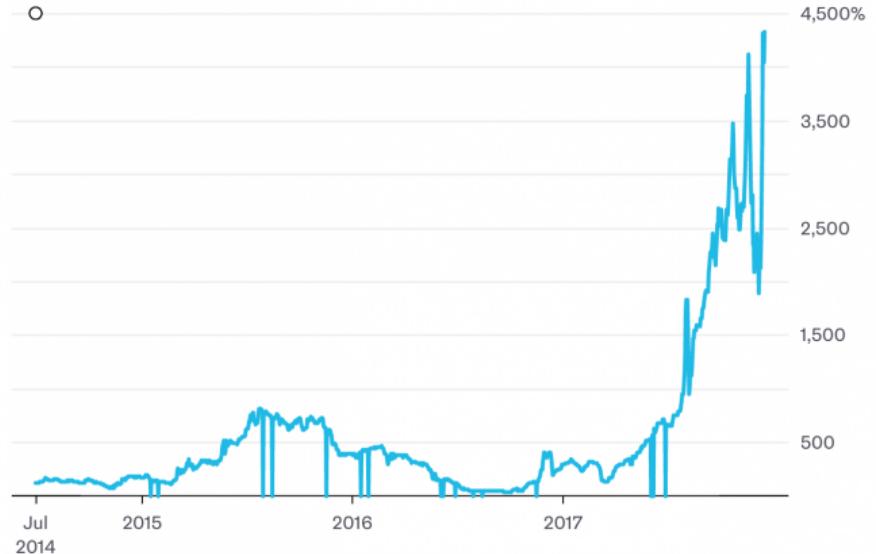
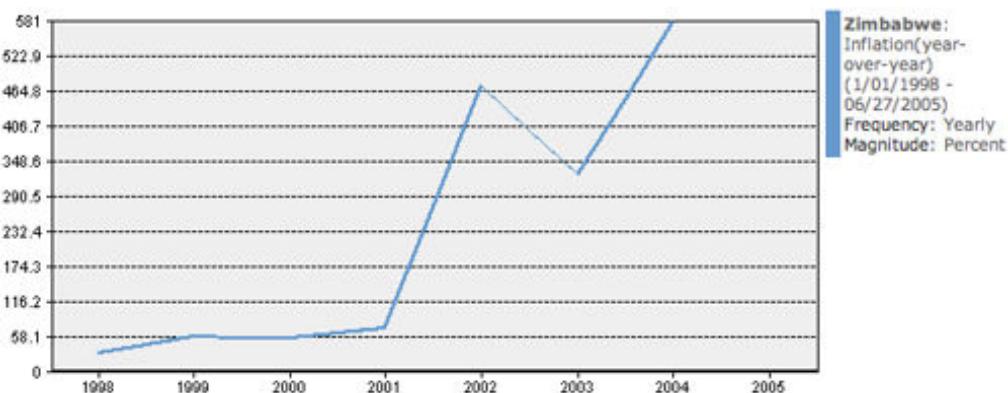
HYPERINFLATION IS TERRIBLE

This is how the family of a high Prussian official lives from day to day. On the thirty-first or first of the month my father would receive his monthly salary, on which we depended for our survival. Bank balances and securities had long since become worthless. What the salary was worth was difficult to estimate; its value changed from month to month. One month 100 million marks could be quite a substantial sum; a little while later 500 billion would be small change. In any case my father would first try to purchase a monthly pass for the subway as quickly as possible. That would at least enable him to get to his office and back, even though the subway involved considerable detours and waste of time. The check would be written out for the rent and school fees, and in the afternoon the whole family went to the hairdresser's. What was left was handed to my mother. Next day the entire family except for my father, but including the maid, would get up at four or five in the morning and go to the wholesale market by taxi. There, in a giant shopping spree, an *Oberregierungsrat's* monthly salary would be spent on nonperishable foodstuffs in an hour. Giant cheeses, whole hams, stack of tinned food, and hundreds of pounds of potatoes were piles into our taxi. If there was not enough room, the maid, with one of us to help, would get hold of a handcart. At about eight o'clock, before school began, we would return home, more or less provisioned for a month's siege. And that was it. There was no more money for the rest of the month. A friendly baker gave us bread on credit. Otherwise, we lived on potatoes, smoked or tinned food, and soup cubes. Now and then there might be an unexpected supplementary payment, but it was quite common for us to be as poverty-stricken as the poorest of the poor for four weeks, not even able to afford a tram ride or a newspaper. Putting aside money for such purposes would have been quite senseless. Within a few days the whole month's salary would not have paid for a single tram ride. I cannot say what would have happened if some misfortune such as a serious illness had befallen us.

Defying Hitler: A Memoir, Sebastian Haffner (Germany in 1923)

Money is a social convention. With hyperinflation, people stopped using it, back to barter, or dollarization

ZIMBABWE AND VENEZUELA



Source: Calculations of Steve Hanke, Johns Hopkins University

ENDING HYPERINFLATION

$$\pi = \mu + \xi \Delta \pi^e - g$$

- Not enough to cut money growth now! If people expect you to print money in the future, expect inflation to accelerate, second term rises.
- Need to also promise to not print more money in credible way. Need **fiscal reform** to credibly signal that will not print more money in the future.
- **Hyperinflation is a monetary phenomenon with fiscal roots.**

LATIN AMERICA, 80-90

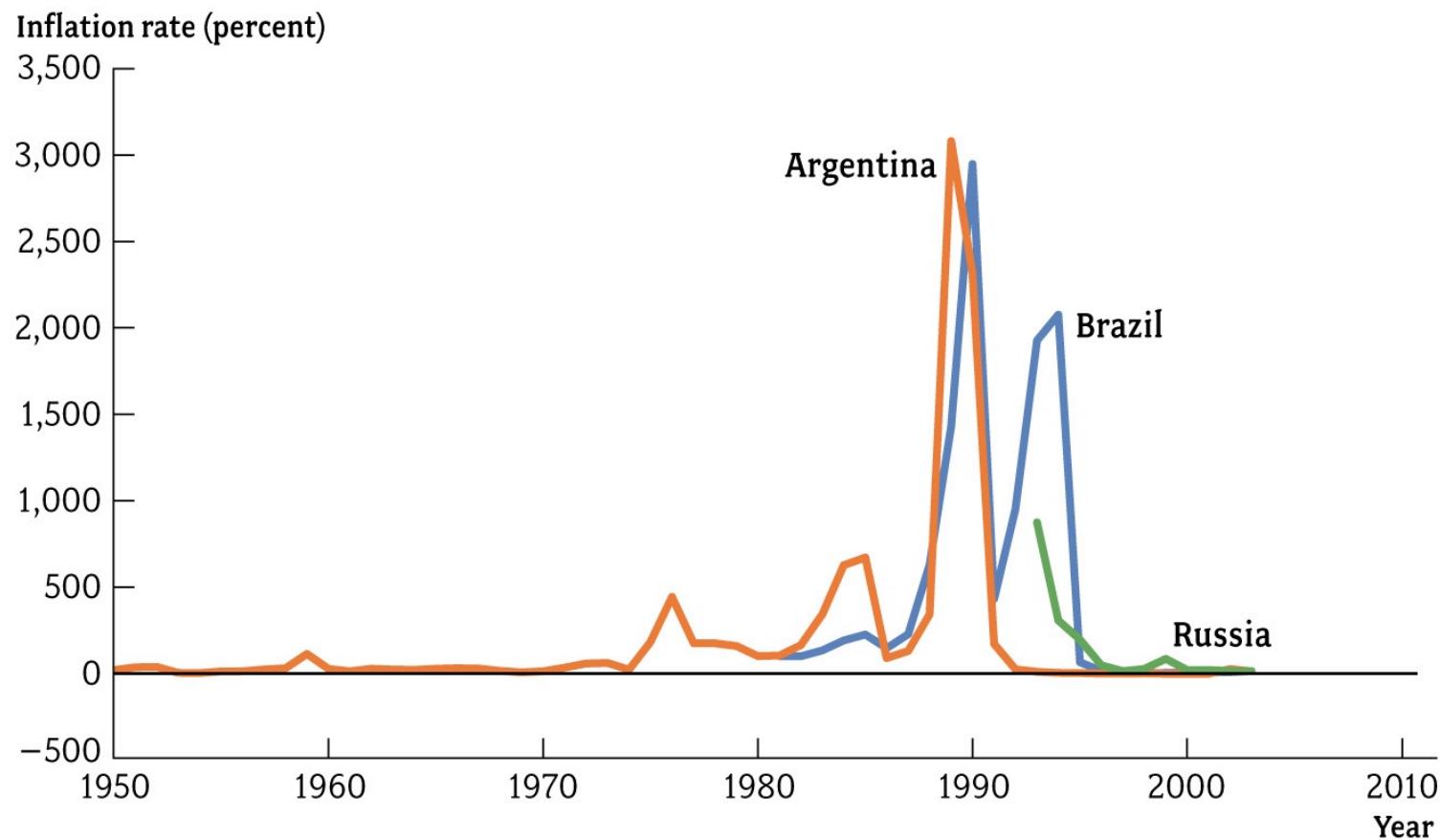


FIGURE 8.5 Hyperinflations in Argentina, Brazil, and Russia, 1950–2005

Macroeconomics, Charles I. Jones
Copyright © 2008 W. W. Norton & Company

LESSONS THIS WEEK

Why do central bank speeches move markets so much?

Yield curve and expectations of future short rates.

What was unconventional monetary policy?

Forward guidance and unconventional monetary policy to move long rates

What are different kinds of money?

Differ anonymity, creation, recording, acceptance as medium of exchange

Why don't we print a lot of money and get rich?

More money growth, more inflation, more tax.

How do hyperinflations come to be?

Fiscal problems leads to desire to collect seigniorage from currency

Why fear that people start expecting high inflation?

It becomes self-fulfilling, with fiscal problems