HE2002 Macroeconomics II
Lecture 4 Financial Markets II: The Extended IS – LM Model

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1 Lecture Outline

- Nominal versus Real Interest Rates
- Risk and Risk Premia
- The Role of Financial Intermediaries
- Extending the IS - LM Model

2 Today's Lecture

- Look at the distinction between nominal versus real interest rates.
- Introduce the notion of risk and risk premium and examine how it affects the interest rates charges to different borrowers.
- Extend the IS-LM model developed in Lecture 3 to account for more than one interest rate.
- Use the extended model to describe the recent financial crisis and its macroeconomic implications.

3 Some Assumptions in The IS-LM Model

- Until now, we assumed that there were only two financial assets - money and bonds
- We also assumed that there is just one interest rate, i.e. the rate on bonds which is determined by monetary policy.
- For simplicity, we assumed that all interest rates were to move together with the interest rate determined by monetary policy.

4 Financial Markets II: The Extended IS-LM Model

- Before the 2008 crisis, the importance of the financial system was downplayed in macroeconomics.
- All interest rates were often assumed to move with the rate determined by monetary policy
- The crisis remind us this assumption was too simplistic and that the financial system has huge major macroeconomic implications.

$\Longrightarrow$ Extend the model to be more realistic and study how finance plays a role in macroeconomics.

5 Nominal versus Real Interest Rates

- **Nominal interest rate** is the interest rate in terms of dollars.
- **Real interest rate** is the interest rate in terms of a basket of goods.
- To get real interest from the nominal interest, we must take into account the **expected inflation**.

6 One-year Real Interest Rate

- One-year real interest rate r_t:

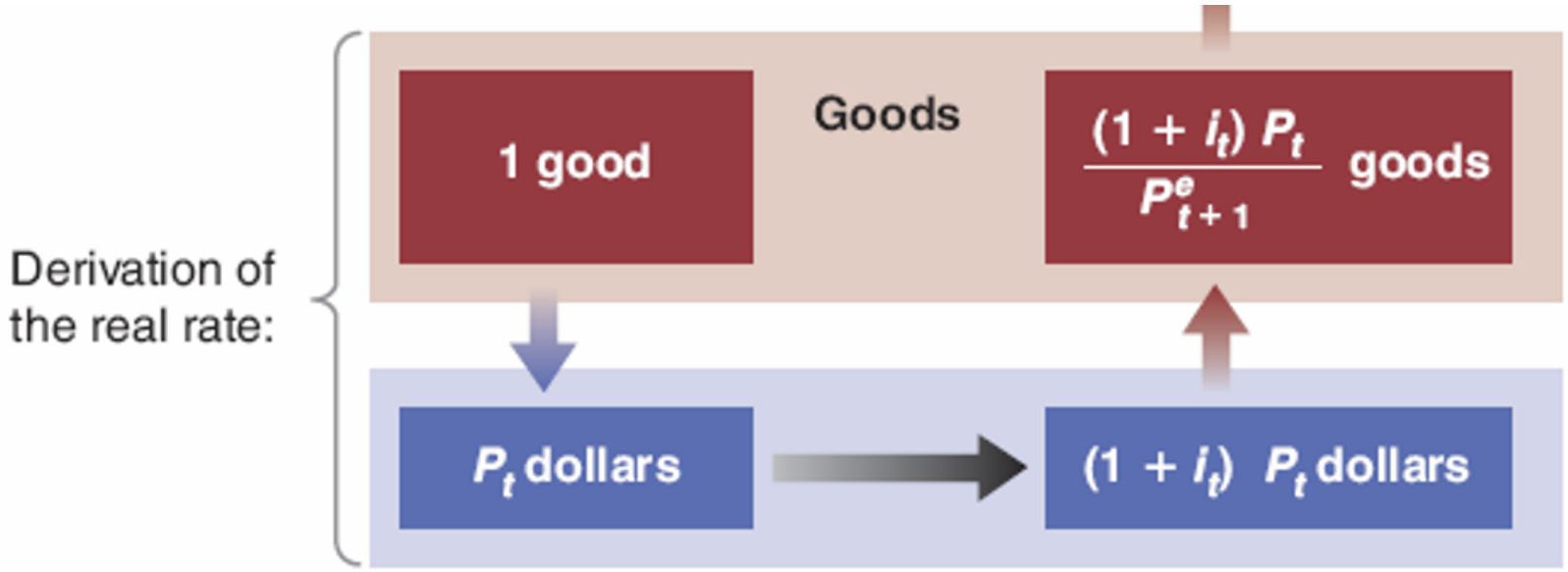
$$1 + r_t = (1 + i_t)\frac{P_t}{P^e_{t+1}} \qquad (4.1)$$

Why this equation holds?

7 Definition and Derivation of the Real Interest Rate I

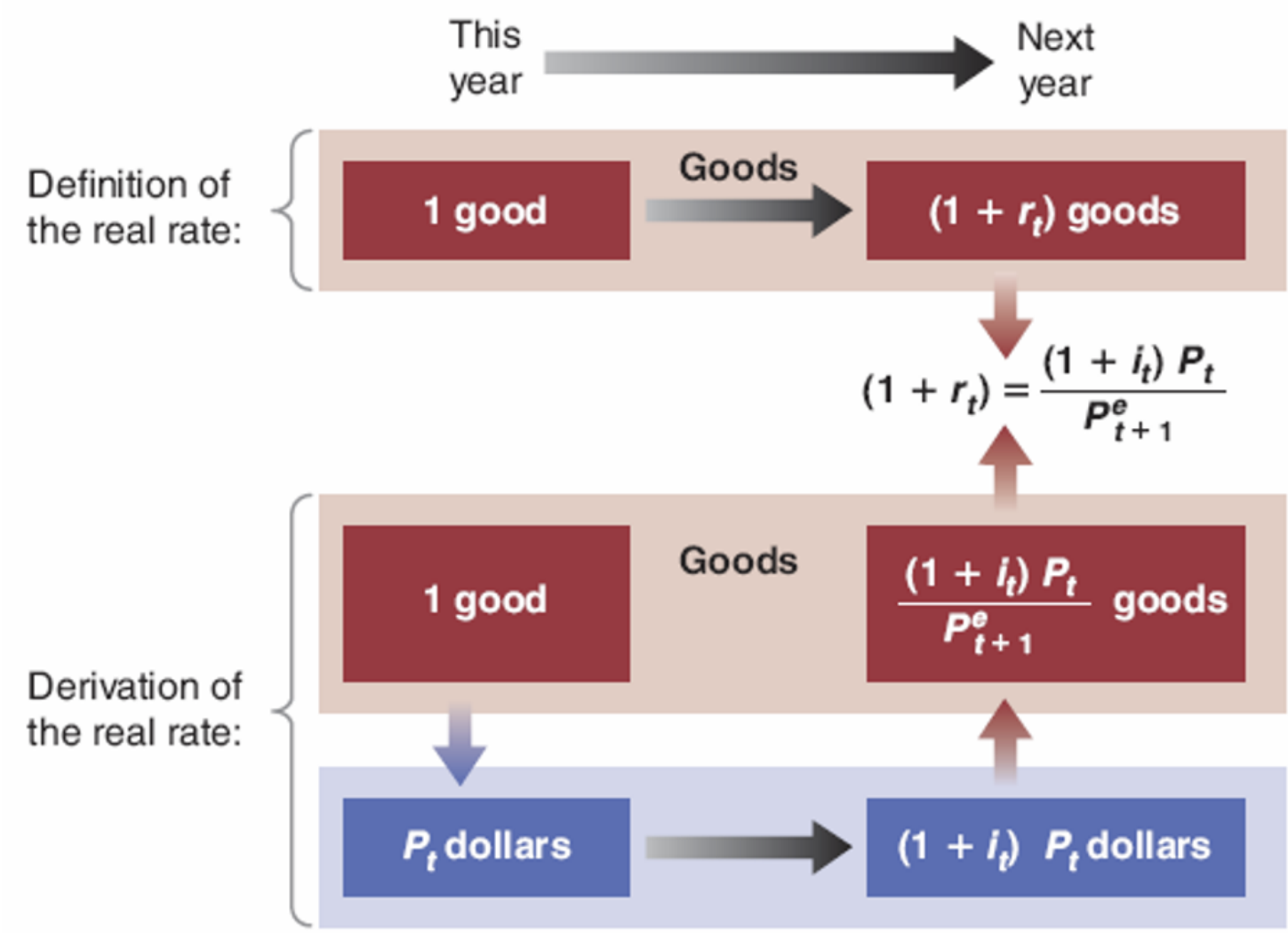
- The real interest rate means 1 unit basket of a goods in current year, can be saved and exchange for $1+r_t$ units basket of goods in the next year.

8 Definition and Derivation of the Real Interest Rate II



- From the perspective of nominal interest rate. Recent price level is P_t, 1 unit basket of good is P_t, if we save P_t dollars, we get $(1+i_t)P_t$ dollars next year. When we think about it today, we don't know the realized price tomorrow, so we can only make an expectation, P^e_{t+1}. Then the money we received can be used to purchased $(1+i_t) * P_t/P^e_{t+1}$

9 Definition and Derivation of the Real Interest Rate III



10 Nominal versus Real Interest Rates

- One-year real interest rate r_t:

$$1 + r_t = (1 + i_t)\frac{P_t}{P^e_{t+1}} \qquad (4.1)$$

- Denote expected inflation between t and $t + 1$ by:

$$\pi^e_{t+1} = \frac{(P^e_{t+1} - P_t)}{P_t} \qquad (4.2)$$

- so that equation (4.1) becomes

$$1 + r_t = \frac{(1 + i_t)}{1 + \pi^e_{t+1}} \qquad (4.3)$$

11 Nominal versus Real Interest Rates: Approximation

- If the nominal interest rate and expected inflation are not too large, a close approximately to equation (4.3) is:

$$r_t \approx i_t - \pi^e_{t+1} \qquad (4.4)$$

- When expected inflation (π^e_{t+1}) equals zero, the nominal interest rate and the real interest rate are equal.

- The real interest rate is typically lower than the nominal interest rate because π^e_{t+1} is typically positive.

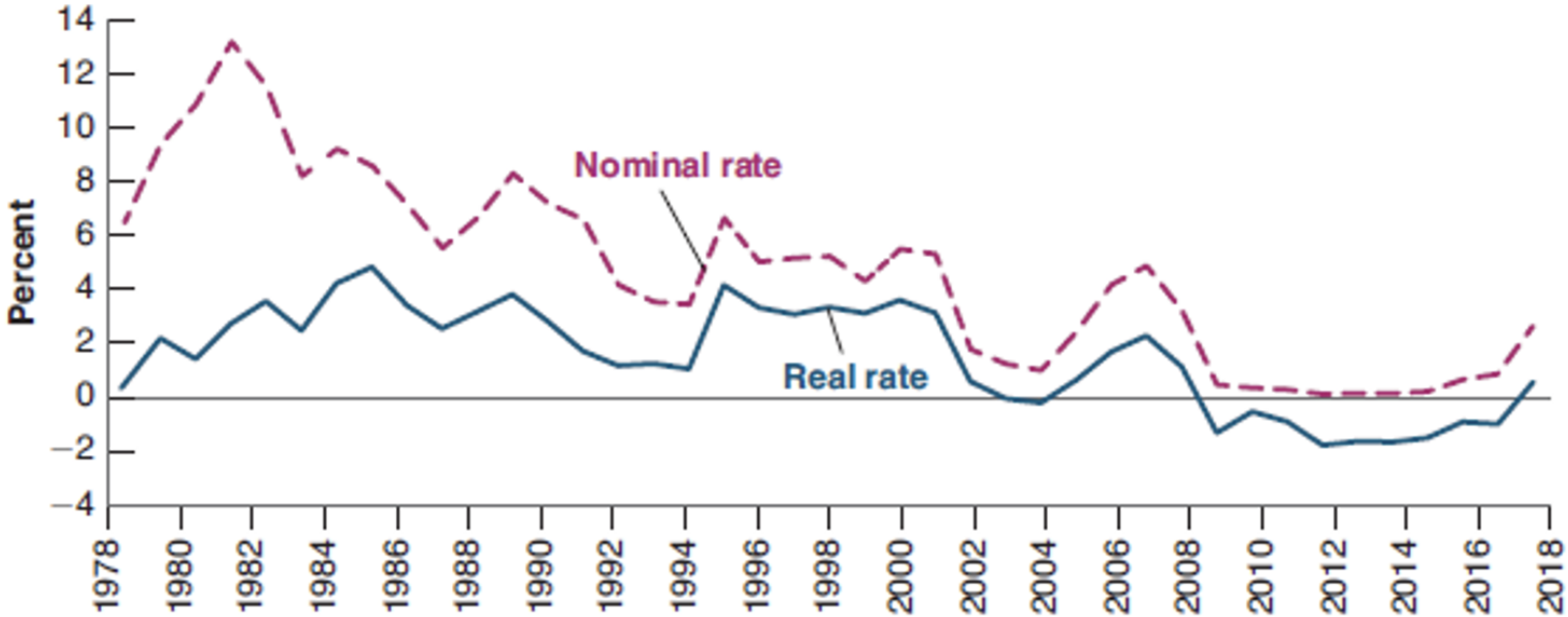
- For a given i_t, the higher expected inflation, the lower the real interest rate.

12 The Real Interest Rate: a Side Note

- The real interest rate $(i - \pi^e)$ is based on expected inflation, so it is sometimes called the ex-ante ("before the fact") real interest rate.

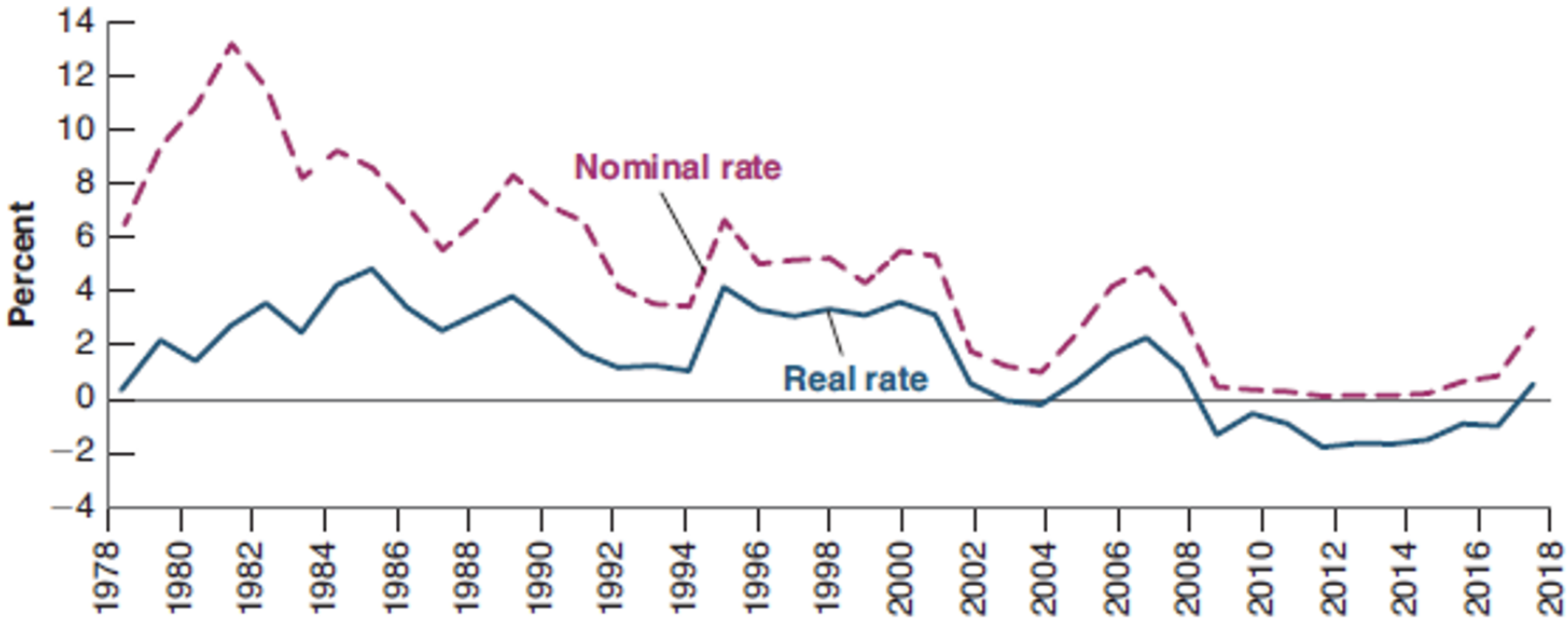
- The realized real interest rate $(i - \pi)$ is called the ex-post ("after the fact") interest rate.

13 Nominal and Real One-Year T-Bill Rates in the US



- The nominal interest rate has declined considerably, but because expected inflation has declined as well, the real rate has declined much less than the nominal rate.

14 Nominal and Real One-Year T-Bill Rates in the US



- This figure shows the importance of adjusting for inflation. Nominal interest rate was much lower in 2006 than it was in 1981 but the real interest rate was actually higher in 2006 (1.7%) than it was in 1981 (1.4%).

15 Which interest rate should enter the IS relation?

- The interest rate that enters the IS relation is the real interest rate.
- The central bank chooses the nominal interest rate.
  - However, it cares about the real interest rate because this is the rate that affects investment decision I, the rate in terms of goods.

16 Which interest rate should enter the IS relation?

- If the central bank wants to set the real interest rate equal to r

  it must choose the nominal interest rate i so that given expected inflation π^e,

  the real interest rate $r = i - \pi^e$ is at the desired level.

17 Numerical Examples I

- For example, if it wants $r = 4\%$, and $\pi^e = 2\%$, it will set $i = 6\%$

18 Numerical Examples II

- In the context of the **liquidity trap**, the **zero lower bound** means that the **nominal interest rate cannot be negative**, otherwise, people would not want to hold bonds.

- This implies that the **real interest rate cannot be lower than the negative of inflation**!

- For example, if $\pi^e = 2\%$, then the lowest real interest rate is $0\% - 2\% = -2\%$.

Note: so long as $\pi^e > 0$, this allows for negative real interest rates.

19 The Lower Bound on r_t if $\pi^e < 0$

- If $\pi^e < 0$, people anticipate deflation, then the lower bound on the real interest rate becomes positive and can be high.

- For example, if $\pi^e = -2\%$, the real interest rate cannot be less than 2%. This may not be low enough to increase the demand for goods by much and the economy may remain in recession.

Sample Question 1 (vevox ID: 142-641-119)

For a given nominal interest rate, a reduction in expected inflation will cause

- A) a reduction in the real interest rate.
- B) an increase in the real interest rate.
- C) an increase in investment.
- D) an increase in money demand.

20 Exploring Risk Premium through a Simple Example

- Some bonds are risky, so bond holders require a **risk premium**.
- Let i be the nominal interest rate on a riskless bond, x be the **risk premium**, and p is the **probability of defaulting**, then to get the same expected return on the risky bonds as on the riskless bond:

$$(1+i) = (1-p) \times (1+i+x) + (p) \times (0)$$

so that the risk premium is

$$x = \frac{(1+i)p}{1-p}$$

21 Determinants of the Risk Premium I

- Since some bonds are risky, bond holders require a risk premium to hold these bonds and to compensate for the risk.

- Risk premium is determined by:
  - The probability of default

    (i) The higher the probability of default, the higher the interest rate investors will ask for.

    (ii) If the interest rate on riskless bonds is 4%, and the probability of default on the risky bond is 2%, then the risk premium required to give the same expected return as on the riskless bond is 2.1%.

22 Determinants of the Risk Premium II

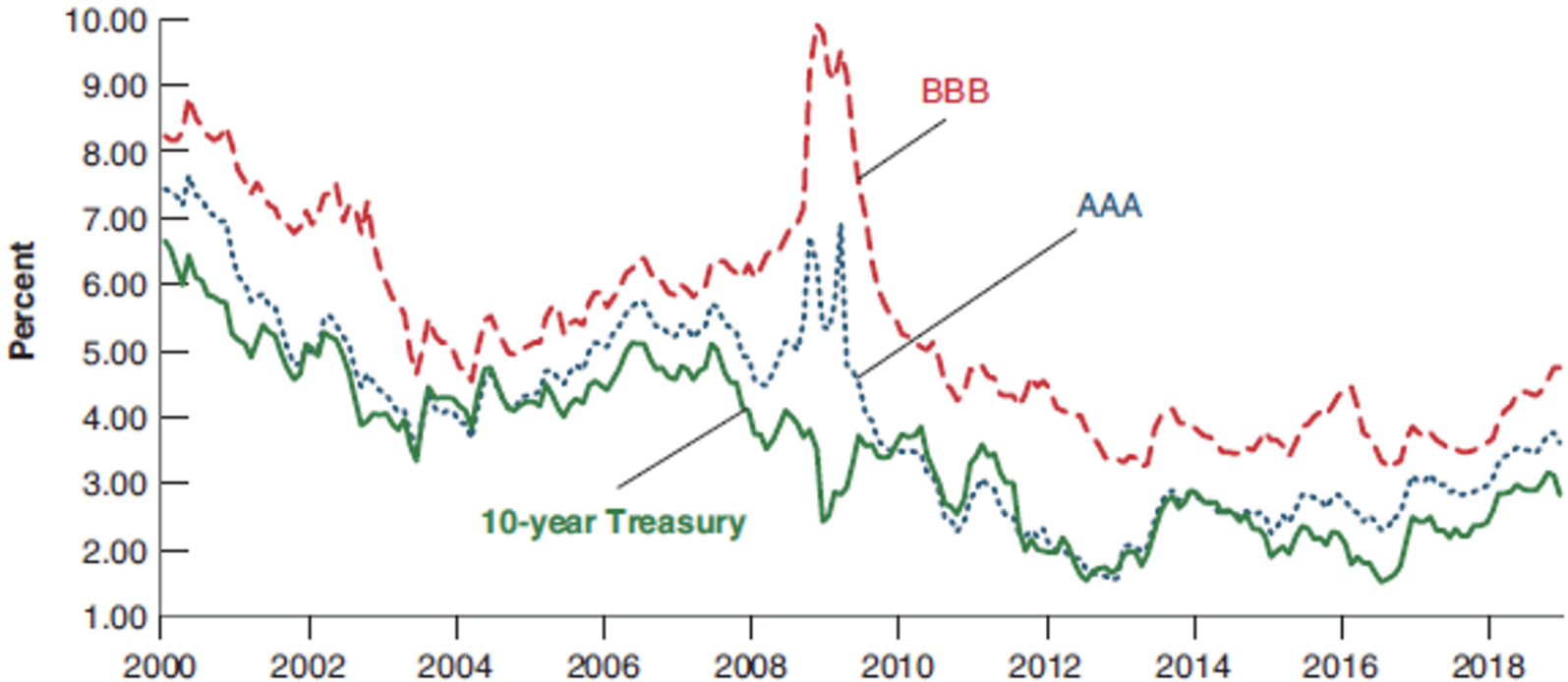
- Since some bonds are risky, bond holders require a risk premium to hold these bonds and to compensate for the risk.

- Risk premium is determined by:
  - The degree of risk aversion of bond holders

    (i) Even if the expected return on the risky bond is the same as on a riskless bond, the risk itself will make them reluctant to hold the risky bond.

    (ii) When bond holders become more risk averse, the risk premium will go up even if the probability of defaults has not changed.

23 Yields on Different Bonds I



Note: US government bonds, which are considered nearly riskless; and corporate bonds rated as safe (AAA) and less safe (BBB) by ratings agencies.

24 Yields on Different Bonds II

- 10-year Treasury has the lowest interest rate, AAA is close to 10-year Treasury.
- But in 2008, interest rate on AAA goes up a lot, saying that during financial crisis, even those firms with high rating and good credit history, used to be thought as safe bonds, also hike in terms of the yield.
  - The investors will only buy those bonds if the yield is high.
- BBB is always much higher than the interest rate AAA corporate bond and the 10-year Treasury yield.
  - The yield goes up much more during the financial crisis.

25 Financial Intermediaries

- Until now, we have looked at **direct finance** – borrowing directly by the ultimate borrowers from the ultimate lenders.
- In fact, much of the borrowing and lending takes place through **financial intermediaries** – financial institutions that receive funds from investors and then lend these funds to others.
- Among these are banks and nonbanks such as mortgage companies, money market funds and hedge funds.
- Note that because it grew in the "shadow" of banks, the nonbank part of the financial system is called shadow banking.

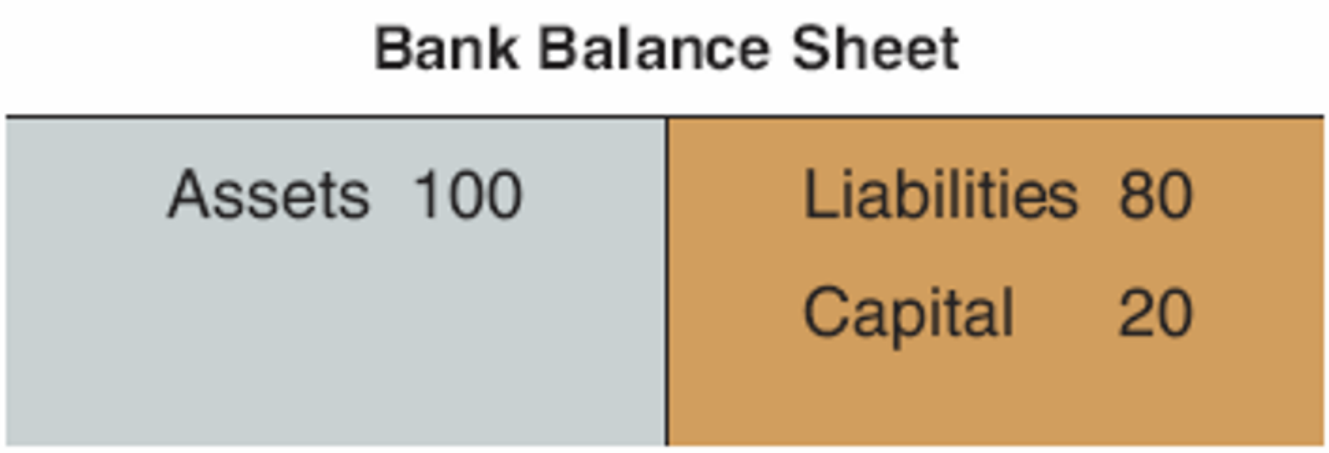
26 A Simplified Bank Balance Sheet I

Bank Balance Sheet

Assets 100	Liabilities 80
	Capital 20

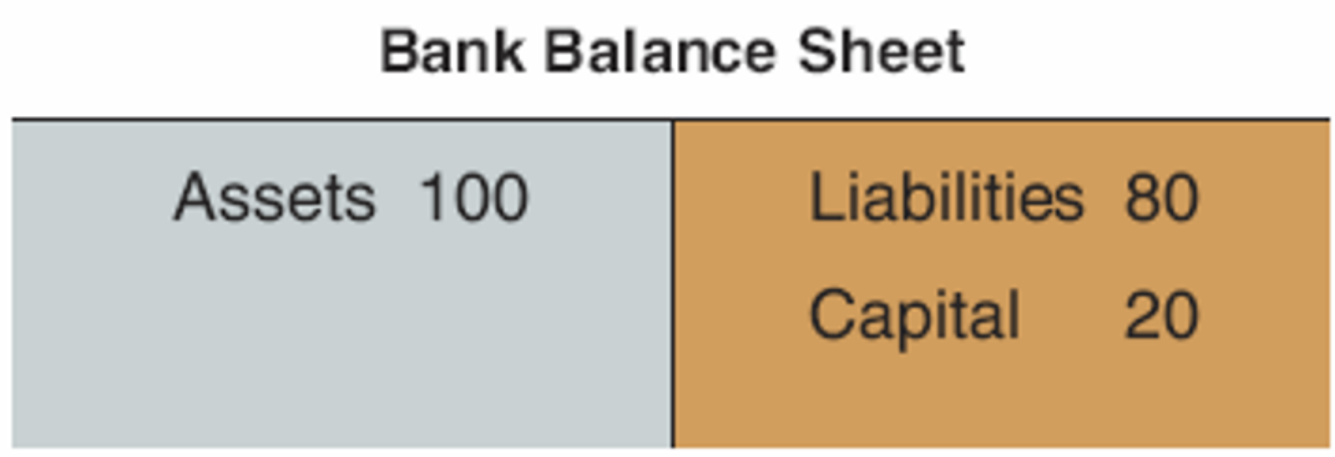
- Consider a bank that has assets of 100, liabilities of 80 and capital of 20. Note that capital of 20 can be seen as the owners of the bank have directly invested 20 of their own funds. The remaining 80 is the borrowing from other investors.

27 A Simplified Bank Balance Sheet II



- Liabilities – checkable deposits, interest-paying deposits or borrowing from investors and other banks.
- Assets – reserves (central bank money), loans to consumers, loans to firms, loans to other banks, mortgages, government bonds or other forms of securities.

28 A Simplified Bank Balance Sheet III



- Capital ratio (the ratio of capital to assets) $= 20/100 = 20\%$
- Leverage ratio (the ratio of assets to capital) $= 100/20 = 5$ (Inverse of capital ratio)

29 What leverage ratio to choose?

- A higher leverage ratio implies a higher expected profit rate, but also implies a higher risk of **insolvency** and **bankruptcy**.

- Two Factors:

  - By increasing its leverage and decreasing its own funds, the bank would increase its expected profit per unit of capital.

  - Why shouldn't bank choose high leverage ratio? Because high leverage also implies a higher risk that the value of assets becomes less than the value of liabilities which in turn implies a higher risk of insolvency.

30 Leverage and Lending I

- Suppose a bank has chosen its preferred leverage ratio and suppose that the value of its assets declines.
- Its leverage ratio increases.
- The bank is still solvent but it is more at risk than it was before.

Fire Sale

Bank Run

2022 Nobel Memorial Prize in Economics

Collapse of Silicon Valley Bank

31 Leverage and Lending II

- What will it want to do?
- It may want to ask investors to provide more funds. Or it may also want to decrease the size of its balance sheet by calling back some loans.
- By calling back loans, its capital ratio can return back to its desired level, but the effect is sharp decrease in bank's lending.

Fire Sale

Bank Run

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Sample Question 2 (vevox ID: 142-641-119)

Which of the following statements are true?

- A) A bank's assets are its sources of funds.
- B) A bank's liabilities are its uses of funds.
- C) A bank's balance sheet shows that total assets equal total liabilities plus equity capital.
- D) A bank's balance sheet indicates whether or not the bank is profitable.

32 Extending the IS – LM Model I

- Rewrite the IS-LM:
  - (1) the nominal interest rate i and the real interest rate r
  - (2) the policy rate set by the central bank and the interest rates faced by borrowers
- Interest rates faced by borrowers depend both on the risk associated with borrowers and on the state of health of financial intermediaries.
- The higher the risks, or the higher the leverage ratio of intermediaries, the higher the interest rate borrowers have to pay.

33 Extending the IS – LM Model II

- Now we extend the IS - LM to reflect the distinction between

$$\text{IS relation: } Y = C(Y - T) + I(Y, i - \pi^e + x) + G$$

$$\text{LM relation: } i = \bar{i}$$

  where expected inflation π^e and the risk premium x enter the IS relation.

- There are two changes to the IS relation: (1) the presence of expected inflation, π^e and (2) the risk premium, x.

34 Extending the IS – LM Model III

- With expected inflation, π^e, it means that spending decisions depend on real interest rate, $r = i - \pi^e$.
- The risk premium captures probability of default and level of risk aversion.
- The rate in the LM equation is the (nominal) policy rate (determined by monetary policy).
- The rate in the IS equation is the (real) borrowing rate.

35 Extending the IS – LM Model IV

- However, the central bank can choose the nominal interest rate in such a way as to achieve the real interest rate it wants.

- The central bank now chooses the real policy rate r, which enters the IS equation as part of the borrowing rate $(r + x)$ for consumers and firms, the IS-LM equations can be rewritten as:

$$\text{IS relation:} \quad Y = C(Y - T) + I(Y, r + x) + G \qquad (4.5)$$

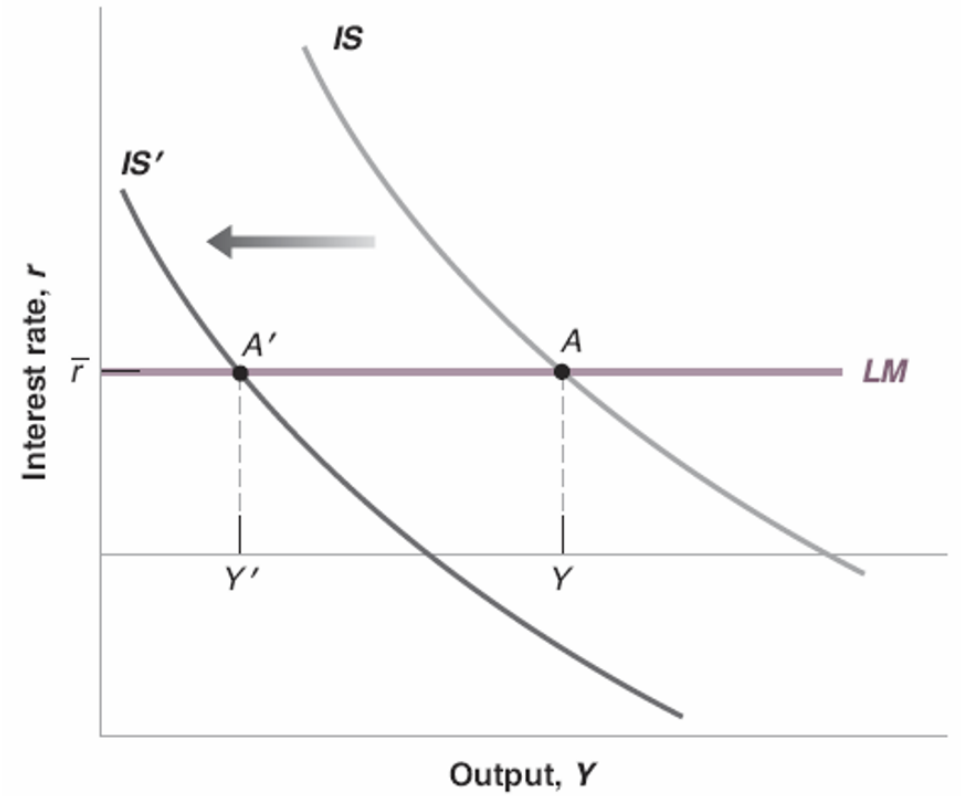
$$\text{LM relation:} \quad r = \bar{r} \qquad (4.6)$$

where expected inflation π^e and the risk premium x enter the IS relation.

36 Financial Shocks and Output

- Suppose that, for some reason, the risk premium x increases.
- At the same policy rate, r, the borrowing rate $r + x$ increases.
- Then, this leads to a decrease in I and hence the IS curve shifts to the left. Equilibrium output decreases.
- $\Longrightarrow$ Problems in the financial system lead to a recession and a financial crisis becomes a macroeconomic crisis.

37 Financial Shocks and Output (Graphical Method)

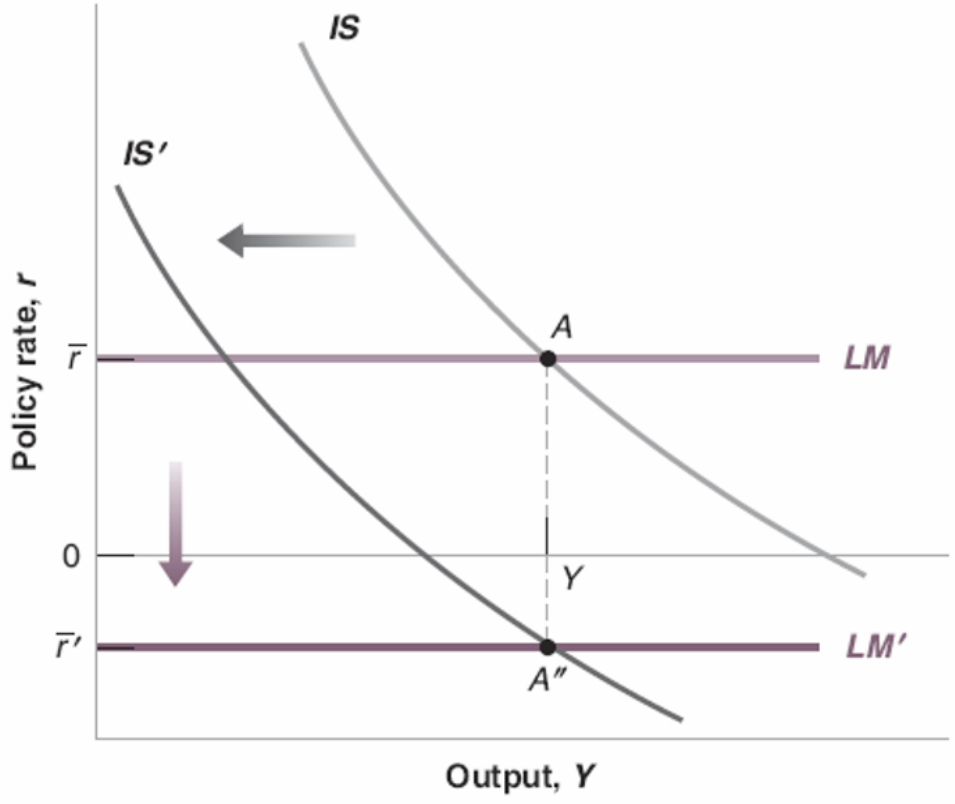


- An increase in x leads to a shift of the IS curve to the left and a decrease in equilibrium output.

38 Financial Shocks and Macroeconomic Policies

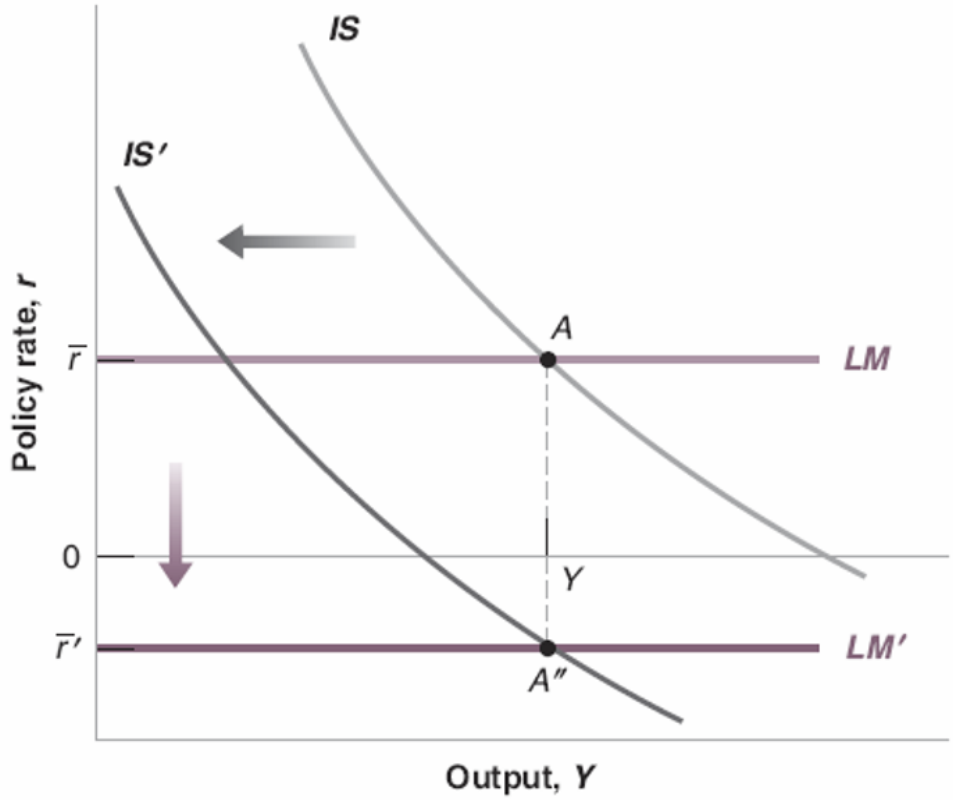
- What can policy do?
- (1) Fiscal policy: An increase in G or a decrease in T. This can shift the IS curve to the right and increase output. But a large increase in G and decrease in T may imply a larger increase in budget deficit $(G - T)$.
- (2) Monetary policy: A sufficient decrease in the policy rate can be enough to bring the economy to point A" keeping output to its initial level. Note that the policy rate necessary to increase demand sufficiently and return output to its previous level may well be negative.

39 Financial Shocks, Monetary Policy, and Output I



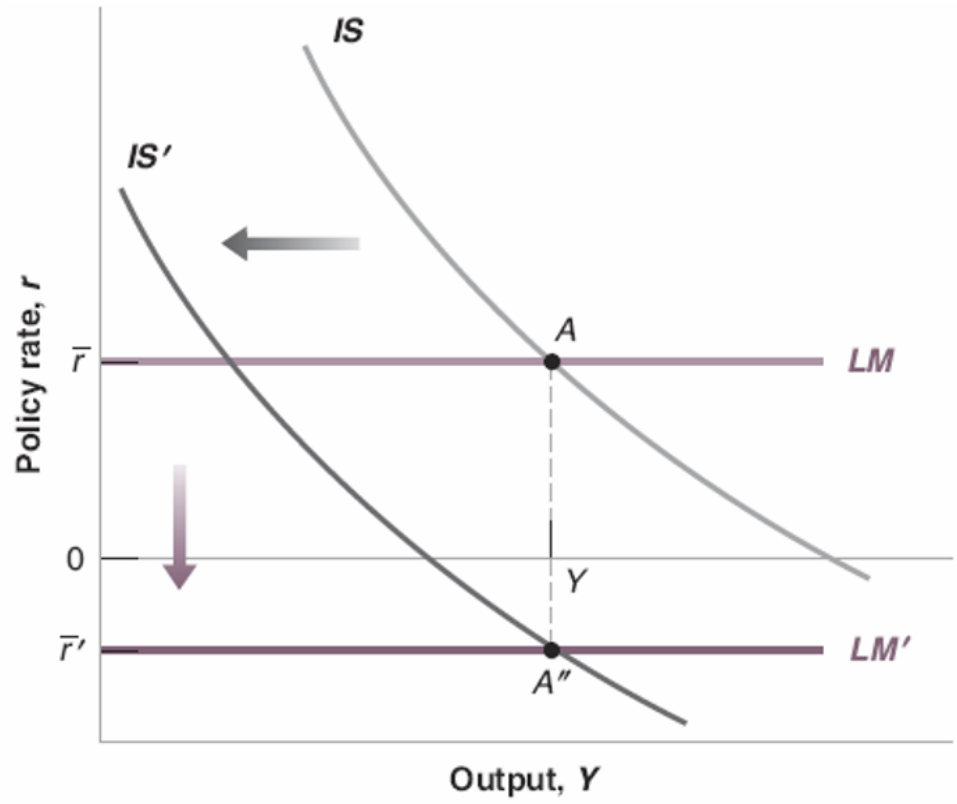
- If sufficiently large, a decrease in the policy rate r can in principle offset the increase in the risk premium x.

40 Financial Shocks, Monetary Policy, and Output II



- Suppose that in the initial equilibrium, $r = 2\%$ and $x = 1\%$.
- Suppose that x increases by 4% to 5%. To maintain the same $r + x$, the central bank must reduce the policy rate from 2% to $2\% - 4\% = -2\%$.

41 Financial Shocks, Monetary Policy, and Output III



- This may lead to the issue of zero lower bound on the nominal interest rate.
- Given the zero lower bound on the nominal interest rate, the lowest real rate the central bank can achieve is given by $r = i - \pi^e = 0 - \pi^e = -\pi^e$.
- The lowest real policy rate the central bank can achieve is the negative inflation. It may not be enough to prevent a recession.

Sample Question 3 (vevox ID: 142-641-119)

In our extended IS-LM model, the borrowing rate is

- A) the rate at which consumers and firms can borrow.
- B) a nominal interest rate.
- C) determined by monetary policy only.
- D) a risk premium.

42 Exit Ticket (vevox ID: 140-793-120)

- One idea you learned today that was surprising or interesting to you.

- Are there topics you wish had been covered in more detail, or questions you feel are unanswered?

- **Any questions?**

You can find me at guangzhi.ye@ntu.edu.sg or by scheduling an in-person meeting through https://calendly.com/guangzhiye24.