Ec 370

Money and Banking

Chapter 4: The Meaning of Interest Rates (Cont’d)

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Today's Contents

- Holding Period Returns - Cont'd
- Interest Rate Risk
- Inflation risk
- Distinction Between Real and Nominal Interest Rates

Holding Period Returns - Cont'd

Participation 4

- Let's review what we have discussed in previous lectures with the participation exercise
- I have uploaded the document "Participation_4" in module "Chapter 4"
- Although it is due 11:59pm (PDT), Sunday June 7, you are strongly encouraged to complete it now and submit it right after this lecture to earn 1 point
- Make sure you compile all pages into one pdf document and submit **one and only one LEGIBLE pdf document** to Canvas

Participation 4

- Q1: At t (today), you spend 1,000 to buy a 10%-coupon-rate coupon bond that has face value of 1,000. The current interest rate is 10%. At $t+1$ (one year from today), you sell the bond after holding for 1 year. Suppose at $t+1$, the interest rate rises to 20%. Complete this table.

	Price of bonds today($)	Current yield	Price of bond next year($)	Rate of capital gain	Rate of return
5 years to maturity when bond is purchased	1000				
3 years to maturity when bond is purchased	1000				
1 year to maturity when bond is purchased	1000				

Participation 4

5 yr to maturity

- Current yield: $i_c = \frac{C}{P_t} = \frac{c \times F}{P_t} = \frac{10\% \times 1000}{1000} = 10\%$
- Price next year: $P_{t+1} = \frac{100}{1+0.2} + \frac{100}{(1+0.2)^2} + \frac{100}{(1+0.2)^3} + \frac{100}{(1+0.2)^4} + \frac{1,000}{(1+0.2)^4} = 741$
- Rate of capital gain: $g = \frac{P_{t+1} - P_t}{P_t} = \frac{741 - 1,000}{1,000} = -25.9\%$
- Rate of return: $R = g + i_c = -25.9\% + 10\% = -15.9\%$

Participation 4

5 yr to maturity

	Price of bonds today($)	Current yield	Price of bond next year($)	Rate of capital gain	Rate of return
5 years to maturity when bond is purchased	1000	0.1	741	-0.259	-0.159
3 years to maturity when bond is purchased	1000				
1 year to maturity when bond is purchased	1000				

Participation 4

2 yr to maturity

- Current yield: same as above, $i_c = \frac{C}{P_t} = \frac{c \times F}{P_t} = \frac{10\% \times 1000}{1000} = 10\%$
- Price next year: $\frac{100}{1+0.2} + \frac{1,000}{1+0.2} = 917$
- Rate of capital gain: $g = \frac{P_{t+1} - P_t}{P_t} = \frac{917 - 1,000}{1,000} = -8.3\%$
- Rate of return: $R = g + i_c = -8.3\% + 10\% = 1.7\%$

Participation 4

2 yr to maturity

	Price of bonds today($)	Current yield	Price of bond next year($)	Rate of capital gain	Rate of return
5 years to maturity when bond is purchased	1000	0.1	741	-0.259	-0.159
3 years to maturity when bond is purchased	1000	0.1	917	-0.083	0.017
1 year to maturity when bond is purchased	1000				

Participation 4

1 yr to maturity

- Current yield: same as above, $i_c = \frac{C}{P_t} = \frac{c \times F}{P_t} = \frac{10\% \times 1000}{1000} = 10\%$
- Price next year: whoever buys this bond will redeem the bond and get 1,000
- Rate of capital gain: $g = \frac{P_{t+1} - P_t}{P_t} = \frac{1,000 - 1,000}{1,000} = 0\%$
- Rate of return: $R = g + i_c = 0\% + 10\% = 10\%$

Participation 4

1 yr to maturity

	Price of bonds today($)	Current yield	Price of bond next year($)	Rate of capital gain	Rate of return
5 years to maturity when bond is purchased	1000	0.1	741	-0.259	-0.159
3 years to maturity when bond is purchased	1000	0.1	917	-0.083	0.017
1 year to maturity when bond is purchased	1000	0.1	1000	0.000	0.100

Holding Period Returns

Years to maturity when bond is purchased	Initial Current yield	Initial price($)	Price of bond next year($)	Rate of capital gain	Rate of return
30	0.1	1000	503	-0.497	-0.397
20	0.1	1000	516	-0.484	-0.384
10	0.1	1000	597	-0.403	-0.303
5	0.1	1000	741	-0.259	-0.159
2	0.1	1000	917	-0.083	0.017
1	**0.1**	**1000**	**1000**	**0.000**	**0.100**

(1) The only bonds whose returns will equal their initial yields to maturity are those whose times to maturity are the same as their holding periods

Holding Period Returns

Years to maturity when bond is purchased	Initial Current yield	Initial price($)	Price of bond next year($)	Rate of capital gain	Rate of return
30	0.1	1000	503	**-0.497**	-0.397
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5	0.1	1000	741	**-0.259**	-0.159
2	0.1	1000	917	**-0.083**	0.017
1	0.1	1000	1000	**0**	0.100

(2) A **rise** in interest rates is associated with a fall in bond prices, resulting in capital losses on bonds whose terms to maturity are longer than their holding periods

Holding Period Returns

Years to maturity when bond is purchased	Initial Current yield	Initial price($)	Price of bond next year($)	Rate of capital gain	Rate of return
30	0.1	**1000**	**503**	-0.497	-0.397
20	0.1	**1000**	**516**	-0.484	-0.384
10	0.1	**1000**	**597**	-0.403	-0.303
5	0.1	**1000**	**741**	-0.259	-0.159
2	0.1	**1000**	**917**	-0.083	0.017
1	0.1	**1000**	**1000**	0.000	0.100

(3) The more distant a bond's maturity date, the greater the size of the percentage price change associated with an interest rate change

Holding Period Returns

Years to maturity when bond is purchased	Initial Current yield	Initial price($)	Price of bond next year($)	Rate of capital gain	Rate of return
30	0.1	1000	503	-0.497	**-0.397**
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5	0.1	1000	741	-0.259	**-0.159**
2	0.1	1000	917	-0.083	**0.017**
1	0.1	1000	1000	0.000	**0.1**

(4) The more distant a bond's maturity date, the lower the rate of return that occurs as a result of an increase in the interest rate

Holding Period Returns

Years to maturity when bond is purchased	Initial Current yield	Initial price($)	Price of bond next year($)	Rate of capital gain	Rate of return
30	**0.1**	1000	503	-0.497	**-0.397**
20	**0.1**	1000	516	-0.484	**-0.384**
10	**0.1**	1000	597	-0.403	**-0.303**
5	**0.1**	1000	741	-0.259	**-0.159**
2	**0.1**	1000	917	-0.083	**0.017**
1	**0.1**	1000	1000	0.000	**0.1**

(5) Even though a bond may have a substantial initial yield to maturity, its return can turn out to be negative if interest rates rise

Interest-Rate Risk

Interest-Rate Risk

- After you have purchased a bond, if there is goin to be a rise in interst rate, then it means that the price of the bond you are holding will fall and experience a capital loss; if the loss is large enough, the bond you are holding can be a poor investment
- **Changes in interest rates** lead to capital gains or losses
- **Interest-rate risk**: the possible reduction in returns associated with changes in interest rates
    - because we never know with certainty what interest rate will be in the future

Interest-Rate Risk

- There is **NO interest-rate risk** for any bond whose time to maturity is equal to the holding period
  - the price at the end of the holding period is already fixed at the face value
- Bonds whose terms to maturity are longer than their holding periods are subject to interest-rate risk

Interest-Rate Risk

- When interest rate **increases**, bonds with a more distant time to maturity suffer a greater **decrease** in price, implying a greater capital **loss** and may be **negative** holding period return
- Prices and returns for long-term bonds are more volatile than those for shorter-term bonds.
- Long-term bonds have substantial interest-rate risk, compared to short-term bonds
- **Changes in interest rates** make investments in **long-term** bonds quite **risky**

Inflation risk

Inflation risk

Bonds are risky!

- Risk: uncertainty in determining assets' return
- We have discussed **Interest-rate risk**
- In addition to interest rate risk, bonds have:
    - default risk (will discuss this in Chapter 6)
    - **inflation risk**

Inflation risk

- At the beginning of 2018, you lend \$100 over one year with an interest rate of 5%. By the end of 2018, you receive \$105. If inflation over the year is 5%, do you think that you really earn \$105?
- The answer is NO. Because of inflation, the real value of your money is \$100 (105/1.05)
  - At the beginning of 2018, bagel price is 1 dollar. \$100 could buy 100 bagels
  - Over the year, the inflation rate is 5%, which means that the price of all goods and services increase by 5%. Hence, bagel now costs 1*1.05 = 1.05
  - At the end of 2018, \$105 can only buy 100 bagels
  - With an inflation of 5%, \$100 at the beginnig of 2018 has the same purchasing power as \$105 at the end of 2018

Inflation risk

- If you knew that inflation would be 5% over the year, then you would have required an interest rate greater than 5%
- No one cares only about the number of dollars. People also care about what those dollars can buy. In other words, everyone cares about **real interest rates**
- **Nominal interest rate**: interest rate that does not take inflation into account (the ones that appear in the newspaper and on bank statements)
- **Real interest rate**: is adjusted for changes in the price level, i.e. inflation (it reflects more accurately the true cost of borrowing or benefits of lending)

Distinction Between Real and Nominal Interest Rates

Fisher Equation: $r = i - \pi^e$

- nominal interest rate i: observable
- π^e: expected inflation
  - Twice a year the Federal Reserve Bank of Philadelphia publishes professional forecasts
  - Once a month, the Survey Research Center of the University of Michigan computes consumer inflation expectations
- real interest rate r: unobservable, but can be estimated by Fisher equation
- Fisher Equation: $r = i - \pi^e$

Fisher Equation: $r = i - \pi^e$

- When the real interest rate is low, is there greater incentives to borrow or to lend?

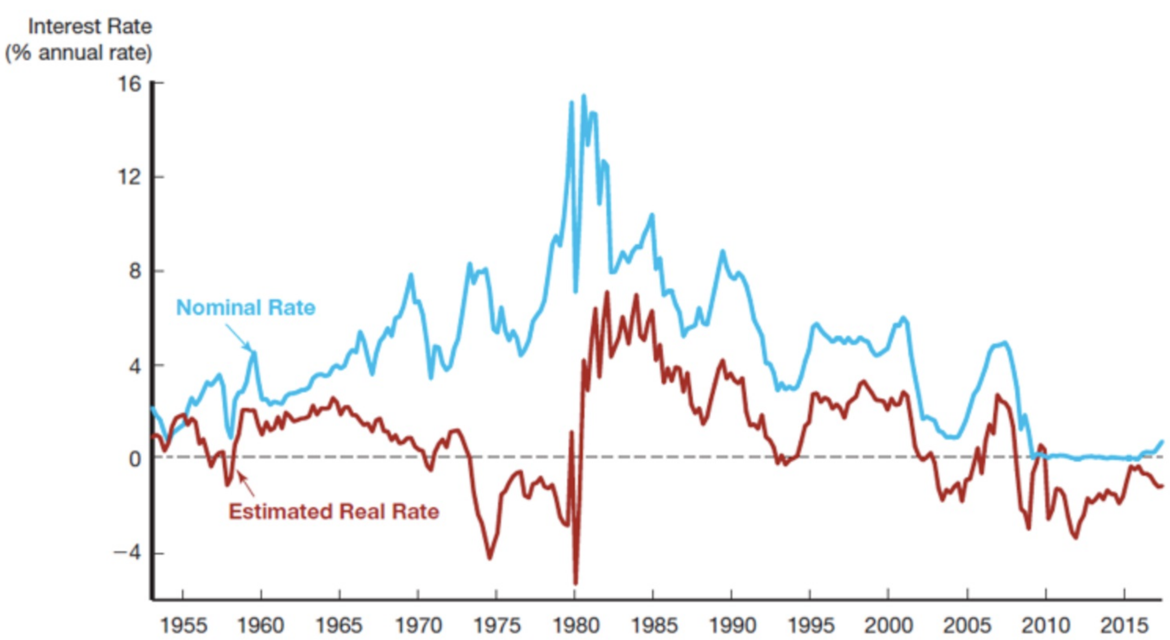
- Answer: To borrow!

- If you expect the inflation rate to be 15% next year and a one-year bond has a yield to maturity of 7%, what is the real interest rate on this bond?

- Answer: $r = i - \pi^e = 7\% - 15\% = -8\%$

Fisher Equation: $r = i - \pi^e$

Figure 1 Real and Nominal Interest Rates (Three-Month Treasury Bill), 1953–2017

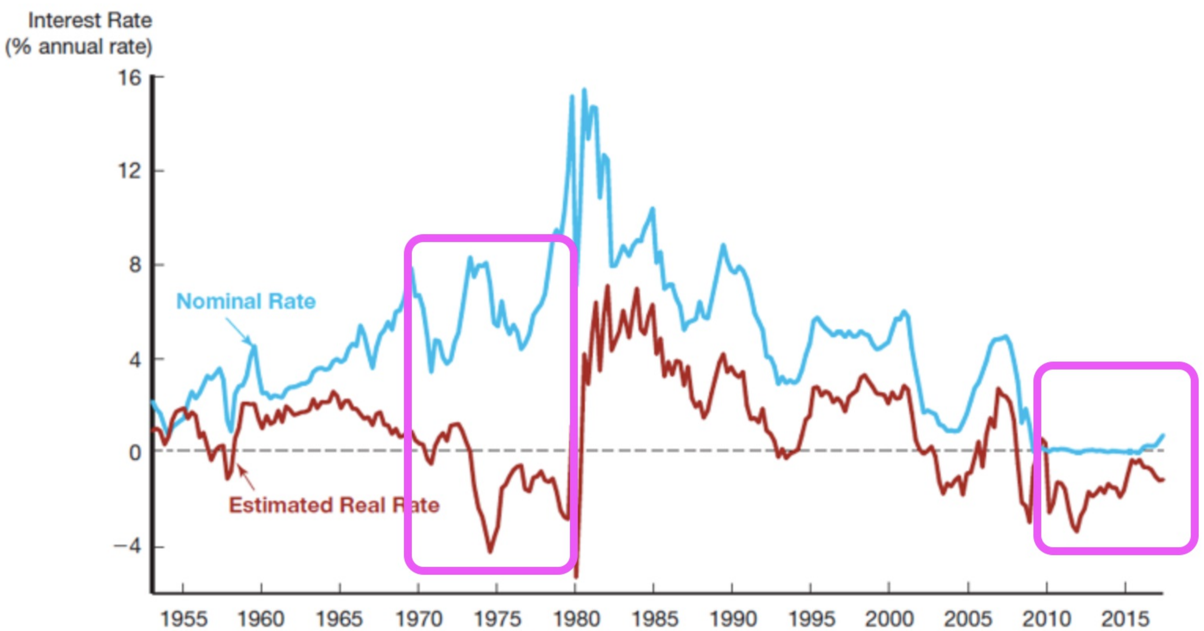


Nominal and real interest rates often do not move together. When U.S. nominal rates were high in the 1970s, real rates were actually extremely low—often negative.

- blue line: nominal interest rate
- red line: estimated real interest rate
- expected inflation: gap between two lines
- when red line goes above blue line, expected inflation is negative

Fisher Equation: $r = i - \pi^e$

Figure 1 Real and Nominal Interest Rates (Three-Month Treasury Bill), 1953–2017

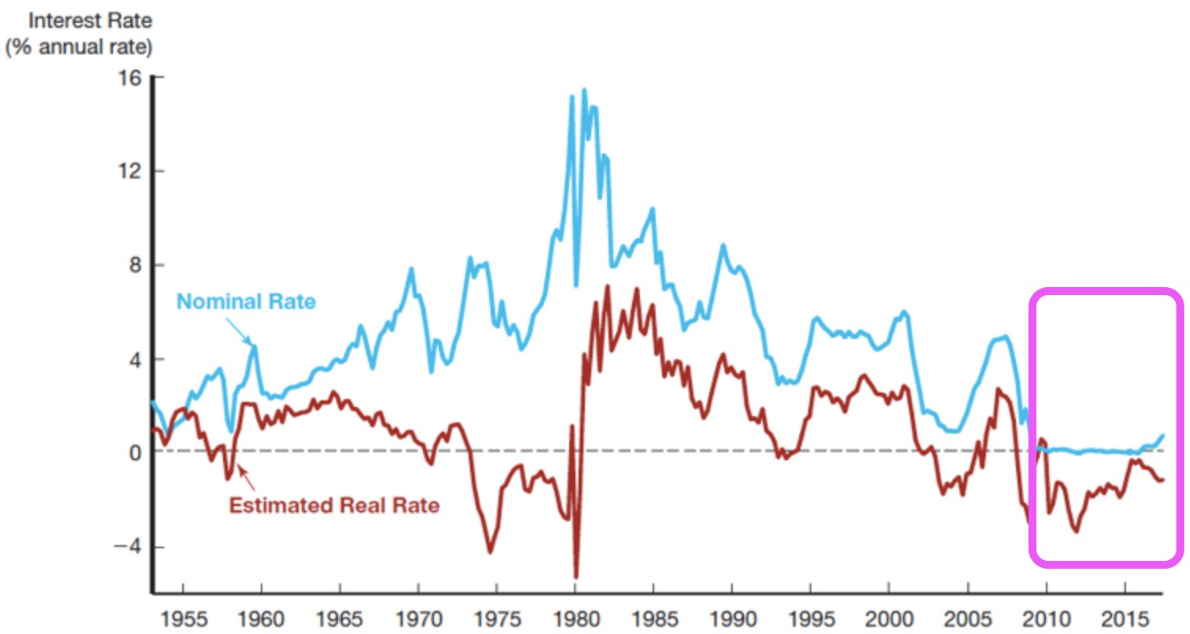


Nominal and real interest rates often do not move together. When U.S. nominal rates were high in the 1970s, real rates were actually extremely low—often negative.

- real and nominal interest rate usually move together but do not always do so (recall Fisher Equation)

Fisher Equation: $r = i - \pi^e$

Figure 1 Real and Nominal Interest Rates (Three-Month Treasury Bill), 1953–2017



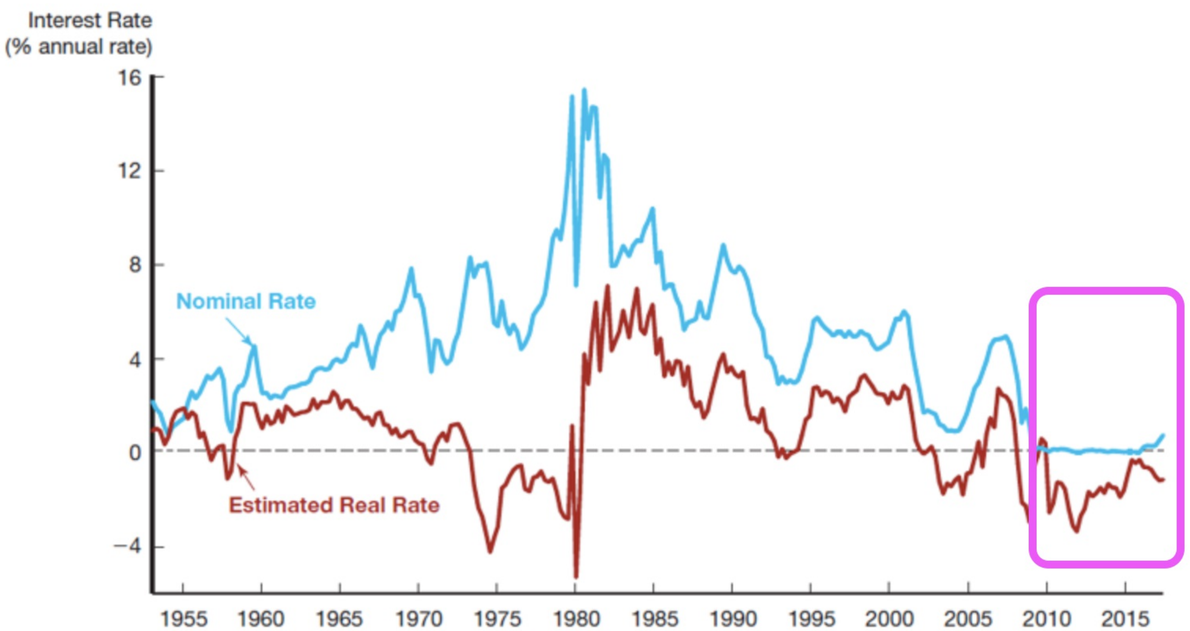
Nominal and real interest rates often do not move together. When U.S. nominal rates were high in the 1970s, real rates were actually extremely low—often negative.

How much was NOMINAL interest rate between 2009 to 2015?

- Roughly nominal interest rate reached a lower limit of zero
- https://ycharts.com/indicators/3_month_t_bill

Fisher Equation: $r = i - \pi^e$

Figure 1 Real and Nominal Interest Rates (Three-Month Treasury Bill), 1953–2017

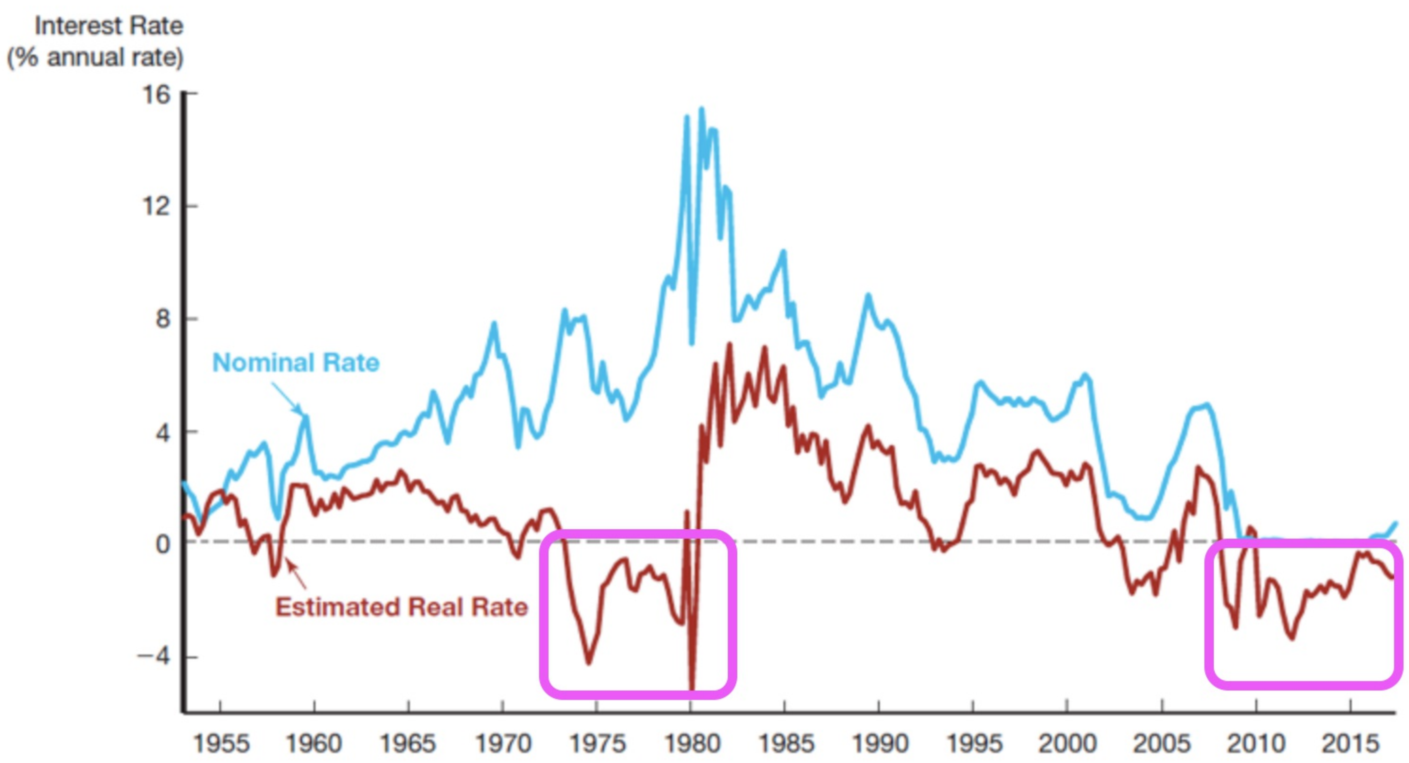


Nominal and real interest rates often do not move together. When U.S. nominal rates were high in the 1970s, real rates were actually extremely low—often negative.

- Historically were there any period that NOMINAL interest rate became negative?
- negative nominal interest rate: Switzerland (1970), Sweden (2009-10), Denmark (2012), EU (2014), Japan (2016)

Fisher Equation: $r = i - \pi^e$

Figure 1 Real and Nominal Interest Rates (Three-Month Treasury Bill), 1953–2017



Nominal and real interest rates often do not move together. When U.S. nominal rates were high in the 1970s, real rates were actually extremely low—often negative.

- Can REAL interest rate be negative? (recall Fisher Equation: when expected inflation exceed nominal interest rate)

- This is the end of Chapter 4. Practice problems and answer key have been posted to Canvas, which will help you work on Problem Set #2.
- Problem Set #2 is due **11:59 (PDT), Sunday April 19**. No late submission will be accepted. Compile all pages into one pdf document and submit **one and only one legible pdf document**. Points will be deducted if submissions do not follow the instructions.
- Participation #2, #3, and #4 are due 11:59 (PDT), Sunday June 7. However, an extra credit assignment has been created for early submissions. If you submit Participation #2, #3, and #4 by **11:59 (PDT), Sunday April 19**, you will get 1 extra credit.
- An announcement will be made on Canvas soon about logistics of this exam and how to prepare for this exam.