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- Interpret the distinction between real and nominal interest rates

Measuring Interest Rates

Present value: a dollar paid to you one year from now is less valuable than a dollar paid to you today.

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Why: a dollar deposited today can earn interest and become $(1 + i) \times \$1$ one year from today

Present value

Let $i = .10$

$$\text{1 year} \quad \$100 \quad \times \quad (1 + 0.10) \quad = \quad \$110$$

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1 year	\$100	$\times$	$(1 + 0.10)$	$=$	\$110
2 years	\$110	$\times$	$(1 + 0.10)$	$=$	\$121

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or	\$100	$\times$	$(1 + 0.10)^2$	$=$	\$121

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3 years	\$121	$\times$	$(1+0.10)$	$=$	\$133

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4 years	\$133	$\times$	$(1 + 0.10)$	$=$	\$146

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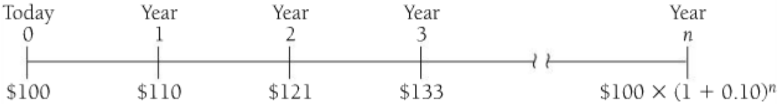
or	\$100	$\times$	$(1+0.10)^4$	$=$	\$146
n years	\$100	$\times$	$(1+0.10)^n$		

Simple present value



Text says "just as happy"

PV = today's (present) value

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CF = future cash flow (payments)

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i = interest rate

PV $=$ today's (present) value

CF $=$ future cash flow (payments)

$i =$ interest rate

$$PV = \frac{CF}{(1+i)^n}$$

PV = today's (present) value

CF = future cash flow (payments)

i = interest rate

$$PV = \frac{CF}{(1+i)^n}$$

Can add up PV of multiple payments

Example: What is the PV of a payment of \$100 in 2 years with an interest rate of 20%?

Need an interest rate concept that lets us compare payments at different points in time:

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Definition: the interest rate that equates the present value of cash flow payments received from a debt instrument with its value today

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Also called the "internal rate of return"

Yield to Maturity on a Simple Loan

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$$i = \frac{\$110}{\$100} - 1 = .1 = 10\%$$

Yield to Maturity on a Simple Loan

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- CF $=$ cash flow in one year $=$ \$110
- n $=$ number of years $=$ 1

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$$i = \frac{\$110}{\$100} - 1 = .1 = 10\%$$

For simple loans, the simple interest rate equals yield to maturity

Fixed payment loan

Same cash flow payment every period

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$$\text{LV} = \frac{\text{FP}}{1+i} + \frac{\text{FP}}{(1+i)^2} + \frac{\text{FP}}{(1+i)^3} + ... + \frac{\text{FP}}{(1+i)^n}$$

*Note: LV = PV (of CF) is the equilibrium condition that defines i

Coupon bond

Similar to fixed payment loan

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TABLE 1 Yields to Maturity on a 10%-Coupon-Rate Bond Maturing in Ten Years (Face Value = $1,000)

Price of Bond ($)	Yield to Maturity (%)
1,200	7.13
1,100	8.48
1,000	10.00
900	11.75
800	13.81

Perpetuity

Consol or perpetuity: a bond with no maturity date that does not repay principal but pays fixed coupon payments forever

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$$P_c = \frac{C}{i_c}$$

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For coupon bonds, this equation gives the current yield, an easy to calculate approximation to the yield to maturity

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For one year discount bond:

$$i = \frac{F - P}{P}$$

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$$P = \frac{F}{(1+i)^n}$$

$$\Rightarrow (1+i)^n = \tfrac{F}{P} \qquad \Rightarrow \qquad i = \left(\tfrac{F}{P}\right)^{\frac{1}{n}} - 1 \quad = \left(\tfrac{F}{P}\right)^{\frac{1}{n}} - \tfrac{P}{P}$$

The Distinction Between Interest Rates and Returns

Rate of return: payment to the owner plus change in value as a fraction of the purchase price

$$\text{RETURN} = \frac{C}{P_t} + \frac{P_{t+1} - P_t}{P_t} = g$$

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$\frac{C}{P_t}$	$=$	current yield
$\frac{P_{t+1}-P_t}{P_t}$	$=$	rate of capital gain, g

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- Even if you do not sell the bond, a higher interest rate means a loss for you

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TABLE 2 One-Year Returns on Different-Maturity 10%-Coupon-Rate Bonds When Interest Rates Rise from 10% to 20%

(1) Years to Maturity When Bond Is Purchased	(2) Initial Current Yield (%)	(3) Initial Price ($)	(4) Price Next Year* ($)	(5) Rate of Capital Gain (%)	(6) Rate of Return [col (2) + col (5)] (%)
30	10	1,000	503	−49.7	−39.7
20	10	1,000	516	−48.4	−38.4
10	10	1,000	597	−40.3	−30.3
5	10	1,000	741	−25.9	−15.9
2	10	1,000	917	−8.3	+1.7
1	10	1,000	1,000	0.0	+10.0

*Calculated with a financial calculator, using Equation 3.

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Example: imagine that you hold a bond that will pay $100 tomorrow, and I offer to pay you $50 for it today. What interest rate will need to exist for you to take my offer?

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Distinction between real and nominal interest rates

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- Real interest rate is adjusted for changes in price level
  - More accurately reflects the cost of borrowing
  - Ex ante real interest rate: adjusted for expected changes in the price level
  - Ex post real interest rate: adjusted for actual changes in the price level

Fisher Equation

$$i = r + \pi^e$$

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Nominal interest rate $= i$

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\text{Nominal interest rate} &= i \\
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Fisher Equation

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Nominal interest rate	$=$	i		
Real interest rate	$=$	r,	$E_t r$,	$E_t(r)$
Expected inflation	$=$	π^e,	$E_t \pi$,	$E_t(\pi)$

Real interest rate:

- When r is low,
  - more incentive to borrow
  - less incentive to loan

Fisher Equation

$$i = r + \pi^e$$

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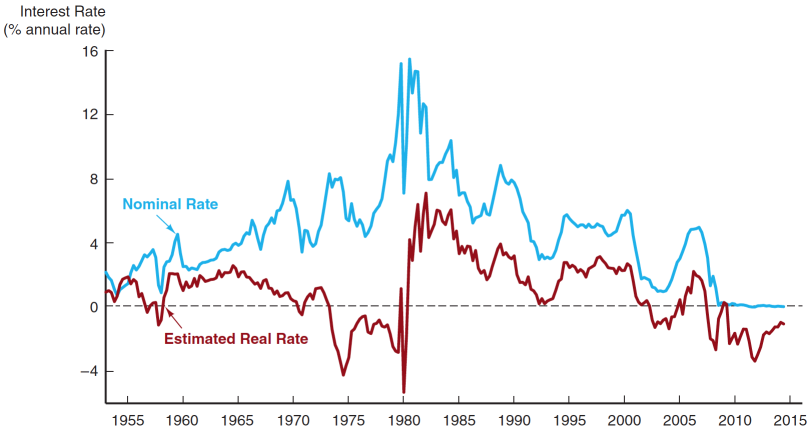
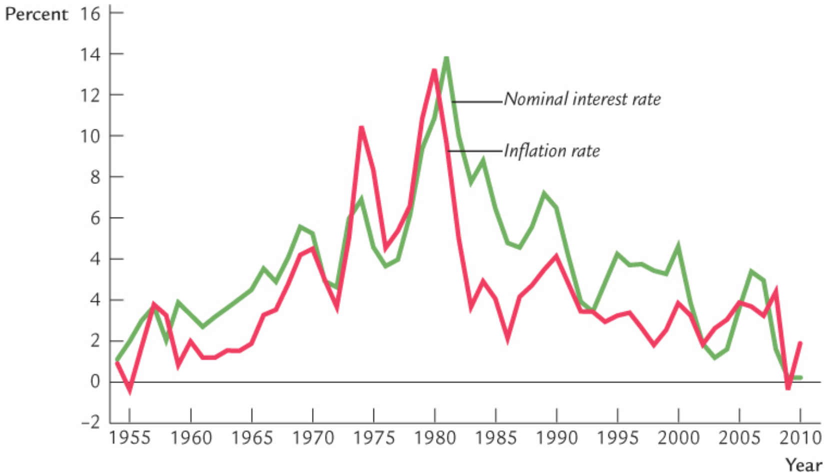
Real interest rate:

- When r is low,
  - more incentive to borrow
  - less incentive to loan
- More informative about loan markets than nominal

Real and Nominal Interest Rates (3-Month T-Bill), 1953–2014

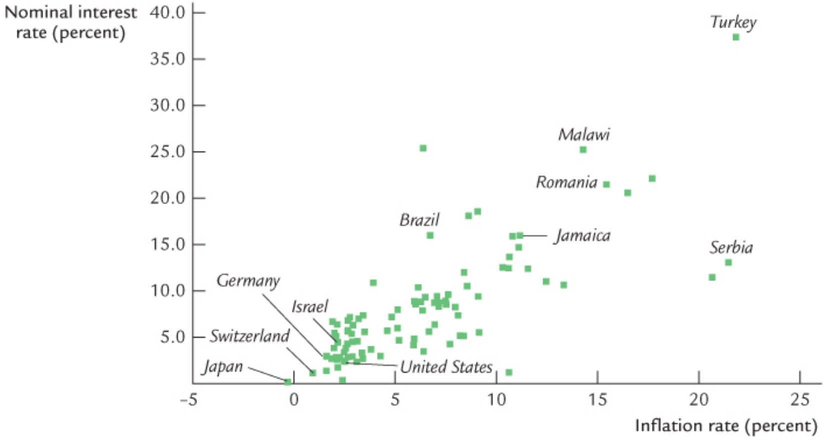


Nominal Interest Rates and inflation



i and π more closely related

National differences in real interest rates



Correlation: .76

Ex ante (before) and ex post (after)

$$i = r + \pi \tag{1}$$

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Investors and lenders know what r they want

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They try to choose i to get that r

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$$i = r + \pi \tag{1}$$

Investors and lenders know what r they want

They try to choose i to get that r

But do you know what π will be this year?

In groups

$$i = r + \pi \tag{2}$$

Suppose

- You and your friend agree that 10% is a reasonable rate of interest on a loan you will give him
- You expect inflation to be 3%

1. What nominal interest rate will you choose?
2. If inflation ends up being 5%, what will be the ex post real interest rate?
3. If inflation ends up being 5%, who loses?

In groups

$$i = r + \pi \quad (2)$$

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If inflation is higher than expected, i is too low

In groups

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If inflation is higher than expected, i is too low

If inflation is lower than expected, i is too high

Whom does inflation help?

Whom does inflation help?

- Borrower pays back less in real terms

Whom does inflation help?

- Borrower pays back less in real terms
- Lender gets paid back less in real terms

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Why do governments like inflation?