14.02 Quiz 2

Real ex rate - price domestic good in foreign currency = $\frac{\text{US good foreign \$}}{\text{foreign good foreign \$}}$

ε

$\varepsilon > 1$ domestic goods more expensive

Nominal E - # of dollars for 1 foreign currency

Appreciation - currency more valuable $E \uparrow$

$\varepsilon = \frac{E P}{P^*}$ | ↑ price domestic in terms foreign

real appreciation - rel domestic $P \uparrow$ rel to foreign

GDP deflator to compare prices

GDP - domestic production

GNP - domestic owned production

$CA = S - I$ ← current acct "above the line"

NX - export > import - foreigners owe us - so like saving abroad

Net return on asset - profits US owned factories - profits foreign owned factories

Net transfers - foreign aid

$CA = (X - IM) + rA^* - rA - aid$

$= \Delta A^* - \Delta A$ ← capital "below the line"

$Z = C + I + G + \frac{IY}{\varepsilon} + X$ (IY: foreign currency)

$IM = IM(Y, \varepsilon)$ (+, +)

$X = X(Y^*, \varepsilon)$ (+, −)

$DD = C + I + G = C(Y_d) + I(Y, r) + G$

Y_d: domestic demand

$AA = DD - \frac{IM}{\varepsilon}$

↑ domestic demand for domestic goods

$ZZ = AA + X$

↑ demand for domestic goods

$Y = Z$ still

- some demand might be foreign
- could have trade deficit/surplus

Marshall-Lerner condition - depreciation leads to $\uparrow NX$

XP $IM \downarrow$ $\frac{1}{\varepsilon} \uparrow$ $\frac{\partial NX}{\partial \varepsilon} < 0$

Depreciation: $NX \uparrow$ $Y \uparrow$ $I \uparrow$ $C \uparrow$ output ↑ factor

$S \neq I$ since can also save w/ $\uparrow NX$

$NX = S + (T - G) + I$

Interest rate parity

$1 + i_t = (1 + i_t^*) \frac{E_t}{E^e_{t+1}}$ ← assume constant

$i \uparrow$ $I \downarrow$ usually - but added more IS dependency

$i_t \approx i_t^* \frac{E^e_{t+1} - E_t}{E_t}$

indirect

$\downarrow NX$ also changes Y, so NX change

- $ZZ \uparrow$ $NX \uparrow$

trade balance improves even more

So can ↓ deficit w/o changing output

- depreciation ↑ output
- Fiscal contraction ↓ output

TI = worse trade surplus

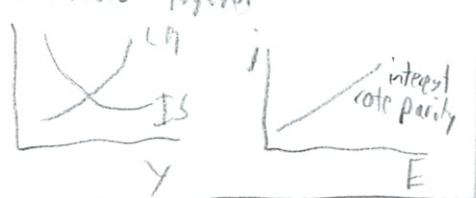
trade surplus = saving > investment

IS has both relations - assume P, P^* constant - no inflation $i = r$

When $i \uparrow$

- $I \downarrow$ like before $\downarrow DD$, $\downarrow$ output
- but also $E \uparrow$ (appreciation) $NX \downarrow$, $DD \downarrow$, $Y \downarrow$

Both effects together



Fiscal Policy $\uparrow G$

$Y \uparrow$, $i \uparrow$, appreciation

domestic bonds more attractive

effect on I still ambiguous

output ↑ meaning more $ to invest

but $i \uparrow$ so less desire to invest

Combine to ↓ NX - so more deficit

Fixed ex rate 4/14

Gov must change M to hold i constant

fiscal policy more powerful

leads to large cramp ↓ / no way to fix

IS-LM in open econ = Mundell Fleming model

Quantative easing

in liquidity trap, buy long term bonds as well

Usual yield curve

Gov must repay $B(1+r)$ next year

Or just Br to keep level

Ricardo equivalence - with some planning horizon households indifferent

- Since save now (earn interest) and plan for gov to pay tomorrow

but if gov planning horizon is longer, Or people can't borrow (liquidity constrained)

$C = C(y_{disp}, Wealth)$

$Wealth = W_{fin} + W_{housing} + PDV(y_{disp})$ ← future income

w/ fixed - if people expect $E \downarrow$, people demand $\uparrow i$ - even more incentive to depreciate

80

14.02 Exam 2

April 13, 2011

Professor: Francesco Giavazzi.

TAs: Joaquin Blaum, Fernando Duarte, Maya Eden, Camilo García, Anna Zabai

Student Name: Michael Plasneier Section: MWF 10A

1 Multiple Choice Questions (5 points each)

1. Under a fixed exchange rate system, monetary policy cannot be used to stimulate aggregate demand because

- a. Under fixed exchange rates, the domestic money market cannot be in equilibrium.
- b. Under fixed exchange rates, uncovered interest parity must hold at all times, which makes monetary policy ineffective.
- c. Under fixed exchange rates, the money supply has to respond to changes in the exchange rate to maintain the nominal interest rate constant.
- d. Under fixed exchange rates, the effect of changes in the nominal interest rate on investment and the trade balance exactly cancel out.
- e. Under fixed exchange rates, demand for domestic goods must be equal to domestic demand for goods, which are unaffected by the LM curve.

2. In an open economy, as income rises domestic demand for goods increases faster than demand for domestic goods because assuming in the domestic economy some foreign

- a. No, domestic demand for goods increases more slowly than demand for domestic goods.
- b. Yes, government spending does not change as income rises.
- c. Yes, part of the increase in domestic demand consists of increased demand for imported goods.
- d. Yes, consumers always prefer to spend their additional income in the purchase of foreign goods.
- e. Yes, as domestic income increases, foreign income must fall, since the world trade balance must be zero.

$E = \frac{eP}{P^*}$

3. The rate of growth of the nominal exchange rate can only differ from the growth rate of the real exchange rate if

- a. There is a flexible exchange rate system.
- b. Inflation in the domestic economy is different from inflation in the foreign economy.
- c. The future expected nominal exchange rate is different from the present exchange rate.
- d. The trade balance is not in equilibrium (equal to zero).
- e. The uncovered interest parity condition does not hold.

4. The fact that in open economies the current account must be equal to net savings implies that

- a. Countries cannot run budget deficits without also running current account deficits.
- b. Depreciations are ineffective in reducing trade deficits because they do not affect savings or investment.
- c. Countries with current account deficits must have positive net investment flows.
- d. The nominal interest rate must be equal to the foreign interest rate.
- e. Countries running systematic trade deficits will grow slower because investment is reduced.

5. A fiscal consolidation leads to a larger contraction of output under a fixed exchange rate than under a flexible exchange rate because

- a. Under fixed exchange rates the money supply has to fall to maintain the domestic nominal interest rate constant.
- b. Under fixed exchange rates the fiscal consolidation leads to a fall in investment income.
- c. Under fixed exchange rates the spending multiplier is smaller.
- d. Under fixed exchange rates the trade surplus is less responsive to changes in domestic spending.
- e. Uncovered interest rate parity does not have to hold under flexible exchange rates.

6. The Government spending multiplier is smaller in an open economy compared to a closed economy

- a. Always.
- b. Never.
- c. Only under flexible exchange rate regimes.
- d. Only under fixed exchange rate regimes.
- e. Only when the increase in government spending is used in the purchase of imported goods.

7. Depreciations intended to reduce the trade deficit will actually increase it when

- a. Investors expect the nominal exchange rate to appreciate in the future.
- b. The quantities of imports and exports respond with a delay to the change in the exchage rate.
- c. The Marshall-Lerner condition is satisfied.
- d. The fall in the nominal interest rate implied by uncovered interest rate parity induces an increase in domestic demand.
- e. Domestic inflation is larger than foreign inflation.

8. Under a fixed exchange rate regime, when investors expect a devaluation to occur (i.e., the price of the domestic currency expressed in units of the foreign currency goes down), the domestic nominal interest rate will

- a. Be higher than the foreign nominal exchange rate because the devaluation will lead to a reduction in the trade deficit.
- b. Be higher than the foreign nominal exchange rate because investors must be compensated for the potential fall in the value of their domestic assets.
- c. Be lower than the foreign nominal exchange rate because the price of bonds must be high to maintain investors' confidence in their domestic assets.
- d. Be lower than the foreign nominal exchange rate because a low interest rate will be a signal that the government is willing to maintain the fixed exchange rate regime.
- e. Remain constant because under fixed exchange rates the government cannot control the money supply.

9. A fiscal expansion can reduce consumption if

- a. The Ricardian Equivalence does not hold.
- b. The increased government spending is used in the purchase of imports only.
- c. The exchange rate is fixed.
- d. Households take into account all of their lifetime resources to decide their current consumption.
- e. The fiscal multiplier in the open economy is too small.

10. Stability in the Debt to GDP ratio can never be achieved if

- a. The interest rate is smaller than the growth rate of the economy, and the government runs a deficit every period.
- b. The interest rate is larger than the growth rate of the economy.

r < g

- c. The interest rate is larger than the growth rate of the economy, and the government runs a balanced budget. – anything
- d. The initial debt to GDP ratio is larger than 1.
- e. The economy is under a fixed exchange rate regime.

2 Short Long Question: Debt (20 points)

does not exist

Assume there is a closed economy which in year 0 has accumulated a real debt of $B_0 = 100$, its real GDP is $Y_0 = 100$, real government spending is $G_0 = 20$, and real taxes are $T_0 = 17$. Assume also that the nominal interest rate is 5%, and inflation is 3%.

↓ G, T T-G ↓ Y

(3 points) a. What is the real Primary Balance to GDP ratio in year 0?

~~Y - (+I + G~~

$$\frac{T-G}{Y} = \frac{17-20}{100} = -\frac{3}{100} = -.03$$

3

$$\text{Real Debt to GDP} = \frac{100(1+.05)}{(1+.03)} + 3 \Big/ 100$$

T, G grow with inflation

(3 points) b. Suppose that the government keeps running a real primary balance ratio equal to the one you found in point a, and that the economy grows at 6% every year. What will the real debt-to-GDP ratio be in year 1?

Wants to keep primary balance ratio to $-\frac{3}{100}$. GDP (denominator) goes up 6% to 106, so T-G must also increase

$$-\frac{3}{100} = \frac{(T-G)}{106} \qquad -318 = 100(T-G)$$

$$(T-G) = -3.18$$

2

So the debt is now 100 + 3 + 3.18. plus interest minus growth

$$\frac{100(1.05)^2}{(1.03)^2} + \frac{3(1.05)}{(1.03)^4} + 3.18 \Big/ 106$$

-to GDP

(3 points) c. Will the real debt ratio be increasing or decreasing over time?

3

decreasing since $g > r$ - even with debt still increasing the real debt-to-GDP ratio decreases over time

(3 points) d. Compute the long-run value of the real debt-to-GDP ratio in this economy.

0

It will go to 0 in the long, long term since the real-debt-ratio is decreasing each time Some time it will be 0

Now Assume this economy is an open economy under a fixed exchange-rate regime, and that the foreign nominal interest rate is $i_0^* = 5\%$, and the nominal interest rate is $E_0 = 1$.

(4 points) e. If suddenly investors believe ~~there~~ (correction exchange) will be a 10% devaluation of the nominal exchange rate because the real debt-to-GDP ratio is too high, will the domestic nominal interest rate fall or increase? By how much and why?

assuming domestic ← TA said ok

$$(1+i) = (1+i^*)\frac{E^e_{t+1}}{E_t}$$

4

If investors think domestic currency will be devalued, then they will require a higher domestic interest rate - so that the real interest rate is the same as the foreign rate - otherwise investors would move their money there.

Domestic interest rate must increase to 16.5%

doing from foreign POV

$$(1+.05) = (1+i)\frac{.9}{1} \rightarrow 1.05 = .9 + .9i$$

$$.15 = .9i \rightarrow i = \frac{.15}{.9} = \frac{.1}{.1} = \frac{.165}{1} \approx 16.5\%$$

(4 points) f. Under this new domestic nominal interest rate, what would be the real debt-to-GDP ratio in year 1? Should investors be even more worried now?

Yes - the real debt-to GDP is now higher with the new interest rate. How much higher?

2

$r > g$ - so debt will spiral out of control. Plus the gov now has even more incentive to devalue further reducing the value of your investment.

3 Long Long Question: Open Economy IS (35 points)

Consider the following open economy:

$$C = c_0 + c_1 Y$$

$$I = c_2 Y$$

$$IM = mYe$$

$$X = \frac{m\tilde{Y}}{e}$$

Do you have to write IM/e or has that been taken care of. Think you do

where C, Y, $\tilde{Y}$, I,IM,X, and e denote aggregate consumption, domestic output, foreign output, investment, imports, exports, and the real exchange rate, respectively. Assume $c_0 > 0$, $0 \leq c_1 \leq 1$, $c_2 > 0$, $0 \leq m \leq 1$, $1 + m > c_1 + c_2 > m$. We will assume throughout the question that the real exchange rate e (the number of foreign goods needed to buy one domestic good) is exogenously given. Denote by G the amount of Government spending.

(3 points) a. Write an expression for net exports (NX) as a function of Y, $\tilde{Y}$, e and m. Does the Marshall-Lerner condition hold in this economy? Why or why not?

$$NX = X - \frac{IM}{e}$$

$$= \frac{m\tilde{Y}}{e} - \frac{mYe}{e} = \frac{m\tilde{Y}}{e} - mY$$

3

Yes because an appreciation would ↑IM and ↓X ↓NX

e increasing

$e' > e$

$\frac{m\tilde{Y}}{e'} - mY$ ↑ causes term to be smaller

& NX falls further decreasing Y causing it to get smaller causing NX to fall more. condition holds

(5 points) b. Write an expression for the equilibrium level of output in the goods market as a function of e, G, $\bar{Y}$ and parameters.

$$Y = C + I + G + NX$$

$$= C_0 + C_1 Y + C_2 Y + G + \frac{m}{e}\hat{Y} - \frac{m}{e}Y$$

$$Y(1 - C_1 - C_2 + m) = C_0 + G + \frac{m}{e}\hat{Y}$$

$$Y = \frac{C_0 + G + \frac{m}{e}\hat{Y}}{1 - C_1 - C_2 + m}$$

5

Suppose there is a drop in consumers' confidence, so that c_0 drops to $c_0' < c_0$. Let $\Delta c_0 = c_0' - c_0 < 0$ be the change in c_0. Let Y_0 and Y_1 denote output before and after the drop in c_0, respectively. Suppose that the Government has decided to bring output back to its original level, Y_0.

straight off practice test

(4 points) c. Can the Government achieve its target with fiscal policy (i.e. changing G)? If so, state the exact amount by which G needs to change (i.e. find ΔG).

Yes, the government must increase G by the same amount as drop in C_0

$$\Delta G = \Delta C_0$$

4

Since both are "in same place" in Formula

$$\frac{\Delta C_0}{1 - C_1 - C_2 + m} = \frac{\Delta G}{1 - C_1 - C_2 + m}$$

$$\Delta C_0 (1 - C_1 - C_2 + m) = \Delta G (1 - C_1 - C_2 + m)$$

$$\Delta C_0 = \Delta G$$

"fixed" real exchange rate = # foreign goods for 1 domestic good

(4 points) d. Assume the government controls e. Can it achieve its target via exchange rate policy (i.e., via a devaluation or a revaluation of the exchange rate)? Compute the new level of the real exchange rate e' that achieves the government's target, and state whether a devaluation or revaluation is required.

Look at the formula $Y = \frac{C_0 + m\bar{Y} + G}{1 - c_1 - c_2 - m}$ It must change e so that y is the same. Since e is in the denominator, it must be decreased (devalued) to offset a drop in C_0 the drop is $\frac{C_0}{1 - c_1 - c_2 - m}$ It must increase by so that e' equals this

$\frac{\Delta C_0'}{1 - c_1 - c_2 - m} = \Delta Y = \frac{m\bar{Y}}{\Delta e'}$

3

See back page ⊗✓

Suppose instead that the Government wants to bring output back to its original level (Y_0), and *at the same* time keep net exports at the level after the drop in c_0 (which we denote by NX_1).

(4 points) e. Show that to achieve this goal the Government needs to use *both* fiscal and exchange rate policy.

Bring output back = expansionary fiscal policy

Speed exports = depreciate currency (devaluation)

NX↑

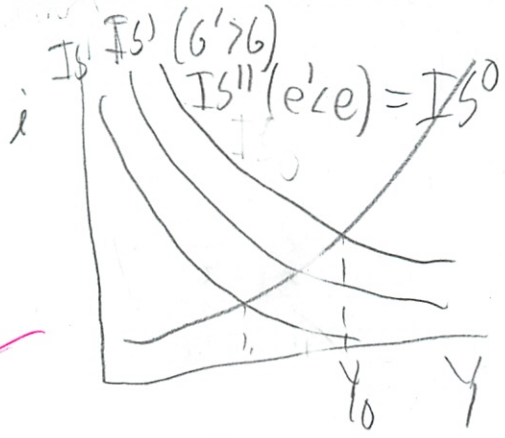
2

how?

↓Darn you just gave away the ans to e

(4 points) f. In particular, show that the Government needs to combine a real devaluation ($e' < e$) with an increase in Government spending ($G' > G$).

Tore sure this is right?



1

?

Rush

Correction From now on, assume foreign country characterized by $\tilde{C} = c_0 + c_1 \tilde{Y}$, $\tilde{I} = c_2 \tilde{Y}$

(4 points) g. Write expressions for imports ($\widetilde{IM}$) and exports ($\tilde{X}$) of the foreign country.

Roughly

currencies off

$\widetilde{IM} = \tilde{X}$

$\tilde{X} = \widetilde{IM}$

$\frac{IM}{e} = \frac{m Y e}{e} = \tilde{X} = \frac{\tilde{m} \tilde{Y}}{\tilde{e}}$

$\tilde{e} = \frac{1}{e}$

$m Y = \frac{\tilde{m} \tilde{Y}}{\tilde{e}}$

$X = \frac{m \tilde{Y}}{e} = \frac{\widetilde{Im}}{\tilde{e}} = \frac{\tilde{m} \tilde{Y} \tilde{e}^2}{\tilde{e}}$?

$\rightarrow e m Y = \tilde{m} \tilde{Y}$

$\tilde{e} m = \tilde{m}$

2

$= \frac{m \tilde{Y}}{e} = \tilde{m} \tilde{Y}$

$\downarrow$

$m \tilde{Y} = \tilde{m} \tilde{Y} e$

$m = \tilde{m} e$

So $e = \frac{m}{\tilde{m}}$

Is $m, \hat{m}$ same thing? Looks like it
- but can't be
What is m anyway?

(4 points) h. Find home country output (Y) and foreign output ($\tilde{Y}$) as a function of parameters (c_0, c_1, c_2, m) and exogenous variables ($G, \tilde{G}, e$).

$$Y = \frac{c_0 + G + \hat{m}\frac{\tilde{Y}}{e}}{1 - c_1 - c_2 + m} \qquad Y = c_0 + G + m\left(\frac{c_0 + \tilde{G} + \hat{m}\frac{Y}{e}}{1 - c_1 - c_2 + \hat{m}}\right)$$

$$\tilde{Y} = \frac{c_0 + \tilde{G} + \tilde{m}\frac{Y}{\tilde{e}}}{1 - c_1 - c_2 + \hat{m}} \qquad \tilde{Y} = c_0 + \tilde{G} + m\left(\frac{c_0 + G + \hat{m}\frac{\tilde{Y}}{e}}{1 - c_1 - c_2 + m}\right)$$

2

Solve!

(3 points) i. Can a real devaluation from the point of view of the home country, (ie a decrease in e) make both countries better off?

2

Intuitively, No. - citizens in the other country would lose money ~~that they had~~ loaned to home country. Also a depreciation will ↑ exports at home, ↑ imports abroad - hurting the "other country" economy.

wrong reason

3d

$$\Delta C_0 (1 - c_1 - c_2 - m) = \frac{m\hat{Y}}{\Delta e} (1 - c_1 - c_2 - m)$$

divide both sides by $1 - c_1 - c_2 - m$

$$\Delta C_0 = \frac{m\hat{Y}}{\Delta e}$$

Solve in terms of Δe ?

$$\Delta e \, \Delta C_0 = m\hat{Y}$$

$$\Delta e = \frac{m\hat{Y}}{\Delta C_0}$$

A lot of figure out as you go

Solutions

14.02 Exam 2

April 21, 2011

Professor: Francesco Giavazzi.

TAs: Joaquin Blaum, Fernando Duarte, Maya Eden, Camilo García, Anna Zabai

Student Name:_____Section:_____

1 Multiple Choice Questions (5 points each)

1. Under a fixed exchange rate system, monetary policy cannot be used to stimulate aggregate demand because

- a. Under fixed exchange rates, the domestic money market cannot be in equilibrium.
- b. Under fixed exchange rates, uncovered interest parity must hold at all times, which makes monetary policy ineffective.
- C. Under fixed exchange rates, the money supply has to respond to changes in the exchange rate to maintain the nominal interest rate constant.
- d. Under fixed exchange rates, the effect of changes in the nominal interest rate on investment and the trade balance exactly cancel out.
- e. Under fixed exchange rates, demand for domestic goods must be equal to domestic demand for goods, which are unaffected by the LM curve.

2. In an open economy, as income rises domestic demand for goods increases faster than demand for domestic goods because

- a. No, domestic demand for goods increases more slowly than demand for domestic goods.
- b. Government spending does not change as income rises.
- C. Part of the increase in domestic demand consists of increased demand for imported goods.
- d. Consumers always prefer to spend their additional income in the purchase of foreign goods.
- e. As domestic income increases, foreign income must fall, since the world trade balance must be zero.

3. The rate of growth of the nominal exchange rate can only differ from the growth rate of the real exchange rate if

- a. There is a flexible exchange rate system.
- B. Inflation in the domestic economy is different from inflation in the foreign economy.
- c. The future expected nominal exchange rate is different from the present exchange rate.
- d. The trade balance is not in equilibrium (equal to zero).
- e. The uncovered interest parity condition does not hold.

4. The fact that in open economies the current account must be equal to net savings implies that

- a. Countries cannot run budget deficits without also running current account deficits.
- b. Depreciations are ineffective in reducing trade deficits because they do not affect savings or investment.
- C. Countries with current account deficits must have positive net investment flows.
- d. The nominal interest rate must be equal to the foreign interest rate.
- e. Countries running systematic trade deficits will grow slower because investment is reduced.

5. A fiscal consolidation leads to a larger contraction of output under a fixed exchange rate than under a flexible exchange rate because

- A. Under fixed exchange rates the money supply has to fall to maintain the domestic nominal interest rate constant.
- b. Under fixed exchange rates the fiscal consolidation leads to a fall in investment income.
- c. Under fixed exchange rates the spending multiplier is smaller.
- d. Under fixed exchange rates the trade surplus is less responsive to changes in domestic spending.
- e. Uncovered interest rate parity does not have to hold under flexible exchange rates.

6. The Government spending multiplier is smaller in an open economy compared to a closed economy

- A. Always.
- b. Never.
- c. Only under flexible exchange rate regimes.
- d. Only under fixed exchange rate regimes.
- e. Only when the increase in government spending is used in the purchase of imported goods.

7. Depreciations intended to reduce the trade deficit will actually increase it when

- a. Investors expect the nominal exchange rate to appreciate in the future.
- B. The quantities of imports and exports respond with a delay to the change in the exchage rate.
- c. The Marshall-Lerner condition is satisfied.
- d. The fall in the nominal interest rate implied by uncovered interest rate parity induces an increase in domestic demand.
- e. Domestic inflation is larger than foreign inflation.

8. Under a fixed exchange rate regime, when investors expect a devaluation to occur (i.e., the price of the domestic currency expressed in units of the foreign currency goes down), the domestic nominal interest rate will

- a. Be higher than the foreign nominal exchange rate because the devaluation will lead to a reduction in the trade deficit.
- B. Be higher than the foreign nominal exchange rate because investors must be compensated for the potential fall in the value of their domestic assets.
- c. Be lower than the foreign nominal exchange rate because the price of bonds must be high to maintain investors' confidence in their domestic assets.
- d. Be lower than the foreign nominal exchange rate because a low interest rate will be a signal that the government is willing to maintain the fixed exchange rate regime.
- e. Remain constant because under fixed exchange rates the government cannot control the money supply.

9. A fiscal expansion can reduce consumption if

- a. The Ricardian Equivalence does not hold.
- b. The increased government spending is used in the purchase of imports only.
- c. The exchange rate is fixed.
- D. Households take into account all of their lifetime resources to decide their current consumption.
- e. The fiscal multiplier in the open economy is too small.

10. Stability in the Debt to GDP ratio can never be achieved if

- a. The interest rate is smaller than the growth rate of the economy, and the government runs a deficit every period.
- b. The interest rate is larger than the growth rate of the economy.

- C. The interest rate is larger than the growth rate of the economy, and the government runs a balanced budget.
- d. The initial debt to GDP ratio is larger than 1.
- e. The economy is under a fixed exchange rate regime.

2 Short Long Question: Debt (20 points)

Assume there is a closed economy which in year 0 has accumulated a real debt of $B_0 = 100$, its real GDP is $Y_0 = 100$, real government spending is $G_0 = 20$, and real taxes are $T_0 = 17$. Assume also that the nominal interest rate is 5%, and inflation is 3%.

(3 points) a. What is the real Primary Balance to GDP ratio in year 0?

A/ Primary Balance $= \frac{G_0 - T_0}{Y_0} = \frac{20-17}{100} = 0.03 = 3\%$

(3 points) b. Suppose that the government keeps running a real primary balance ratio equal to the one you found in point a, and that the economy grows at 6% every year. What will the real debt-to-GDP ratio be in year 1?

A/ $\frac{B_1}{Y_1} = (1 + r - g)\frac{B_0}{Y_0} + \frac{G_0 - T_0}{Y_0} = (1 + 0.05 - 0.03 - 0.06)\frac{100}{100} + 0.03 = 0.99.$

(3 points) c. Will the real debt ratio be increasing or decreasing over time?

A/ Decreasing.

(3 points) d. Compute the long-run value of the real debt-to-GDP ratio in this economy.

A/ $\left(\frac{B}{Y}\right)^* = (1 + r - g)\left(\frac{B}{Y}\right)^* + \frac{G_0 - T_0}{Y_0}$

$\Rightarrow \left(\frac{B}{Y}\right)^* = \frac{\frac{G_0 - T_0}{Y_0}}{g - r} = \frac{0.03}{0.04} = 0.75 = 75\%.$

Now Assume this economy is an open economy under a fixed exchange-rate regime, and that the foreign nominal interest rate is $i_0^* = 5\%$, and the nominal interest rate is $E_0 = 1$.

(4 points) e. If suddenly investors believe there will be a 10% devaluation of the nominal exchange rate because the real debt-to-GDP ratio is too high, will the domestic nominal interest rate fall or increase? By how much and why?

A/ By uncovered interes rate parity, the domestic nominal interest rate increases: $(1 + i_0) = (1 + i_0^*)\left(\frac{E_0}{E_1^e}\right)$.

The expected nominal exchange rate is $E_1 = (1 - 0.1)E_0 = 0.9E_0$.

$\Rightarrow (1 + i^0) = (1 + 0.05)\left(\frac{1}{0.9}\right) = 1.16$

$\Rightarrow i^0 = 0.16 = 16\%.$

The domestic nominal interest rate must increase so that investors are still indifferent between holding domestic and foreign assets.

(4 points) f. Under this new domestic nominal interest rate, what would be the real debt-to-GDP ratio in year 1? Should investors be even more worried now?

A/ $\frac{B_1}{Y_1} = (1 + r - g)\frac{B_0}{Y_0} + \frac{G_0 - T_0}{Y_0} = (1 + 0.16 - 0.03 - 0.06)\frac{100}{100} + 0.03 = 1.1.$

Real debt-to-GDP increases by 10%. Now the real debt-to-GDP ratio will be increasing over time, so investors will be even more worried!

3 Long Long Question: Open Economy IS (35 points)

Consider the following open economy:

$$C = c_0 + c_1 Y$$

$$I = c_2 Y$$

$$IM = mYe$$

$$X = \frac{m\tilde{Y}}{e}$$

where C, Y, $\tilde{Y}$, I,IM,X, and e denote aggregate consumption, domestic output, foreign output, investment, imports, exports, and the real exchange rate, respectively. Assume $c_0 > 0$, $0 \leq c_1 \leq 1$, $c_2 > 0$, $0 \leq m \leq 1$, $1 + m > c_1 + c_2 > m$. We will assume throughout the question that the real exchange rate e (the number of foreign goods needed to buy one domestic good) is exogenously given. Denote by G the amount of Government spending.

(3 points) a. Write an expression for net exports (NX) as a function of Y, $\tilde{Y}$, e and m. Does the Marshall-Lerner condition hold in this economy? Why or why not?

A/

$$NX\left(Y, \tilde{Y}, e\right) = \frac{m\tilde{Y}}{e} - mY$$

Marshall-Lerner condition holds because NX is decreasing in e.

(5 points) b. Write an expression for the equilibrium level of output in the goods market as a function of e, G, $\tilde{Y}$ and parameters.

A/

$$Y = c_0 + c_1 Y + c_2 Y + G + m\tilde{Y}/e - mY$$

$$Y = \frac{1}{1 - c_1 - c_2 + m}\left[c_0 + G + m\tilde{Y}/e\right]$$

Suppose there is a drop in consumers' confidence, so that c_0 drops to $c_0' < c_0$. Let $\Delta c_0 = c_0' - c_0 < 0$ be the change in c_0. Let Y_0 and Y_1 denote output before and after the drop in c_0, respectively. Suppose that the Government has decided to bring output back to its original level, Y_0.

(4 points) c. Can the Government achieve its target with fiscal policy (i.e. changing G)? If so, state the exact amount by which G needs to change (i.e. find ΔG).

A/ Yes, G needs to be increased by $\Delta G = -\Delta c_0 > 0$.

(4 points) d. Assume the government controls e. Can it achieve its target via exchange rate policy (i.e., via a devaluation or a revaluation of the exchange rate)? Compute the new level of the real exchange rate e' that achieves the government's target, and state whether a devaluation or revaluation is required.

A/ Yes, via a real devaluation the Government can increase output. The new level of the real exchange rate

$e' < e$ is characterized by

$$\frac{1}{1-c_1-c_2+m}\left[c_0' + G + \frac{x\tilde{Y}}{e'}\right] = Y_0 \tag{1}$$

Suppose instead that the Government wants to bring output back to its original level (Y_0), and *at the same* time keep net exports at the level after the drop in c_0 (which we denote by NX_1).

(4 points) e. Show that to achieve this goal the Government needs to use *both* fiscal and exchange rate policy.

A/ Mathematically G' and e' should satisfy

$$\frac{1}{1-c_1-c_2+m}\left[c_0' + G' + \frac{m\tilde{Y}}{e'}\right] = Y_0 \tag{2}$$

$$\frac{m\tilde{Y}}{e'} - mY_0 = NX_1 \tag{3}$$

The second equation implies that the exchange rate must change. But why do we also require fiscal policy? Because, in the absence of fiscal policy, the exchange rate that brings output back to Y_0 was characterized by eq. (1), which need not coincide with the exchange rate prescribed by eq. (2).

(4 points) f. In particular, show that the Government needs to combine a real devaluation ($e' < e$) with an increase in Government spending ($G' > G$)

A/ Since $NX_1 > NX_0$, equation (3) directly implies that $e' < e$, in other words, a real devaluation is required. To see that $G' > G$, note that eq. (3) can be written as

$$\frac{m\tilde{Y}}{e'} = \frac{m\tilde{Y}}{e} + m\left(Y_0 - Y_1\right)$$

which into eq. (2) implies

$$\frac{1}{1-c_1-c_2+m}\left[c_0' + G' + \frac{m\tilde{Y}}{e} + m\left(Y_0 - Y_1\right)\right] = Y_0$$

Using the original expression for output before the drop in c_0, (equation 1), we have

$$\begin{aligned} G' - G &= c_0 - c_0' - m\left(Y_0 - Y_1\right) \\ &= c_0 - c_0' - m\left(Y_0 - Y_1\right) \end{aligned}$$

Noting that

$$Y_0 - Y_1 = \frac{1}{1-c_1-c_2+m}\left[c_0 - c_0'\right]$$

we get

$$G' - G = \frac{1-c_1-c_2}{1-c_1-c_2+m}$$

From now on, assume that the foreign country is characterized by

$$\tilde{C} = c_0 + c_1\tilde{Y}$$

$$\tilde{I} = c_2 \tilde{Y}$$

where $\tilde{C}, \tilde{I}$ denote aggregate consumption, domestic output, foreign output, investment, imports, exports, and the real exchange rate, respectively.

(4 points) g. Write expressions for imports ($\widetilde{IM}$) and exports ($\tilde{X}$) of the foreign country.

A/ Since world trade must be balanced: $\widetilde{IM} = X = m\tilde{Y}/e$, and $\tilde{X} = IM = mYe$.

(4 points) h. Find home country output (Y) and foreign output ($\tilde{Y}$) as a function of parameters (c_0, c_1, c_2, m) and exogenous variables ($G, \tilde{G}, e$).

A. First find foreign output as a function of home's output:

$$\tilde{Y} = \frac{1}{1 - c_1 - c_2 + m} \left[c_0 + \tilde{G} + mYe \right] \tag{4}$$

Then plug this back into the expression found in part 2, to get

$$Y = \frac{1}{1 - c_1 - c_2 + m - \frac{m^2}{1 - c_1 - c_2 + m}} \left\{ c_0 + G + \frac{m/e}{1 - c_1 - c_2 + m} \left(c_0 + \tilde{G} \right) \right\} \tag{5}$$

(3 points) i. Can a real devaluation from the point of view of the home country, (ie a decrease in e) make both countries better off?

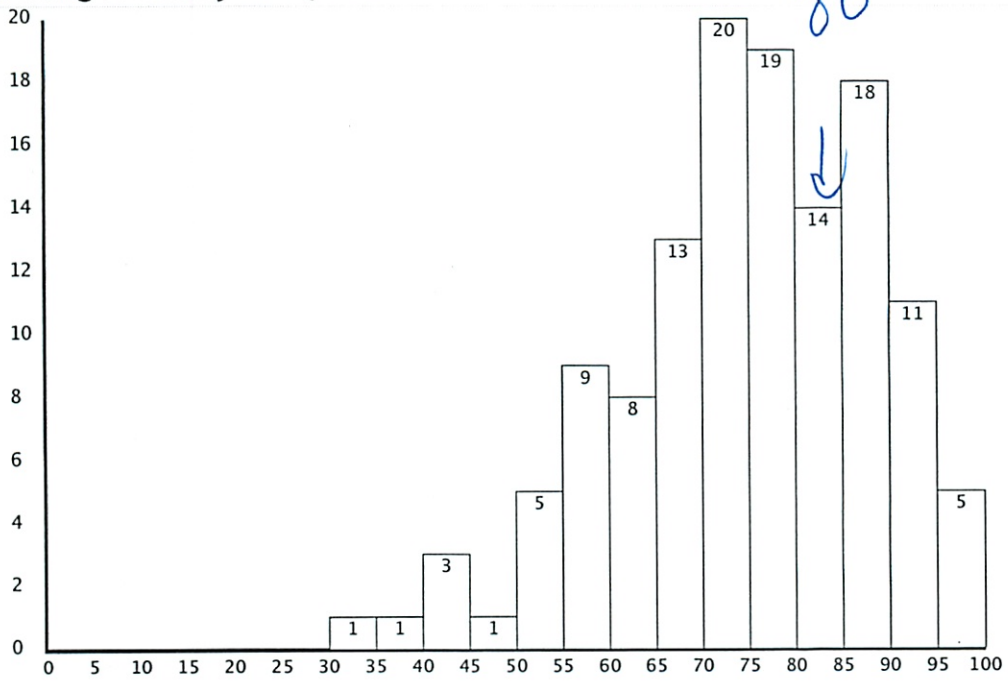
A/ No, a real devaluation leads to an increase in Y and a decrease in $\tilde{Y}$.

14.02 Principles of Macroeconomics

Dashboard | Students | Assignments

Grading Summary for Quiz 2

80



Number of Scores:	128
Average:	74.20
Standard Deviation:	13.49

Chap 13 Tech, Progress, Wages, Unemp

4/16
Car

long run tech progress is key
- Some people think tech makes you unemployed
- but nations w/ high have some of lowest unemp.

$Y = F(k, AN)$ in last chap
- A ↑ state of tech = output per worker

We will skip over k in this chap. So $Y = AN$
- N ↑ labor

$N = \frac{Y}{A}$
- employment ↑ = $\frac{\text{output}}{\text{productivity}}$

So when A ↑ does Y ↑ to keep N constant??

Look at short-run AS-AD model
- for a given A

If A ↑ - it depends how AS / AD shifts

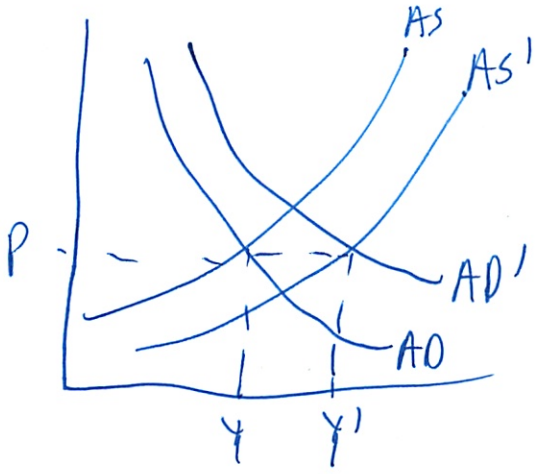
But productivity ↑ are not in a vacuum
- could ↑ demand at a given P AD →
- since consumers more optimistic about the future
- or need to buy tech to put in place AD ←

But sometimes from using foreign tech more efficiently
- like foreign competition forcing downsizing

(2)

So first case

AS↓ AD→



= economic boom

% Δ employment = % Δ output − % Δ productivity

?output must ↑ along w/ productivity

Empirical

- largely the other way:
  output growth leads to productivity growth
- Okun's law
  - bad time: firms hoard labor
  - good times: employees work hard again

But what about exogenous tech change?

- just as ambiguous as theory
- Sometimes output ↑ enough to avoid ~~#~~N↓ when A↑

13.2 Productivity & Natural Rate Unemp

So far SR

In MR econ goes back to natural rate

- but is natural rate affected by productivity?

Price Setting

each worker A units output

- one extra unit output = $1/A$ worker

and if nominal wage $= W$

- price is $\frac{1}{A} \cdot W = \frac{W}{A}$

and firms have μ markup

PS $\quad P = (1+\mu)\frac{W}{A}$

Wage setting

Wages are typically set to reflect productivity

$$W = A^e P^e F(u, z)$$

- A^e: expected productivity
- P^e: price level since workers care about real wages
- u: unemp rate
- z: other factors

(4)

Natural Rate of Unemployment

from PS, WS relations

expectations must be correct.

$p^e = p$

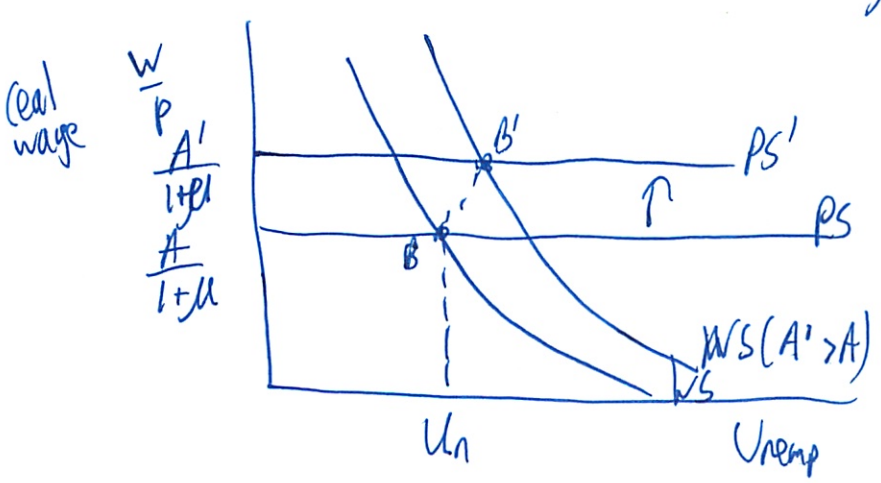
$A^e = A$

So $\frac{w}{p} = \frac{A}{1+\mu}$ price setting

↑ increases 1 for 1 w/ productivity

$\frac{w}{p} = A\,F(u, z)$ wage setting

Suppose A ↑ 3%



Wage from PS ↑ 3%

Wage from WS also ↑ 3%

Un same!

3% ↑ A is 3% reduction (correct) in price leading to 3% ↑ in real wages

Steady growth = same thing

(5) Empirical Evidence Un not affected by productivity / productivity growth

- hard to see natural rate unemp
- so look at relation productivity growth + unemp over decades
  - average out labor hording
- is a slight relation if leave out great depression
- but generally tech progress ↓ Unemp
- and periods w/ strong prod. growth have ↓ unemp

Takes a long time for lower productivity to show up in the estimates

- workers still ask for unjustified wage ↑

13.3 Distributive Effects

Workers fear structural change - their specific skills will no longer be needed.

Creative distruction / churning

- some new jobs created
- others no longer needed

large increase in wage inequality by edu level

- Since 1980s
- ~~ask~~ demand in 1960s + 70s as well for skilled workers
  - but demand was matched by large supply as well then

(6)

- US outsources low-skilled jobs to foreigners
- but mostly new jobs require more skills
  - more flexible as well
- future might be different
  - trend in rel. demand may slow down
    - less skills req for PC
    - or high skilled job replaced by PC
  - tech progress not exogenous
    - firms decide how much to invest in R+D
    - can decide to just use low-wage workers
  - higher return on skills might make more people go to college

---

Why Europe so high u_{nemp}

1. ↑ U_n?
   - remember inflation π based on $U_t - U_n$
     - if $\pi > 0$ then $U_t < U_n$
2. Initial factors?
   - oil price shock
   - less tech progress
3. Hysteresis?
   - U_n actually depends on U_t
   - "equilibrium depends on history"
   - some people are now unemployable since
   - since out of job for so long

(7)

- or large unemp led gov to offer lots of benefits
  - more cushhy
- but does not seem to be the case

4. Eurosclerosis
   - Euro labor institutions not well adapted to new tech
   - low skill jobs can't cut wages
   - is less wage inequality

14 Expectations: Basic Tools

4/16
Car

Can I afford a new car?
more equipment?

Many decisions have to do w/ expectations - not current situation

Nominal vs Real Interest rates

Inflation factors into asset prices

When we lend - want to know how many goods we will have in future - not just how many $ dollars.

nominal - in terms of dollars i_t

real in terms of goods r_t

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

(think I got on the exam)

1 good $\rightarrow$ $\frac{(1+i_t)P_t}{P^e_{t+1}}$ goods

P_t dollars $\longrightarrow (1+i_t)P_t$ dollars

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

(2)

So $\frac{P_t}{P^e_{t+1}} = \frac{1}{1+\pi^e_{t+1}}$

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

So if nominal i and π^e are $\lesssim 20\%$, approximation

$r_t \approx i_t - \pi^e_{t+1}$

So when $i_t = r_t \rightarrow \pi^e_{t+1} = 0$

But usually $\pi^e_{t+1} > 0$ so $r_t < i_t$

14.2 Expected Present Discount Value

- need to discount future income/costs back to todays costs
- must expect interest and inflation

(did this in other classes already)

$\$ V_t = \$ Z_t + \frac{1}{(1+i_t)} \$ Z_{t+1} + \frac{1}{(1+i_t)(1+i_{t+1})} \$ Z_{t+2}$

- V_t: present value (discounted)
- Z_t: today's payment
- Z_{t+2}: payment in 2 years

(3)

Usually assume constant interest rates

$$\$V_t = \$Z_t + \frac{1}{(1+i)}\$Z^e_{t+1} + \frac{1}{(1+i)^2}\$Z^e_{t+2} + \dots$$

Weighted sum of current + expected future payments

Weights ↓ geometrically over time

Constant interest and payments

Can simplify formula further

$$\$V_t = \$Z \frac{1 - \frac{1}{(1+i)^n}}{1 - \frac{1}{(1+i)}}$$

Constant interest and payments forever

$$\$V_t = \frac{\$Z}{i}$$

Nominal vs real

Just put in real interest rates

$$V_t = Z_t + \frac{1}{(1+r_t)}Z^e_{t+1} + \frac{1}{(1+r_t)(1+r^e_{t+1})}Z^e_{t+2} + \dots$$

remember $r = i - \pi^e$

(4)

$$\frac{\$V_t}{P_t} = V_t$$

So can calculate in 2 ways
- PV of seq in $ then divide by Price level
  - easier to do bond calc.

Or using real interest rates - previous pg

14.3 IS-LM and i, r

i affects Investment (IS)

Money vs Bonds (LM)

So is it i or r?

IS Firms care about r not i

$$Y = C(Y-T) + I(Y, r) + G$$

LM care about nominal rate i

- since bonds pay i vs money which pays 0

$$i - 0 = i$$

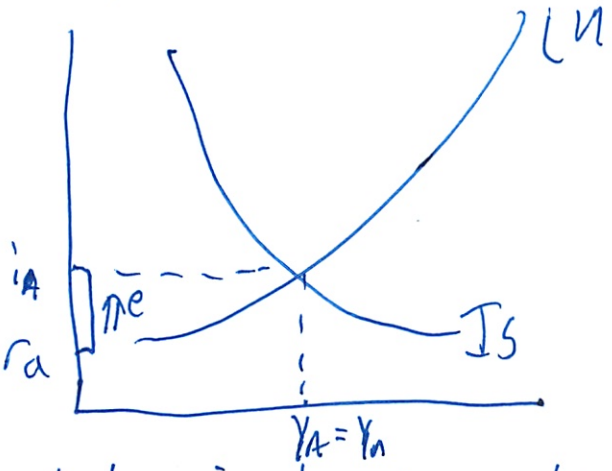
So $$\frac{M}{P} = Y\, L(i)$$

this is the one that affects monetary policy

⑤ Money growth

Higher money growth leads to both ↑ and ↓ in i

- ↓ i SR
- ↑ i MR
- ↓ r SR
- no effect r MR



IS ↓ in i also ↓ r in IS for given π^e

- i and r move together

LM Given money stock, Y↑ leads to ↑ demand for money

So i ↑

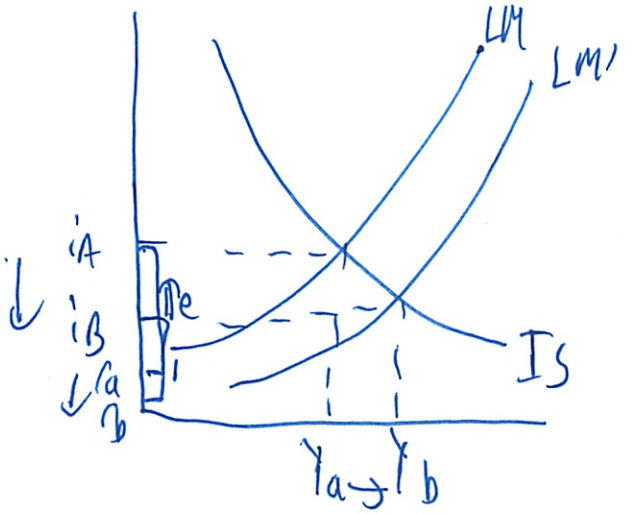
So $r_A = i_A - \pi^e$

Short Run

- so central gov ↑ rate of growth of $
- the growth in $ is not matched by ↑ in P
- So real money stock $\frac{M}{P}$ ↑

(6)

- So $LM \downarrow$
- For given Y - the $\uparrow$ in M means $i \downarrow$
- If people don't Δ their π^e immediately - IS same
- So econ moves down IS curve from A to B



So can $\uparrow$ output in SR w/ $\downarrow i$

Medium Run

- natural level of output, unemployment

$$Y = C(Y-T) + I(Y, r) + G$$

- Given G, T, what r needed to sustain Y?

$$Y_n = C(Y_n - T) + I(Y_n, r) + G$$

- So there is a r_n
  - indep of real M growth

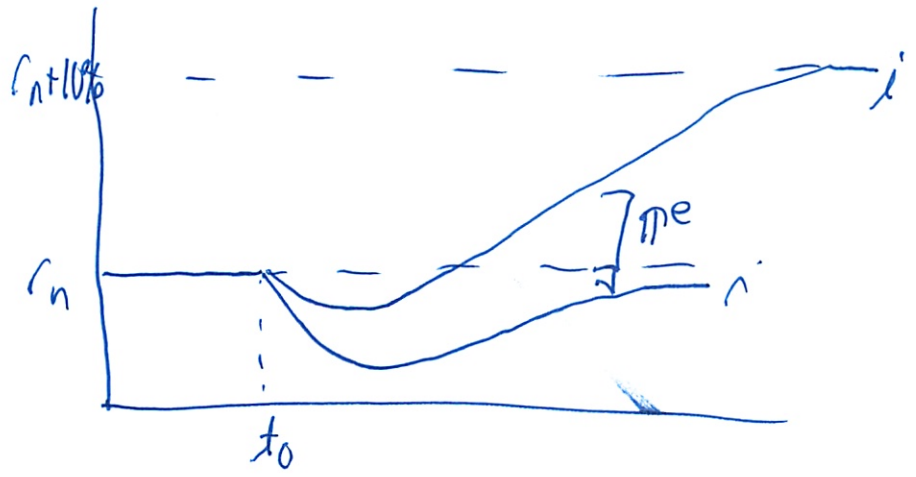
(7)

So π = Money growth − Output Growth

Money growth
- does not affect r
- affects π, i 1 for 1

Called the Fisher effect

SR to MR
- in SR r, i ↓
- but low i → ↑ Y → so ↑ π so $\frac{M}{P}$ ↓ so i ↑



Empirical
- Lots of evidence SR
- LR: hard to see
  - look across countries
  - or across many years
    - takes a long time

15 Fin Markets + Expectations

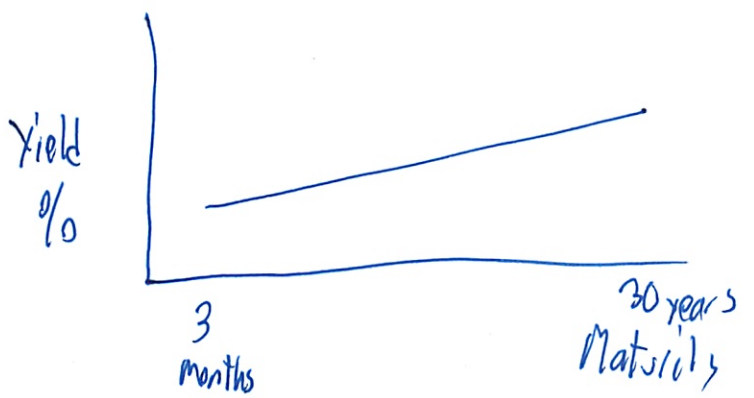
4/19
Car

There is more than just 1 type of bond
- Short or long term

2 differentiators on bonds
- default risk
- maturity time

Yield to maturity = yield = associated interest rate

- yield curve = term structure of interest rates



To find
1. Get bond prices for each maturity
2. Get bond yields from bond prices

Bond prices are PV

(did all this stuff before in other classes)

No arbitrage can be possible - or someone will grab

Find YTM - kinda like avg i rate

(2)

$i^e_{t+1} = 2i_{2t} - i_{1t}$

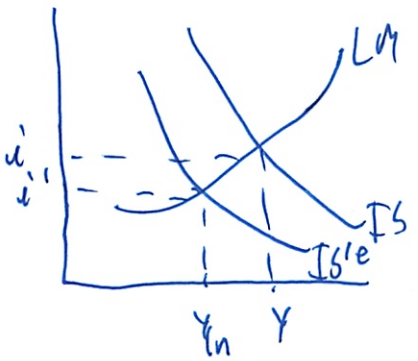
↑ expected next year rate

When yield curve upward sloping

- $i_{long} > i_{short}$
- Market expects ~~SR rates~~ i_{short} ↑

Economic Activity

- economic ~~activity~~ downturn = ↓ i_{short}
- but if rates are expected to recover i_{long} does not change
- like in 2001 when $Y > Y_n$
  - So ~~soft~~ soft landing expected
  - with small ↓ in i



- But slowdown was much steeper than expected
  - So monetary expansion so i ↓ faster
- Long-term rates still high as people thought econ would recover

(3)

- Can tell when fin. markets think things will improve

15.2 - Stock Prices

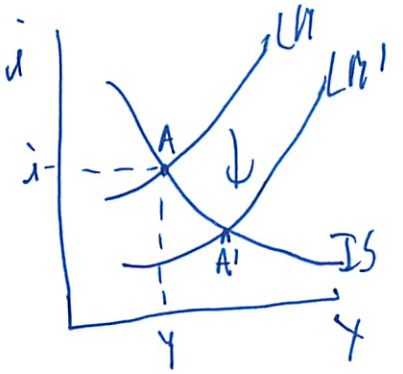
- Companies can raise $ 2 ways
  - equity financing - stocks = shares
    - pay dividends
  - debt financing - bonds + loans

Stock price is value of expected cash flows, discounted to PV
(also did in 15.401)

- So ↑ i means stock prices ↓
- movements unpredictable
  - or else everyone would jump on board

Monetary Expansion

- if people fully anticipate - nothing will happen
- if unexpected ↑ stock prices
  - ↓ i and ↑ dividends (current + expected)



(4)

↑ Consumer Spending

- incomplete
- ignore effect on i, r
- movement along LM ↑Y, ↑i
- ↑ i means ↓ stock prices

Which one?

Depends on shape of LM curve

- ignores Fed's behavior
  - will Fed accommodate IS shift?
    - ↑M along w/ MO↑ to keep i steady?
    - will cause LM ↓
  - Or will Fed worry ↑Y > Y_A leads to ↑
    - if Y_a close to Y_n
    - So LM may monetary Contract

15.3 Bubbles, Fads, Stock Prices

- prices don't always move according to fundamental value
- prices can ↑ if investors expect them to
- and many investors are not rational
- belive in fads
- go down too = bubbles burst

16: Expectations: Consumption + Investment

4/19
Car

How do expectations affect consumption and investment?

16.1 Consumption

- C does not just depend on current income
- but also expectations
- permanent income theory of consumption
- life cycle theory of consumption

Very Foresighted Consumer

- financial wealth = value stocks + bonds
- housing wealth = value of house
- human wealth = expected future income

So $C_t = C$ (total wealth)

(Fraction of)

(did this in 14.02 class - but skipped over fairly quickly)

Like a college student deciding if to go to college

But

1. Expenses/consumption not even over life
2. Most people don't actually think this way
3. Real life can vary from expectations
4. Bank may not be willing to loan

(2)

So current income is also a factor

$$C_t = (\text{Total wealth}_t, Y_{LI} - T_t)$$
(+) (+)

So expectations ~~of~~ of both human + non human wealth matter

But Consumption not likly to move 1 for 1 w/ current income
- esp if person thinks change is temp

Consumer confidence can also change w/o income changing
- national mood
- set by president or news

16.2 Investment

- Chap 5: i and Y
- Chap 14: r not i
- but basically look at expectations
- expected future sales vs cost of capital

Depreciation

δ = amt of usefulness machine loses from 1 year to another

PV Expected Profits

Π = profits

(3) Year 1

$$\frac{1}{1+r_t}\,\Pi^e_{t+1} = PV_t$$

Year 2

$$\underbrace{\frac{1}{(1+r_t)(1+r^e_{t+1})}}_{\text{discount to year 0}}\ \underbrace{(1-\delta)}_{\text{Depreciation}}\ \underbrace{\Pi^e_{t+2}}_{\substack{\text{expected}\\ \text{total}\\ \text{profit}\\ \text{till now}}} = PV_t$$

$$V(\Pi^e_t) = \frac{1}{1+r_t}\Pi^e_{t+1} + \frac{1}{(1+r_t)(1+r^e_{t+1})}(1-\delta)\Pi^e_{t+2} + \cdots$$

↑ PV Expected Profits

So $V \geq$ cost of capital $= I_t$

$$I_t = I\big(V(\pi^e_t)\big)$$

(+)

Special Case

Suppose future Π = future i

Called static expectations

$$V(\Pi^e_t) = \frac{\Pi_t}{r_t+\delta}$$

(4)

So $I_t = I\left(\frac{\Pi_t}{r_t + \delta}\right)$

$r_t + \delta$ = user cost = rental cost of capital

- shadow cost
- equal to cost of renting it out
- since could also rent at instead

Current vs Expected Π

- expected future profits move strongly w/ current profits
- cash flow matters too empirically
- more reluctant to borrow than it would use its own $
- or banks don't lend to it

$$I_t = I\left(\underset{(+)}{V(\Pi_t^e)}, \underset{(+)}{\Pi_t}\right)$$

Profit + Sales

What affects profit per unit of capital?

1. Level of sales
2. Existing capital stock

$$\Pi_t = \Pi\left(\underset{(+)}{\frac{Y_t}{K_t}}\right)$$

(5)

Π ↓ in recessions, ↑ in expansions

So companies expect ↑ Π in economic expansion

16.3 Volitality

- if ↑ or ↓ is temp of perm matters a lot
  - well what people expect it to be
- Consumers will only ↑ C up to 1 for 1 in income
- biz have no such expectation for I

- So biz $ I much more volitale
  - but is less as % of econ

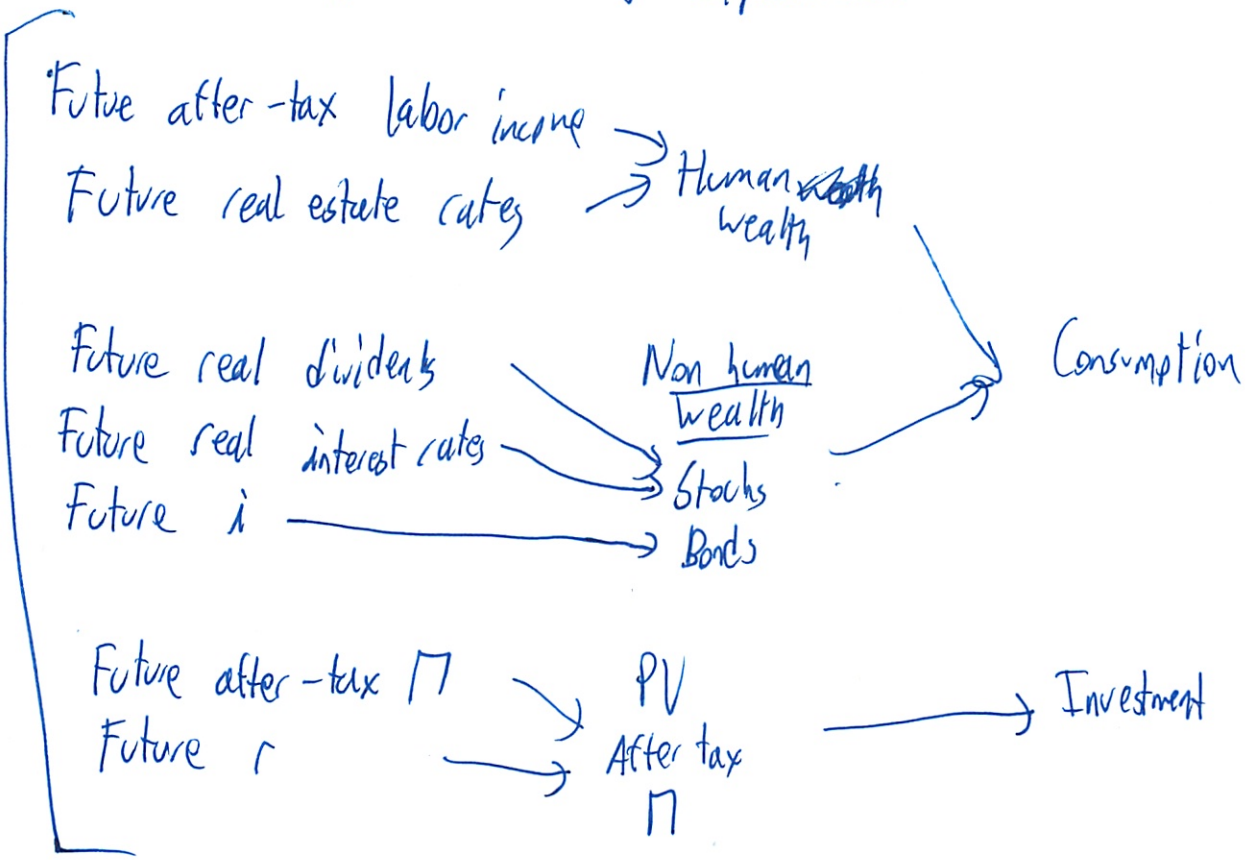
17: Expectations: Output + Policy

4/19
Car

Put the pieces together in this chap

17.1 Taking Stock

lots of things can change expectations



$$Y = ((Y-T) + I(Y,r) + G$$

$$A(Y,T,r) = ((Y-T) + I(Y,r)$$

↑ aggregate private spending

$$Y = A(Y,T,r) + G$$

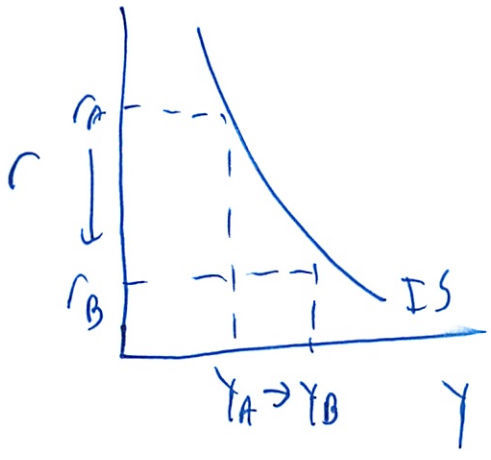
$$\oplus\ \ominus\ \ominus$$

$$Y = A(Y, T, r, Y^{1e}, T^{1e}, r^{1e}) + G$$

$$\oplus\ \ominus\ \ominus \qquad \oplus \qquad \ominus \qquad \ominus$$

(2)

New IS curve



Given expectations, ↓ r

- much steeper
- large ↓ in i only has a small effect on Y
- Since
  - ↓ in current while i long unchanged does not affect spending that much
  - multiplier likely to be small,
    - change in current income w/o much change in long term income

∴ ↑ Y^e will shift IS → as people expect more future income

LM revisited

$$\frac{M}{P} = YL(i)$$

$M^s = M^d$

M^d only depends on current income and current nominal i

(3)

17.2 Monetary Policy : Expectations + Output

in Chap 5 only 1 i in both IS and LM

but there are many is

- and distinction nominal vs real
- distinction current vs expected future rates

Some economists say long-term rate matters for spending + output

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

So

$$r^{1e} = i^{1e} - \pi^{1e}$$

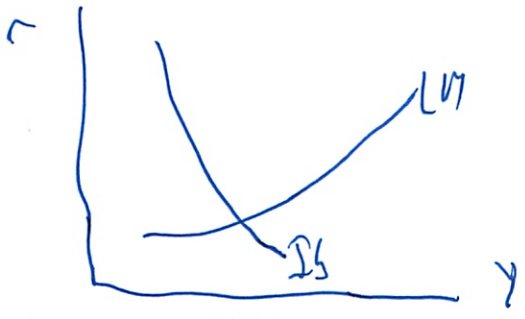
So effect on i depends on 2 factors

- if π M leads Fin markets to revise i^{1e}
- if π M " " " " π^e and π^{1e}

So

IS $Y = A(Y, T, r, Y^{1e}, T^{1e}, r^{1e}) + G$

LM $\frac{M}{P} = Y L(i)$



(4)

Monetary Policy Revisted ↑M

(B) assume expectations don't change ←

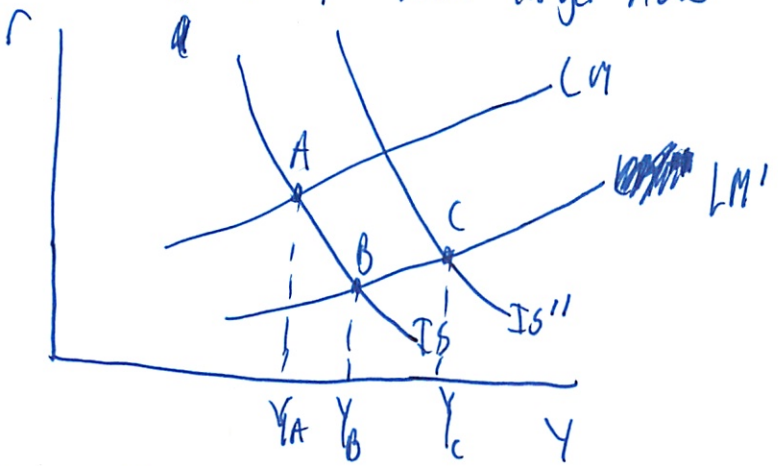
LM ↓

- but only small effect on output since

(C) what if fin markets expect ↓ i_{future} as well as ↑ Y_{future}

So IS →

- So change in Y much larger now



Remember if changes expected → no change

So can economists still predict stiff?

- Expectations are not arbitrary
- formed by economic thinking = rational expectations

17.3 Deficit Reduction: Expectations + Output

In MA ↓ budged deficit = ↑ S ↑ I → ↑ Capital → ↑ Y

But SR G↓ means ↓ Y

So hard to do politically

But if people take expectations into account - could it help SR?

- People expected future $\uparrow\pi$ (from $i\downarrow$) balances at $G\downarrow$

W/o more info can't tell which shift dominates

~~But expect~~

backload w/ more cut$ in future

- So can be offset by expectations
- more fine for expectations to set in

but program must ~~be~~ have credibility

- So need some cuts now

- Timing
- Composition
- inital gov spending also matters

14.02

Models of the Financial Crisis [1]

Francesco Giavazzi

April 26, 2011

Updated 4/29

[1] This material will be the subject of the last Quiz on May 5. The two classes after the last Quiz—which are optional—will furher discuss the financial crisis (A new set of Notes will be posted).

The source of the 2007-10 recession

- The shock that started this recession and eventually resulted in the US unemployment rate rising from 5 to 10% was an unprecedented fall in house prices which hit
  - families because their wealth mostly consists of the value of their house
  - banks which had issued the mortgages, *i.e.* the loans with which families had bought their houses

This recession was different

- This was different from other recessions:
  - 1974-75: the shock that started the recession was an increase in the price of oil
  - 1990-91: the shock was a fall in consumer confidence (c_0), possibly associated with the start of the first Iraq war
  - 2001: the shock was a stock market crash (the burst of the *internet bubble*) which hit families, but not banks
- It is the role of banks and other financial firms that made this recession different because they worked as an *amplifier* making the initial shock bigger and turning this into the deepest recession since the 1930s
- Understanding this recession thus requires understanding how the financial system works and why in 2008-09 it stopped functioning

Financial System

- What is the financial system? What function does it serve?
  - The role of the financial system is to transfer the savings of households to those who need the funds to finance real economic activity, *e.g.* set up a new company or expand an existing one
- Before studying the financial system we need to understand what a *balance sheet* is
  - The balance sheets of banks and other financial firms are central to understanding how a financial system works. So far in 14.02 we never mentioned balance sheets (except, briefly, when we discussed the bank multiplier and later when we discussed the balance sheet of the central bank in a fixed exchange rate regime)

Balance sheet explained to your younger brother

Assets	**Liabilities**
Saving for a rainy day	*Other people's money*
Money working for you	*Own skin in the game*

- Assume you wished to set up a company and to start you need 100K$. You have 10K of your own (your *skin in the game*) and borrow 90K from a venture capitalist. You then spend 95k to start the company (this is the *money working for you*) and put 5K in the bank as a buffer in case something (small) goes wrong
- Accountants call
  - *Other people's money:* **Debt**
  - *Your Skin in the Game:* **Equity**
  - *Saving for a rainy day:* **Reserves**
  - **Leverage** $= \frac{Assets}{Your\ Skin\ in\ the\ Game} = \frac{Assets}{Equity}$

The example of the balance sheet of a household

- Consider a household which bought a house financed by a mortgage
- How large is the mortgage as a fraction of the value of the house obviously makes a big difference
- Also the type of mortgage makes a difference: is the interest rate fixed, or does it float with market rates? At current interest rates and at current house prices the household may look perfectly able to make the mortgage payments, but what if house prices fall, or interest rates rise?
- To understand how risky is the position of this household we need to know its balance sheet, *i.e.* the value of the house and the size and conditions of the mortgage.

Balance sheet of a household (thousand $)

Assets		**Liabilities**	
House	1.000	Mortgage	900
Stocks	50	Equity	160
Bank deposits	10		

- this family has purchased a house with a downpayment of 100 and a mortgage worth 900. Its net worth (its *Equity*) is 160: 100 (equity in the house) + 60 (cash and stocks)
- its leverage (the ratio of Assets to the family's net worth) is $1060/160 = 6.625$

Balance sheet of a household (thousand $)

- Assume house prices fall 30% and the value of the house falls to 700. The family is broke: it's net worth has become negative: $160 - (100 - 300) = -140$ (because the 100 of equity in the house is less than the fall in the value of the house)

Assets		**Liabilities**	
House	700	Mortgage	900
Stocks	50	Net worth	−140
Bank deposits	10		

- The family is still able to make its monthly mortgage payment: just looking at flows (monthly income and monthly mortgage payments) we would not have guessed the family could be in trouble.
- The problem is that this family had too much debt. What would have happened if its leverage had been 2 instead of 6.625?
- But what does "being broke" mean in practice?

Balance sheet of a household: the *youwalkaway.com* solution

- Assume the mortgage is a *non-recourse loan*, *i.e.* if the borrower is delinquent the bank has only the right to re-possess the house. Now the bank is broke

household				bank			
Assets		Liabilities		Assets		Liabilities	
House	1000	Mortgage	900	Mortgage	900	Deposits	760
Stocks	50	Net worth	160			Equity	140
Bank deposits	10						

household				bank			
Assets		Liabilities		Assets		Liabilities	
House	0	Mortgage	0	House	700	Deposits	760
Stocks	50	Net worth	60			Equity	−60
Bank deposits	10						

Balance sheet of a household: assets as additional collateral

- Assume instead that the mortgage contract gives the bank the right to re-posses not only the house, but any other households' assets. Now the bank survives: its equity is zero but not negative.

household				bank			
Assets		Liabilities		Assets		Liabilities	
House	1000	Mortgage	900	Mortgage	900	Deposits	760
Stocks	50	Net worth	160			Equity	140
Bank deposits	10						

household				bank			
Assets		Liabilities		Assets		Liabilities	
House	0	Mortgage	0	House	700	Deposits	760
Stocks	0	Net worth	0	Assets	60	Equity	0
Bank deposits	0						

Financial System

- Remember: the role of the financial system is to transfer the savings of households to those who need them to finance real economic activity
- How can this be done? Start from the simplest case: the economy of Robinson Crusoe

Robinson has a project: a land to farm. In his economy there is no financial system, because Robinson has no one with whom to trade

Assets	Liabilities
Projects	*Equity*

Projects (farming) are wholly owned by the farmer. In this economy there is no borrowing, and no "delegation", thus no need to monitor the managers who carry out the projects.

Financial System and Delegation

- Who owns the savings rarely is the best person to run a project which uses those savings
- Modern economies have contracts that allow to delegate the running of projects to others
- The financial system provides the institutional framework to do this

Delegation without intermediaries

Firm's balance sheet		*Household's balance sheet*	
Assets	Liabilities	Assets	Liabilities
Projects	*Debt*	*Firm's bonds*	
	Shares	*Firm's shares*	*Equity*

Financial System and Delegation via Banks

Bank's balance sheet

Assets	Liabilities
Loans to firms	*Deposits*
Other assets	*Equity (shares issued by the bank)*

Firm's balance sheet

Assets	Liabilities
Projects	*Debt (Bonds)*
	Bank loan
	Shares

Household's balance sheet

Assets	Liabilities
Firm's bonds	
Shares of firms and banks	
Bank deposits	*Equity*

The Financial System

- Now that we have understood why balance sheets are important (because they give information on leverage) we can repeat the exercise for all sectors of the economy
- The data that allow us to do this are in the **Flow of Funds matrix**
- The matrix (produced, for the U.S., by the Federal Reserve) reports the balance sheets of all the different sectors of the economy: households, firms, banks, state and federal administrations (*http://www.federalreserve.gov/releases/z1*).
- For each sector the matrix reports how much it has borrowed, how much it has lent, through which financial instruments (bonds, stocks, bank deposits, etc) and to whom.
- The next slide reports the balance sheets of the three main sectors of the U.S. economy in 1990 and in 2009 (we compare these two years to show how the economy has changed in two decades)

Balance Sheets (US $, trillion): 1990 and 2009

	HOUSEH.		FIRMS		BANKS	
	1990	2009	1990	2009	1990	2009
Assets	22,8	68,2	7,8	26,3	12,3	63,5
of which: financial assets	14,0	45,2	2,5	14,3	12,3	63,5
real assets (houses and plants)	8,8	23,0	5,3	12,2	-	-
DEBT	3,8	27,0	3,7	13,6	11,8	59,6
- of which mortgages	2,4	20,3	0,2	1,0	-	-
EQUITY	19	45,0	3	9,2	1,0	3,6
LEVERAGE = assets / equity	1,2	1,5	2,6	2.9	12,3	17.6

- leverage varies across the economy. In the case of banks it has increased significantly in the past 20 years.
- not all households are as highly leveraged as the one in the example above (whose leverage was 6,625). Households' average leverage is 1,5 because the value of their houses is typically much higher than the value of their debts, which are mostly mortgages. This is because few mortgages are "bullet mortgages": as time goes by families pay down their mortgage.
- for banks, on the contrary, leverage is very high. In 2009, with a leverage of 17,6, a 6% fall in the value of bank assets was enough to wipe out their equity and bankrupt banks

Flow of credit from lenders to borrowers

- The *Flow of Funds Matrix* also keeps track of the borrowing and lending that goes on among all the different sectors of the economy
- For each sector the entries in the matrix report how much it has borrowed, how much it has lent, through which financial instruments (bonds, stocks, bank deposits, etc) and to whom
- Along the columns of the Flow of Funds matrix "u" indicates the uses of funds, *i.e.* lending, "s", the sources of funds, *i.e.* borrowing

Flow of Credit: an example (#'s are made up)

	households		firms		banks		total	
	u	s	u	s	u	s	u	s
Savings		90		62		0		152
Real investment (houses, plants)	67		85		0		152	
Δ money (bank deposits)	-2		3			1	1	1
Δ other financial assets	35		14		51		100	
Δ fin.liab.(borrowing from banks)		10		40		50		100
	100	100	102	102	51	51	253	253

("u" indicates uses of funds, i.e. lending, "s", sources of funds, i.e. borrowing).

- Net flows: savings (152: 90 by hh, 62 by firms) = investment (152: 67 by hh who buy houses, 85 by firms). What households don't use to buy houses they lend to firms.
- Gross flows: assets purchased (253) = assets created (253)

101 worth of assets are created by banks: deposits (1) + other bank assets (100) sold to households, firms and other banks

Why keeping track of credit flows is important

- Households don't lend to firms directly: they lend to banks. Firms don't borrow from households directly, but from banks.
- Households use their savings (90) in part to buy houses (67), in part to accumulate financial assets ($33 = 35 - 2$). But they also borrow 10 from banks. Their net lending to banks is 23 ($33 - 10$). This net amount (23) is lent out from banks to firms, and is what provides them with the cash needed to invest ($85 - 62 = 23$).
- For firms too their net borrowing from banks ($23 = 40 - 17$) is different from their gross borrowing. The gross borrowing is 40, but of this amount firms lend 17 back to banks.
- Banks too lend to each other. Their net lending to each other is zero, but this is the result of gross borrowing of 51 and gross lending of the same amount
- The bottom line is that there is borrowing and lending in the economy beyond what is needed to finance the investment needs of households and firms.

Why such much lending and borrowing back and forth?

- Why do households and firms borrow from banks (10 households, 40 firms) and then lend some of this back to banks?
- Why do banks borrow from and lend to each other?

Answering to these questions is the first step in understanding:

- why banks exist? More generally, why does a financial system exist?
- what do banks do, and how did it happened that banks and the financial system in 2008-09 almost stopped working?

Why do banks exist?

- Banks (and other financial firms) exist because people in the economy are different: they have different skills and different needs.
- Banks (and the financial system more generally) help solving the problems posed by these differences.

Why do banks exist? First example

- Entrepreneurs are very special individuals. Their characteristic is to have the skills necessary to turn ideas into projects and then running them. They do this borrowing from people who do not have these skills. Investors are happy to lend to entrepreneurs because they hope to participate in the returns produces by the exploitation of smart ideas
- The contract between a lender and an entrepreneur is complicated
  - entrepreneurs may not have the incentive to run their project diligently enough (once they have raised the funds from investors they may prefer to spend time on the beach), and
  - lenders (small investors) cannot observe how diligently the entrepreneur is running her project, thus they can be fooled
- this "lack of trust" can be overcome if entrepreneurs risk enough of their own in the project
- banks can facilitate the contract between entrepreneurs and lenders, monitoring the entreprenurs, thus facilitating the flow of savings from the one to the other

Why do banks exist? Second example

- Some agents wish to hold very liquid assets (demand deposits). Other agents need to borrow long term, *e.g.* a 30-year mortgage to buy a house or to build a new plant.
  - another role banks can play is associated with the fact that they can *transform maturities*, *i.e.* borrow by issuing demand deposits and lend for 30 years

We shall now study two models which describe some the mechanisms underlying these two reasons why banks exist. In both, as we shall see, balance sheets are central. (Of course our list of reasons why banks exist is not exhaustive: there are a few more, like the fact that banks may be better at evaluating the firms' projects.)

1. Entrepreneurs, banks and small investors
2. The benefits and the risks of transforming maturities and providing liquidity

1. Entrepreneurs, banks and small investors

[Bengt Holmostrom and Jean Tirole, "Financial intermediation, loanable funds and the real sector", *Quarterly Journal of Economics*, 1997]

There are 3 actors in the economy: entrepreneurs, small investors and banks

Entrepreneurs

- there are many of them; each one has
  - an idea that costs I dollars to implement
  - an amount A of cash they can dedicate to their idea, $A < I$
- an idea implemented today will produce tomorrow
  - $R > 0$ with prob p
  - 0 with prob $(1 - p)$
- if they don't invest their cash in their idea, entrepreneurs can buy a safe government bond whose return is $0 < \gamma I < R$

The contract between entrepreneurs and small investors

Since $A < I$, the idea, to be implemented, needs outside funding. Assume there are only *small investors*. They are *small* in the sense that they do not have the resources to monitor how diligently the entrepreneur whom they have financed runs her project

- Entrepreneurs can affect p, the probability of success, by deciding how much effort to put into running their project. This creates a **moral hazard** if their effort cannot be observed
- If they put little effort they enjoy a private benefit B (*e.g.* they spend more time on the beach, less on their project)
  - if private benefits are 0, $p = p_H$
  - if private benefits are B, $p = p_L < p_H$
- Small investors do not observe the entrepreneur's effort

The contract between entrepreneurs and small investors

We assume that returns are such that investing in the entrepreneur's idea yields a higher return than investing in a safe government bond **only if the entrepreneur puts in enough effort**:

- $p_H R > \gamma I$
- $p_L R + B < \gamma I$

How to make sure that entrepreneurs are diligent

To make sure that she works hard and thus achieves p_H, small investors need to offer the entrepreneur a contract that is sufficiently attractive to induce her to work hard. Consider the following contract:

- if the project succeeds R will be divided between R_E for the entrepreneur and R_S for the investors with R_E such that the entrepreneur has an incentive to put in p_H
- R_E must saitsfy

$$p_H R_E \geq p_L R_E + B$$

i.e.

$$R_E \geq B/(p_H - p_L) = B/\Delta p$$

- Note that, as $p_L \longrightarrow p_H$, the contract becomes unfeasible because giving the entrepreneur the necessary incentive becomes impossible

Pledgeable income

- Since $R_E \geq B/\Delta p$ for the entrepreneur to be credible when he commits not to shirk, not all the income produced by the project can be pledged to outside (small) investors

$$R_S \leq (R - B/\Delta p) < R$$

- Limited pledgeability arises because of the moral hazard problem of entrepreneurs
- Limited pledgeability is what makes **contract theory** (a lively branch of economics) interesting. It is also what opens up an intersting role for financial intermediaries (banks) because sometimes they can attenuate the moral hazard problem

To have an incentive to be diligent the entrepreneur must contribute a minimum of her own to the project

- Consider the small investor. If he does not finance the project, his alternative is to buy the safe bond with a return γ. Thus he will only invest if

$$p_H R_S \geq \gamma (I - A)$$

- and since

$$R_S \leq (R - B/\Delta p)$$

- small investors will lend as long as

$$A = \bar{A}(\gamma) \geq I - [p_H/\gamma (R - B/\Delta p)]$$

i.e. unless the entrepreneur contributes a minimum amount of her own, $\bar{A}(\gamma)$, she cannot credibly commit to p_H

- which will be the return for small investors when they invest in the project? Competition among them will bring it down to γ, the return on their alternative option, which is investing in safe bonds

How can banks help

Banks are large investors who can finance the entrepreneur's project. Beyond financing her project, banks can also monitor how diligently she runs it. They cannot control the entrepreneur perfectly (*i.e.* make sure $B = 0$) but by spending some money they can avoid "extreme" negligence, *i.e.* they can reduce the entrepreneur's outside benefit to $b < B$. When the entrepreneurs enjoys b the prob of success remains p_L. Monitoring costs c.

- if the project succeeds, R will be divided between R_E , R_S and R_B
- the entrepreneur must be guaranteed

$$R_E \geq b/\Delta p$$

where the only difference is that now $b < B$

- the bank must be guaranteed

$$p_H R_B - c \geq p_L R_B$$

i.e.

$$R_B \geq c/\Delta p$$

The minimum amout banks must contribute to be credible when they say they will monitor the entrepreneur

- For banks to have an incentive to monitor

$$R_B \geq c/\Delta p$$

- Let I_B be the amount of capital that the bank invests in the project it monitors. Then the *gross* return (that is not counting the monitoring cost c) to the bank

$$\beta = \frac{p_H R_B}{I_B} \geq \frac{p_H\ c}{I_B \Delta p}$$

- Thus for any given β, $I_B \geq \frac{p_H c}{\beta \Delta p}$ is the minimum amount the bank must contribute to be credible when it says it will monitor the entrepreneur
- Note that a bank that has no capital—and thus can contribute nothing of its own to the project—and simply finances all its loans issuing deposits is useless (at least if we think that the main reason why banks exist is to monitor firms)

Why does the entrepreneur go to the bank at all?

- Monitoring is costly, thus $\beta > \gamma$. This means that the entrepreneur will finance through the bank as little of the project as possible. But why does she go to the bank at all?
- When R_E and R_B are such that the entrepreneur has an incentive to be diligent, and the bank has an incetive to monitor, small investors get

$$R_S = p_H \left[R - (b + c)/\Delta p\right]$$

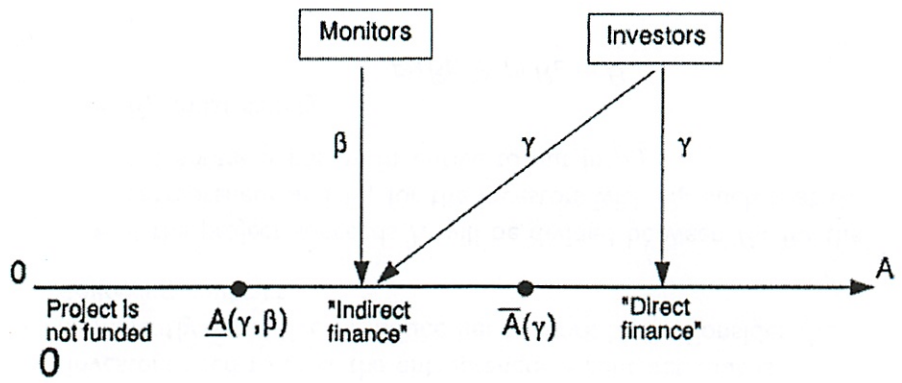
and must contribute $I - A - I_B$. Since their alternative remains the safe bond, they will finance the project provided

$$\gamma \left[I - A - I_B(\beta)\right] \leq p_H \left[R - (b + c)/\Delta p\right]$$

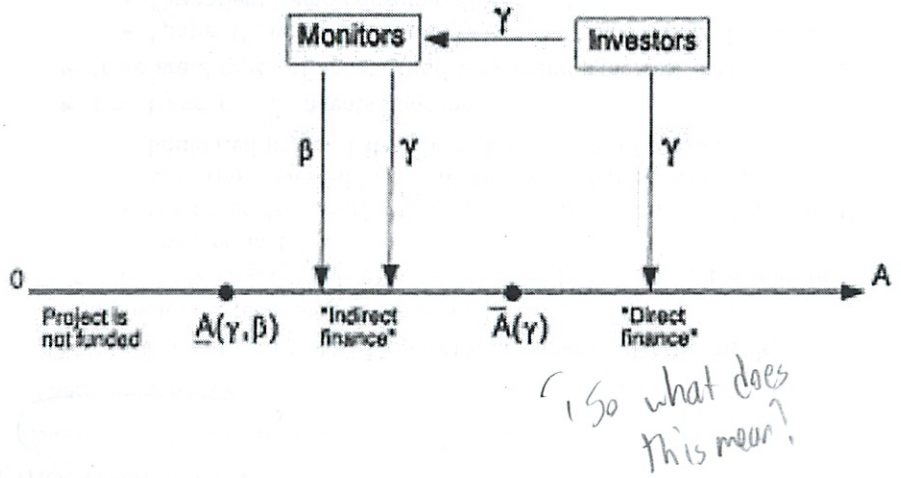
- This condition can be re-written as

$$A \geq \underline{A}(\gamma, \beta) = I - I_B(\beta) - (p_H/\gamma)\left[R - (b + c)/\Delta p\right]$$

Which Project Are Financed?



Direct and Indirect Financing



So what does this mean?

What can go wrong? (1)

A could fall

Assume the entrepreneur contributes the real estate, for instance the land where the project is developed. If real estate prices fall, A will fall. If it falls below $\bar{A}(\gamma)$, projects that previously could be financed only by small investors, now need a bank because the value of what the entrepreneur contributes is no longer sufficient to attract small investors.

What can go wrong? (2)

Remember that $I_B \geq \frac{c}{\beta} \frac{p_H}{\Delta p}$. If the bank claims the cost of monitoring, c, is small (or underestimates the cost of monitoring) it will contribute too little to the project. Ex-post it will have no incentive to do the monitoring. In this case the entrepreneur's private benefit will remain B because

$$R_E = \frac{b}{\Delta p} < \frac{B}{\Delta p}$$

and $p = p_L$

What can go wrong ? (3)

$I_B(\beta)$ could fall.

The bank may not have enough capital to credibly commit to monitor entrepreneurs. Remember that the minimum amount a bank must contribute to the project is $I_B(\beta) = \frac{c}{\beta} \frac{p_H}{\Delta p}$. If it commits less then $I_B(\beta)$ its return is insufficient to cover the cost of monitoring, thus the bank will not monitor.

What happened before and during the crisis ?

Each one of the three things that could go wrong has gone wrong:

1. before the crisis banks had reduced their direct investments in the projects they had financed. They had done this selling their loans to other investors (what is called *securitization*, assembling a large number of mortages and building a financial security which contains them all.) The benefit was less exposure to risk; the cost was reduced incentive to monitor.
2. banks' capital fell during the crisis. This means that banks had less capital for direct lending.
3. the fall in real estate prices and in asset prices in general, reduced the value of A, the resources entrepreneurs could commit to their projects.

2. The benefits and the risks of transforming maturities and providing liquidity

- The second role banks can play is associated with the fact that they can can "transform maturities", i.e. borrow *short* (by issuing checking accounts) and lend *long* (e.g. for 30 years).
- This is useful because some agents in the economy wish to hold very liquid assets (checking accounts), while other agents need to borrow long term, e.g. a 30-year mortgage to buy a house or to build a new plant.
- Without a bank it would be harder to find a mortgage. Assume all households wished to keep their savings in checking accounts: then who would by a 30-year mortgage?

Model 2

A model of liquidity

[Diamond, D., and P. Dybvig "Bank runs, deposit insurance and liquidity", Journal of Political Economy, 1983]

There are 3 periods

- $t = 0$ agents start with 1 unit of endowment. Investment decisions are made. 2 technologies are available:
  - one delivers 1 unit of output in $t = 1$ for each unit of output invested in $t = 0$
  - the other delivers $R > 1$ units of output in $t = 2$ for each unit of output invested in $t = 0$. However, if this technology is liquidated in $t = 1$ it delivers $L < 1$ units of output
- $t = 1$ and $t = 2$: agents consume
- there are 2 types of agents (and very many agents of each type)
  - "patient", who consume only in $t = 2$ and nothing in $t = 1$
  - "impatient" who consume all in $t = 1$
  - agents learn their type only in $t = 1$ all they know in $t = 0$ is
    $prob(being\ patient) = \pi$
    $prob(being\ impatient) = 1 - \pi$
- of course if you knew your type in $t = 0$ you could invest everything in one technology or the other.

The world of Robinson Crusoe: no banks and no one with whom to trade

Call I the amount agents invest in the technology with return R at $t = 0$. Then their consumption options are

- if impatient: $c_1^A = (1 - I) + LI = 1 - (1 - L) I \leq 1$ ($= 1$ only for $I = 0$)
- if patient: $c_2^A = (1 - I) + RI = 1 + I (R - 1) \leq R$ ($= R$ only for $I = 1$)

where A stands for "Autarky", Robinson's world

Market economy (when there is someone with whom to trade in t=1)

Now in $t = 1$ agents can trade. An agent who finds out he is impatient can issue a bond that promises to pay 1 unit of good in $t = 2$, sell it and eat. The price of this bond is p. Clearly $p \leq 1$, otherwise (for those who buy the bond delivering the good in $t = 2$) storing the good would be better. Investing I in $t = 0$, you can now obtain

- $c_1 = 1 - I + pRI$ if impatient, in which case in $t = 1$, he will sell RI bonds
- $c_2 = \frac{(1-I)}{p} + RI$ if patient, in which case in $t = 1$, he will buy RI bonds

In $t = 0$ agents choose $\{I, c_1, c_2\}$ taking the price p as given (there are many agents and no one thinks he can influence p). The price p has to be such that the agents' choices are **feasible**, *i.e* there are enough resources to provide c_1 and c_2 in each period.

Market economy (cont.)

If $p > 1/R$, agents choose:

$$\tilde{I} = 1, \tilde{c}_1 = pR, \tilde{c}_2 = R.$$

If $p < 1/R$, agents choose:

$$\tilde{I} = 0, \tilde{c}_1 = 1, \tilde{c}_2 = 1/p.$$

Neither $p > 1/R$, nor $p < 1/R$ are feasible because they imply that $\{\tilde{c}_1, \tilde{c}_2\}$ exceed the resources available to the economy

- $p > 1/R \Longrightarrow I = 1$, $\tilde{c}_2 = R$ and $\tilde{c}_1 = pR > 1$: this is unfeasible
- $p < 1/R \Longrightarrow I = 0$, $\tilde{c}_1 = 1$ and $\tilde{c}_2 = 1/p > R$: this is also unfeasible

Market economy (cont.)

The only feasible equilibrium is $p = 1/R$ where agents choose

- $\tilde{c}_1 = 1$ if impatient
- $\tilde{c}_2 = R$ if patient
- $\tilde{I} \in [0, 1]$

In order for these choices to be feasible $\tilde{I}$ must be such that

$$\begin{aligned} (1-\pi)\,\tilde{c}_1 &= 1 - \tilde{I} \\ \pi \tilde{c}_2 &= R\tilde{I} \end{aligned}$$

So $\tilde{I}$ must be equal to π.

Why the market outcome is (in general) not optimal

The market equilibrium is:

- $c_1^M = 1$ if impatient
- $c_2^M = R$ if patient

i.e. agents who find out they are impatient forgo R and consume $1 < R$.

- the market economy yields the same allocation agents would have chosen had they known their type in $t = 0$.
- i.e. it eliminates the inefficiency caused by uncertainty (the Autarkic equilibrium is inefficient: there is always some liquidation).
- $\{c_1^M = 1,\ c_2^M = R\}$ may not be the best solution. If in $t = 0$ agents could insure against the possibility that in $t = 1$ they find out they are impatient, they might wish to consume $\{c_1^* > 1,\ c_2^* < R\}$ where * denotes optimal consumption levels. How could they insure? [2]

[2] We are assuming that agents give identical importance to consumption in the two periods, i.e. there is no discounting. In other words agents maximize $U = \pi u(c_1^I) + (1-\pi)\, u(c_2^P)$. They will wish to insure provided $u'(1) < Ru'(R)$ where u' is the marginal utility of consumption.

How can a bank improve upon the market outcome

- Assume we want to achieve $\{c_1^* > 1,\ c_2^* < R,\ c_1^* < c_2^*\}$
- in $t = 0$ the bank issues demand deposits: in exchange for a deposit of one unit at $t = 0$, agents receive either c_1^* at $t = 1$, or c_2^* at $t = 2$. To achieve this the bank, in $t = 0$ stores $(1 - \pi)\, c_1^*$ and invests $\pi c_2^* / R$ in the technology which yields R in $t = 2$
- the bank achieves the optimal allocation provided no individual withdraws at $t = 1$ unless she does not have to, i.e. unless she discovers she is impatient. No patient consumer withdraws in $t = 1$
- provided $c_1^* < c_2^*$ this assumption is not unreasonable because it would be irrational for a "patient" consumer to withdraw at $t = 1$ pretending he is impatient.

Bank runs: why can they happen

- suppose a patient consumer anticipates that all other patient consumers will pretend they are impatient and withdraw at $t = 1$
- at $t = 1$ the bank must liquidate all its long term investment. The total amount of resources available to the bank are $(1 - \pi)\, c_1^* + \pi c_2^* L < (1 - \pi)\, c_1^* + \pi c_1^* L < c_1^*$: the bank is thus unable to pay c_1^* to all its clients and fails
- thus the bank fails provided depositors anticipate that a large enough number of them will want to withdraw early

Correction: Bank only gone at $t=1$ if $1 < \frac{c_2^*}{c_1^*} < \frac{R}{4}$

always fails | fails if run | always succeeds

1 | R/c | c_2^*/c_1^*

Bank runs: possible remedies

- Narrow banking. The bank invests nothing in the illiquid technology and stores everything
  - can be withdrawn any time
- Suspension of convertibility. The bank has the option of stop paying its depositors when it runs out of cash. This means that any client who shows up "late" will see her/his deposit transformed from a demand deposit to a 2-period bond
- Deposit insurance. The government steps in when the bank runs out of cash

w/ their own $

Leverage: another reason for the fragility of banks

- Now that we have understood why banks exist, we return to their balance sheets
- We have seen one reason why banks' balance sheets are important: if banks have less capital they will do less monitoring and fewer projects will be financed. Thus a fall in asset prices that hits banks' capital will result in lower investment and could start a recession
- Now we study another channel through which banks' balance sheets could start a recession
- Remember that the reason banks (or firms, or households) hold equity is to absorb possible losses on the assets they own

w/o going bankrupt

Leverage

Now use the expression for the leverage ratio $\lambda = \frac{L}{K}$

The probability that a bank will go broke is

$$\text{Prob}\left(p < 1 - \frac{\bar{K}}{\alpha L}\right) = \text{Prob}\left(p < 1 - \frac{1}{\alpha\lambda}\right)$$

- for given α, the probability that a bank will go broke is an increasing function of the leverage ratio λ
- for given α, the value of λ such that $\text{Prob}(p < 1 - \frac{1}{\alpha\lambda}) = 5\%$ is ~~increasing~~ decreasing with $Var(p)$ [3]

Correction

[3] This is strictly true if the ditribution of p is Normal. It is not true for some other distributions.

Leverage Ratios for some U.S. and European Banks before the crisis

U.S. banks:

Bank of America	11.7
Citigroup	19.2
JPMorgan	12.7
Wells Fargo	12.0

European banks:

Deutsche Bank	52.0
UBS	53.4
Credit Suisse	22.7
Fortis	25.5
Dexia	36.8
BNP Paribas	28.5
Barclays	37.8
Royal Bank of Scotland	21.7

The leverage of some European banks is very high. But banks may have a high λ and still be safe by keeping α low–and indeed this was the case for most European banks which owned lots of safe government bonds.

Leverage and the Crisis

- In the years before the crisis macroeconomic volatility was low, thus $Var(p)$ was low
- low $Var(p)$ meant that banks, for given α, could afford a relatively high λ—or, for given λ, they could afford a higher α (they could hold a higher share of risky assets)
- at the start of the crisis volatility suddenly increased and banks responded by lowering λ and α. But this
  - takes time because raising capital and reshuffling the bank's assets takes time
  - it also means that the bank sells risky assets
    - if it sells loans to firms (or stops lending to firms), this negatively affects investment
    - if it sells other risky assets, such as shares, it pushes share prices down precisely at a time when the stock market (beacuse of the crisis) is already falling. This could generate a negative *leverage cycle*

Leverage Cycles and Fire Sales

Assume for simplicity $\alpha = 1$. The bank's initial balance sheet (with leverage = 10) is

Assets	Liabilities
110	*Deposits* 99
	Capital 11

Balance sheet after the fall in asset prices (leverage = 10,9)

Assets	Liabilities
109	*Deposits* 99
	Capital 10

The bank can return to a leverage ratio of 10 selling assets and paying back deposits

Assets	Liabilities
100	*Deposits* 90
	Capital 10

The bank ignites a **fire sale**: it sells assets precisely when asset prices are falling !

Leverage

- Assume a bank has an amount of deposits D_0 and an amount of equity ($\bar{K}$). Its liabilities are $L = D_0 + \bar{K}$, equal to its total assets
- The bank holds two types of assets
  - *loans* and *other investments* (what we called *Money working for you*)
  - *reserves* (what we called *Savings for a rainy day*)
- Let α be the fraction of total assets invested, and $(1-\alpha)$ the fraction kept as reserves
- Investment is risky: for each dollar invested today you get p dollars tomorrow; where p is a random variable. We may assume $E(p) > 1$ still with some probability $p < 1$

Leverage

The Bank's Balance Sheet today

Assets	Liabilities
$(1-\alpha)\,L$ (reserves)	$L = D_0 + \bar{K}$ (equity)
αL (loans and other risky investments)	

The Bank's Expected Balance Sheet tomorrow

Assets	Liabilities
$(1-\alpha)\,L$	Deposits: D_0
$p\,(\alpha L)$	Capital: $\bar{K} + (p-1)\,(\alpha L)$

- Here we see why banks hold equity (or capital): in order to be able to absorb losses (or gains) on their assets. Note that the capital tomorrow is equal to the original capital plus the capital gain $(p-1)\,(\alpha L)$—which is a capital loss for $p < 1$
- The bank's *leverage ratio* is $\lambda = \frac{Assets}{\bar{K}} = \frac{L}{\bar{K}}$, the ratio of total assets (equal to total liabilities) to capital

Leverage

The bank goes broke if $\bar{K} + (p-1)\,(\alpha L) < 0$.
Note that we can rewrite the condition as

$$\begin{aligned}
\bar{K} + (p-1)\,(\alpha L) &< 0 \\
\bar{K} + p\,(\alpha L) - (\alpha L) &< 0 \\
\bar{K} + p\,(\alpha L) - (\alpha L) + (1-\alpha)\,L &< (1-\alpha)\,L \\
\bar{K} + p\,(\alpha L) + (1-\alpha)\,L &< L \\
p\,(\alpha L) + (1-\alpha)\,L &< L - \bar{K} \\
p\,(\alpha L) + (1-\alpha)\,L &< D_0
\end{aligned}$$

The last line says that the bank is broke when the value of assets tomorrow is not enough to pay for deposits

Leverage

What is the probability that a bank will go broke?

$$\text{Prob}\left(\bar{K} + (p-1)\,(\alpha L) < 0\right) = \text{Prob}\left(p < 1 - \frac{\bar{K}}{\alpha L}\right)$$

which is increasing in α : the higher the fraction of total assets the bank invests in the risky asset, the higher the probability it goes broke.
How do banks choose α? They choose it so that the probability of going broke is less than or equal to some number—say 5%

$$\text{Prob}\left(p < 1 - \frac{\bar{K}}{\alpha L}\right) \leq 5\%$$

the above inequality determines the value of α.
$|\,(p-1)\,\alpha L\,|$ is also called the bank's **Value at Risk.** $\bar{K}$ should be large enough to absorb a loss equal to $|\,(p-1)\,\alpha L\,|$ which occurs with a 5% probability.

Correction $VaR = \left|\frac{(p-1)\,\alpha L}{\bar{K}}\right|$ not $VaR = |(p-1)\,\alpha L|$

Raising Capital to Avoid Fire Sales

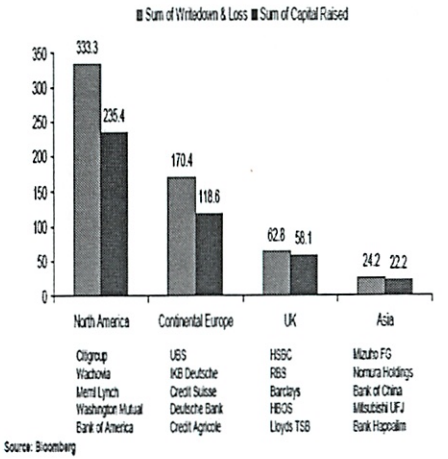
Balance sheet after the fall in asset prices (leverage = 10,9)

Assets	Liabilities
109	*Deposits* 99
	Capital 10

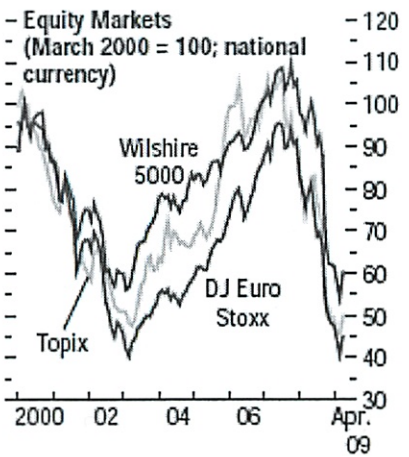
The bank can return to a leverage ratio of 10 instead of selling assets, by rasing capital

Assets	Liabilities
109	*Deposits* 99
	Capital 10, 9

Writedowns and Re-capitalizations: 08/2007 - 08/2008



Fire Sales: Stock Market Indeces



bank's equity = bank's owners' state in bank
— their own $!
AE goes into that

leverage ratio = $\frac{\text{equity}}{\text{assets}}$

14.02

4/17

Lots of errors on quiz

Financial Crisis

- topic of rest of classes
- and final quiz

2007-2010 Recession

- housing prices fell
  - families hit since made up most of their wealth
  - banks had many assets in housing
- led to large unemployment 5 → 10%
- loans defaulted on
- had huge reprecussions
  - amplification

- Every recession is different
  - 1974-75 oil prices
  - 1990-91 fall in consumer confidence from Iraq war
  - 2001 stock market crash (internet bubble)
    - hit families, not banks
- Roles of banks different now than before
  - How does it work?
  - Why did it stop working?

(2)

"real side of economy" = something clear, tangable happened

Financial System

- Goal: to transfer savings of households to companies for them to finance investment

- balance sheet - Assets vs Liabilities
  - Assets
    - $ for rainy day
    - Money working for you
  - Liabilities
    - Other People's $ (Debt)
    - Your own skin in the game (Equity)

- allows households to decide when to consume based on their perm. income
  - by lending + taking loans

- Leverage = $\frac{\text{Assets}}{\text{Equity}}$

Balance Sheet of Household

- consider household w/ a morage
- what is morgage as fraction of value of hase
- is the interest rate fixed or does it varry

Some houses were very highly leveraged

equity = net worth

how much they own of the house

downpayment + what's been paid off

(3)

If house prices fall enough,
a family's net worth can go ⊖

* They owe more on its house than its worth *

Family can still make mortgage payments w/ cash flow
→ But don't want to pay off debt
Also this does include missing human capital

Assumes no cost to default
Or cost lower than what you would have to pay

Assumes they would not want to default at all costs

Basically too much debt relative to assets

Non-recourse loans - Banks can only repossess house, no more
Also forclosed homes ↓ value of homes nearby
- people trash the place
- deserted neighborhoods

Who owns savings can't manage
- appoint managers
- banks do this

(9)

Recently banks have become very leveraged 17:1!

- small shock to assets has big deal -6% drop

Flow of Funds matrix

also flow households to households

14.02

4/22

Quiz 2 Returned

I actually got a lot wrong for getting 80

The 5 bonus points

As are 20% of class

Getting > 50% is passing

On curve

~~# 1 of Exam~~

1.1) ~~a~~ - not stated if creditable or not
(lots of discussion over)
Uncovered interest parity = not hold in realworld

1.2) c

1.3) b

1.4) c (discussed extensively as well)

14.02

4/25

(6 min late)

Ent have ideas - but not $ to finance it

sectors
- Ent
- small investors
- banks

Small inv - ~~[illegible]~~ unintermediated savings + investment

Ent control project sucess w/ effort
- effort is observable

Small investor can't contract on effort though

Moral Hazard problem - Ent have less ~~effort~~ incentive if own less so put in less efforts

People will put in less efforts
- if put in less effort, gets private benefit B
- "Beach"

2 levels of effort: low and high

$p = p_L < p_H$ $p = p_H$

↑ prob of sucess

(2)

Return on ent's business only higher than risk free rate of return only if ent. puts in enough effort (high effort)

- $p_H R \geq \gamma I$

  - $p_H R$: return on risky project, 0 if failure
  - γI: return on safe asset

$p_H R$ = $E[R]$ given high effort

Social Perspective

$p_L R + B < \gamma I$

- $p_L R$: return given low effort
- B: private benefit

- would not want to implement

So need to make sure investors are dilligant ? put in high effort

- So small investors need to induce Ent. to put in high effort

Contract = schedule of how returns are divided b/w ent, small investor

(5)

$R_{Ent} = R_E$

$R_{small\ inv} = R_S$

$$\underbrace{p_H R_E}_{\text{returns to Ent given high effort}} \geq \underbrace{p_L R_E + B}_{\text{returns to Ent given low effort}}$$

aka

$$R_E \geq \frac{B}{p_H - p_L} = \frac{B}{\Delta p}$$

Pledgeable Income

Return to small investor

$$R_S \leq R - \frac{B}{\Delta p} < R$$

- so limited pledgability
- contract theory — ents can't pledge their entire returns
- opens up role for financial intermediars (banks)
  - ↑ before up to no — assumed no banks

(4) But First

Small investors also have incentive to buy safe asset

- would have to put in $I - A$

↑ implementation cost

Ent has

actually

γ = return on each unit of gov bonds

$$p_{t+1} R_s \geq \gamma (I - A)$$

- another restriction on parameters

$$R_s \leq \left(R - \frac{B}{\Delta p}\right)$$

- So small investors will invest as long as

$$A = \bar{A}(\gamma) \geq I - \left[\frac{p_{t+1}}{\gamma}\left(Q - \frac{B}{\Delta p}\right)\right]$$

So Ent must commit a min $\bar{A}(\gamma)$

Competion among Ent brings return down to γ

Note

People are risk neutral

People indifferent to riskless + risky

Risk is not priced

- Not true in real life of course

(5)

Now back to Banks

Banks are large investors

Can monitor how much effort is put in

Can nag and make sure Ent not on beach

- reduces B to b which is $b < B$

Bank is distructive, nagging force if ya put in low effort

Bank encurs monitoring costs C

Seems like bad socially

But actually improves them

R_B = return to banks

— nothing to do w/ benefits B

Ent must be guarenteed

$$R_E \geq \frac{b}{\Delta p}$$

but now $b < B$

Bank must be guarenteed

$$p_H R_B - C \geq p_L R_B$$

$$R_B \geq \frac{C}{\Delta p}$$

(6)

Ent more likely to put in high effort -
- so needs a lower inital investment
- more socially efficent

Bank must have its investment on C pay off

New constraint on how much return has to go to banks

So since $R_B \geq \frac{C}{\Delta p}$ we know how much financed by bank (I_B)

So gross return (not covering c) is

$$\beta = \frac{p_H C}{I_B \Delta p}$$

For any given β, $I_B \geq \frac{p_H C}{\beta \Delta p}$ is min amt bank must contribute for it to creditable when it says it will monitor ent

Gives us return per unit investment

Only care about banks that have capital - not just loan out deposits.

(7) So why do ent go to bank?

Monitoring is costly, thus $\beta > \gamma$ to ent

So ent will not want to go to bank

Since R_E and R_B are such that Ent is diligent

$$R_S = \rho_H \left[R - \frac{(b+c)}{\Delta p} \right]$$

↑ Maya - may not need

And must contribute $I - A - I_B$

Since alt is safe bond, small inv will finance if

$$\gamma \left[I - A - I_B(\beta) \right] \leq \rho_H \left[R - \frac{(b+c)}{\Delta p} \right]$$

Rewrite

$$A \geq A(\gamma, \beta) = I - F_B(\beta) - \frac{\rho_H}{\gamma} \left(R - \frac{(b+c)}{\Delta p} \right)$$

So what could go wrong in banking system?

A ↓ (initial wealth of ent)

Monitoring cost can be small
- or banks claim
- lets them invest less initially
- can rely more on depositors

(8) Banks

Capital vs Depositors

- Banks req to take action (monitor)
- Need incentive
- Need their own $ at state
- (Assuming no depositors)

Read slides 42, 43

14.02 Bank Runs

4/27

example of MIT style of econ
- take complex stuff
- then really, really simplify
- makes model seem unrealistic
- so can use core of mechanism

this is one of first times teaching this in intro course

Bank Runs Diamond - Dybvig Model

Why do banks exist?
- monitoring
- maturity transformation ← today
  borrow short, lend long

time
3 periods
$t = 0, 1, 2$

technology

	$t=0$	$t=1$	$t=2$	
Short term tech →	1	1	0	
Long term tech →	1	0	R	$R > 1$
Storage →	1	L	0	$L < 1$

(2)

Storage tech	0	1	1

The longer ya wait - the bigger your return

Long term is illiquid - if take out before maturity penallty

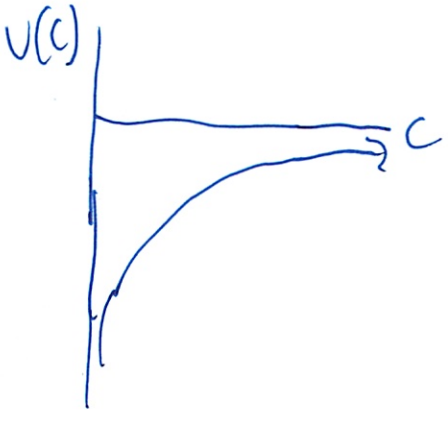
Storage is storing under your mattress
- similar to short term

agents

- large # (∞) Indexed by i on $[0,1]$
- patient: only care about consuming corn at $t=2$
- impatient " " " " " $t=1$

$-U_p(c_1,c_2) = f(c_2) = -\frac{1}{c_2}$

$-U_p(c_1,c_2) = f(c_1) = -\frac{1}{c_1}$



(3)

At $t=0$ you don't know what type of agent you will be

$P(\text{patient}) = \pi$

$P(\text{impatient}) = 1-\pi$

↳ can think of π as $\frac{1}{2}$

each person "flips" indep.

At $t=1$, a fraction π will be patient

$1-\pi$ impatient

4 ~~things~~ cases to look at

1. Perfect info
   - god tells everyone if patient/impatient
2. Autarky
   - each agent is on their own
3. Market Economy
   - people can interact w/ each other
4. Banks
   - do maturity transformation

(4)

Case 1 Perfect Info

I = amt each person invests in long-term tech

Everyone starts w/ 1 unit (endowment)
Storage tech is not used
So what is the best I?

- if you are patient $I = 1$

  Consume $C_1 = 0$
  $C_2 = R$

- impatient $I = 0$

  Consume $C_1 = 1$
  $C_2 = 0$

Case 2 Autarky

- don't know what type you will be at $t=0$
- find out what you are at $t=1$
- if you find out you are impatient and invested long-term → lose $
- if find patient + invested short-term → lost $ (could have made more)

(5)

So do a little of path

$$V(c_1, c_2) = (1-\Pi)\, u(c_1) + \Pi\, u(c_2)$$

- So if impatient

$$c_1 = (1-I) + I \cdot L$$

$$c_2 = 0$$

- if patient

$$c_1 = 0$$

$$c_2 = (1-I) + I \cdot R$$

You do worse than perfect info
Don't know what will happen
So hedge

---

3 Market

People can talk and trade
Can sell bonds

$t=0$	$t=1$	$t=2$
0	p	1
↑ does not exist here	↑ bought + sold	

(6)

Need a matching buyer or seller
- unlike storage

- if impatient

$$C_1^A = (1 - I) + RIP$$

↑ instead of liquidating
Can sell a bond
will get $R \cdot I$ at time 2
Can promise that to someone

$$C_2 = RI - RI = 0$$

↑ get $R \cdot I$, pay out

- if patient

$$C_1 = 0$$

↑ Can use $t=1$ $ to buy bonds

$$C_2 = \frac{(1-I)}{P} + I \cdot R$$

↑ return on bonds ↙ long term tech

$t=0$	$t=1$
I	0
$1-I$	$1-I$

? don't want to consume
Can store or buy bonds

Can buy $\frac{1-I}{P}$ bonds of AI valu

(1)

So need to figure out p

$p = \frac{1}{R}$

any other p makes it impossible for econ to feed everyone

$p < \frac{1}{R}$ everyone wants $I = 0$

$p > \frac{1}{R}$ everyone wants to be in bond biz - patient + nonpatient

See notes

So impatient $c_1 = 1$

$c_2 = 0$

patient $c_1 = 0$

$c_2 = R$

Same as (1) Market economy!

---

(4) Banks

- next time

4.02

4/29

Today: Bank Runs (for reals) or not!
P-Set moved to Mon
#1 on exam - will accept b

Diamond-Dybvig Cont.

Time

$t=0$ $t=1$ $t=2$

Technology

	$t=0$	$t=1$	$t=2$	
Short T.	-1	1	0	
Long T	-1	0	R	$R>1$
	-1	L	0	$L<1$
Storage	0	-1	1	

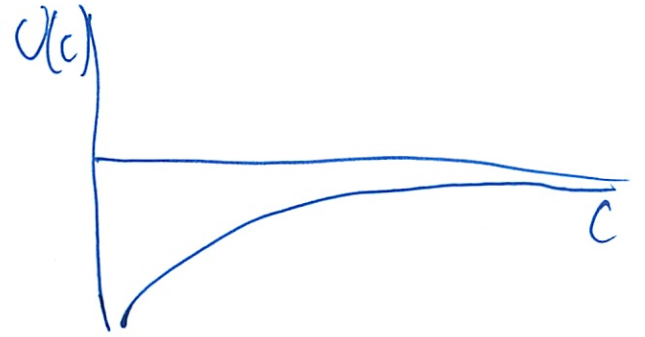
Agents

- Large amount, ∞
- Each starts w/ 1 unit at $t=0$ (endowment)
- 2 types
  - Patient - only want to consume $t=2$
  - Impatient - " " " " " $t=1$

$U_p(c_1, c_2) = c_1$ $U_p(c_1, c_2) = c_2$

(2)

V is increasing, concave



At $t=0$, Prob of being patient $= \pi$

impatient $= 1-\pi$

You find out your type at $t=1$

Proportion of patient agents $= \pi$

impatient $= 1-\pi$

I = amt invested in the long-term asset/technology

4 cases

(1) Perfect Info

(2) Autarky

(3) Market Econ

(4) Banks

(3)

(1) Perfect Info

At $t=0$, you know your type

Will be 2 different Is

- impatient $I=0$ $C_1=1$ $C_2=0$
- patient $I=1$ $C_1=0$ $C_2=1$

(2) Autarky

We don't know what type we are
We can't enter into any agreements

- impatient
- patient

$C_1 = \underbrace{L \cdot I}_{\text{long term}} + \underbrace{1-I}_{\text{short term}}$ $C_2=0$

$C_1=0$ $C_2 = I\Lambda + (1-I)$ (ST + storage)

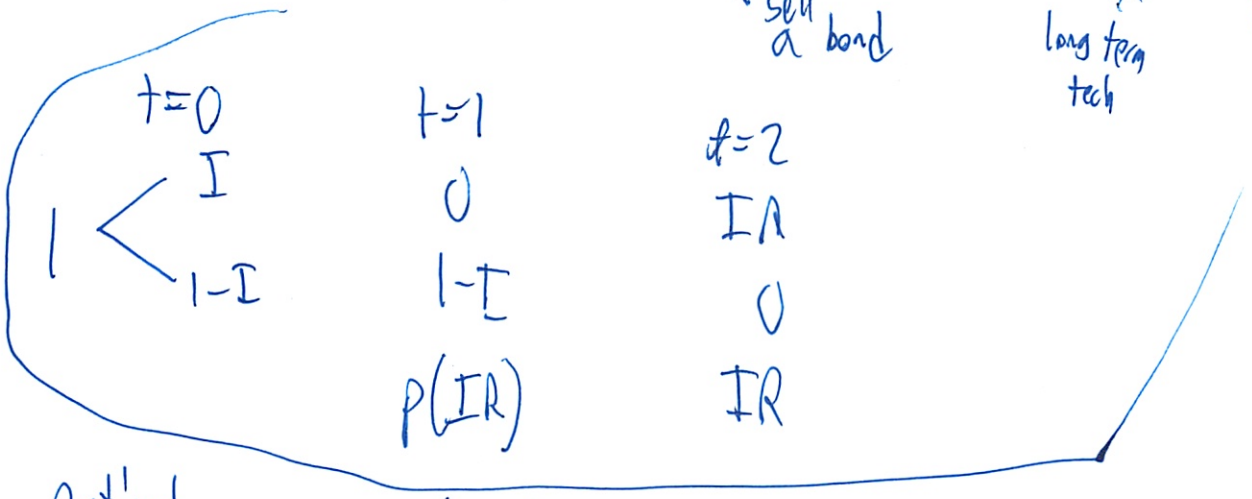
Worse than perfect info case
You pick I in middle b/c you don't know when you want to consume, so put your money in both - one fund won't pay off to its full potential

(3) Market Economy

Trade a bond - created by agents themselves need a person-to-person trade

	$t=0$	$t=1$	$t=2$
Bond	—	$-p$	1

impatient $C_1 = (1-I) + pIR$ ← sell a bond $\qquad C_2 = IR - IR = 0$ ← long term tech ← pay off bond



patient $C_2 = \frac{(1-I)}{p} + RI \qquad C_1 = \underbrace{pIR - pIR}_{??} = 0$

$p = \frac{1}{R}$ is only price that can survive, since w/ any other price we will run out of fund

If $p > \frac{1}{R}$

imp $C_1 = 1 + (pR - 1)I$

pat $C_2 = \frac{1}{p} + \frac{1}{p}(pR - I)I$

(5)

$p > \frac{1}{R} \rightarrow pR - 1 > 0$

number bigger than 0

in order to max. total consumption, both people eat in $t=1$

with $p = \frac{1}{R}$

imp $C_1 = pR$

pat $C_2 = R$

$t=2$ food : $\pi R = (1-q)R$ ← want to eat, ↓ have w/ tech

$t=1$ food $(1-\pi)pR = qL$) Society needs to come up w/ these resources

↑ q = fraction that ya liquidate

add → $\pi + (1-\pi)p\frac{R}{L} = 1$

$(1-\pi)\left(p\frac{R}{L} - 1\right) = 0$

↑ ~~can never hold~~

only holds if $\pi = 1$ or $p = \frac{L}{R}$

↑ can't happen $\because L < R$ $p > \frac{1}{R}$

(6)

When $p > \frac{1}{R}$ pat $c_2 = R$

imp $c_1 = 1$

(4) Banks

- accept deposits
- can withdraw whenever you want

Deposits	$t=0$	$t=1$	$t=2$	
	1	c_1^*	0	(consumer chooses) ← savings account
		0	c_2^*	Dec $c_1^* < c_2^*$

Can pick c_1^*, c_2^* so that everyone is happier than in market economy

At $t=0$

Each agent decides how to invest

Does not know if they are patient/impatient

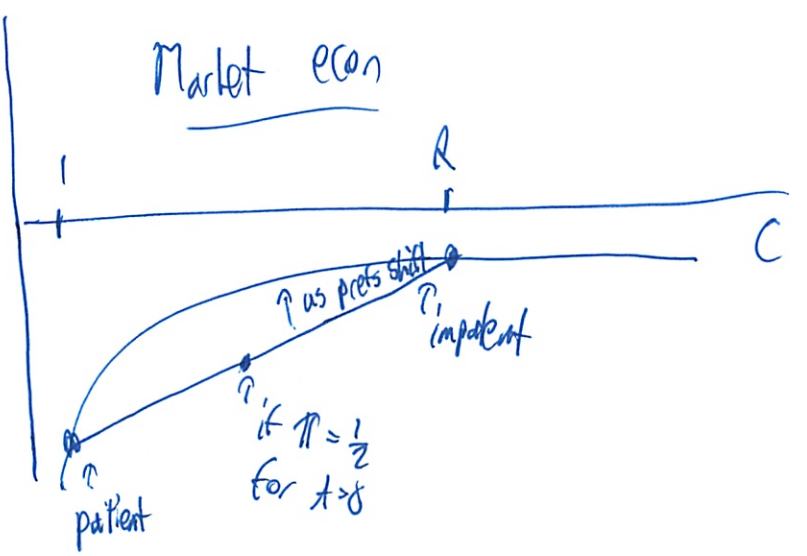
- so use combo of the two

$$U(c_1, c_2) = \pi U_p(c_1, c_2) + (1-\pi) U_I(c_1, c_2)$$

$$= \frac{\pi}{c_2} - (1-\pi)\frac{1}{c_1}$$

(2)

$u(c) = \frac{1}{c}$



$C_1^* = 1 + Little$

$C_2^* = R - Little$

Bank takes 1 at $t=0$

invests π in long term tech $I = \pi$

So at $t=1$

Only imp people want to withdraw \$

$C_1 =$ C_1^* in total $= (1-\pi)C_1^*$

each gets C_1^* is Consumed

At $t=2$

Only patient withdraw

$C_2 = C_2^*$ in total πC_2^*

each

8

Everyone consumes more

Can the bank do it?

Resources at $t=1$

Need $(1-\pi)c_1^*$

$$(1-\pi)c_1^* = (1-\pi)c_2^*$$

all short term investments

gives $c_2^* > c_1^*$

(9)

What if you thought everyone withdraws $t=1$

Bank can not satisfy everyones demand

$$(1-\pi)+\pi L < 1$$

Do if you think everyone else will do it

So you rush to bank

Self fulfilling prophecy

At $t=2$ no food at all

TA Correction to 4/29 Lecture

4/29

Bank invests

$$I = \frac{\Pi C_2^*}{R} \quad \text{not} \quad \Pi$$

Problem Set # 6
14.02 Spring 2011
Due April 29

April 22, 2011

1 True/False [20 points]

Please state whether each of the following claims are True or False, and provide a brief justication for your answer. You may include graphs and equations to support your answer.

1. "Deposit accounts by consumers are considered part of banks' assets" [5 points]
2. "In the Holmstrom-Tirole (1997) model seen in class, an agent who is not wealthy enough to be financed by a small investor may be able to obtain finance from a bank." [5 points]
3. "In the Holmstrom-Tirole (1997) model seen in class, if the entrepreneur's action has no effect on the probability of success ($p_H = p_L = p$) then the entrepreneur will not be able to get outside finance from a small investor". [5 points]
4. "If the maturity of a bank's assets coincides with the maturity of its liabilities, then the bank is not subject to a bank run." [5 points]

2 The Holmstrom-Tirole Model [40 points]

Consider the Holmstrom-Tirole model discussed in class. Assume there are many entrepreneurs and many small investors (but no banks). Entrepreneurs have cash A, and an idea for a project that costs $I > A$ to implement. The project is risky. Its return can either be $R > 0$ with probability p, or 0 with probability 1-p. The entrepreneur can affect the probability of success: $p = p_H$ if he works hard, while $p = p_L < p_H$ is he does not work hard. Assume that the entrepreneur's actions are not observable to the outside investor, and that the entrepreneur gets a private benefit of B units of cash when he does not

work hard. Investors have access to a Government bond with return γ. Assume further that:

$$p_H R > \gamma I \quad (1)$$
$$p_L R + B < \gamma I \quad (2)$$

A small investor can fund an entrepreneur by providing $I - A$ units of cash.

1. Explain in words what conditions (1) and (2) mean. [5 points]
2. A contract between one investor and one entrepreneur can be characterized by (R_E, R_S). What do R_E and R_S stand for? [5 points]
3. Write a condition that guarantees that the entrepreneur will work hard. Explain the intuition behind this condition. [5 points]
4. Write a condition that guarantees that the investor is willing to fund the entrepreneur. [5 points]
5. Show why the condition derived in point 4 implies the entrepreneur's wealth (A) has to be greater than some threshold (which depends on I, p_H, γ and R_S). [5 points]
6. From now on assume that R_E is the smallest possible value compatible with the condition you found in point 3. Using this information, re-write the wealth threshold found in point 5 as a function of I, p_H, p_L, γ, R and B. [5 points]
7. Suppose that the probability of success when the entrepreneur does not work hard (p_L) increases. Is this good or bad for the economy? Explain intuitively. [Hint: consider what happens to the wealth threshold] [5 points]
8. Suppose that B increases. Is this good or bad for the economy? [5 points]

3 A Model of Bank Runs [40 points]

Consider the model of Diamond and Dybvig (1983).

1. In class we have seen that the market allocation is given by $c_1^M = 1$ and $c_2^M = R$, while the "autarky" allocation was $c_1^A \leq 1$ and $c_2^A \leq R$. How is the market able to do this? No need to reproduce the algebra of the notes, just explain intuitively what is going on. [5 points]
2. Consider now the arrangement with banks. Each agent gives its endowment unit to the bank at t=0. In turn, the agent is entitled to c_1^* units of consumption at $t = 1$ or c_2^* units of consumption at $t = 2$. Show that the aggregate resource constraint for the economy is:

$$\pi c_1^* + (1 - \pi) \frac{c_2^*}{R} = 1 \quad (3)$$

[5 points]

3. Show why, in the arrangement with banks, it is possible to have $c_1^* > 1$, and $c_2^* < R$. [Hint: use equation (3)]. [5 points]

4. Explain, intuitively, why the agents may prefer the allocation (c_1^*, c_2^*) with $1 < c_1^* < c_2^* < R$, to the market allocation. [5 points]

5. Could the bank offer $c_1^* > c_2^*$ as a contract? [5 points]

6. Explain why a bank run may occur. In particular, explain what should a patient agent do if she expects all other patient agents to show up at $t = 1$. [5 points]

7. Suppose that the bank follows a "*suspension of convertibility*" policy. It announces that it will pay c_1^* to the first π depositors who withdraw at $t = 1$. If more people show up at $t = 1$, it will tell them to wait until t=2 to collect c_2^*.

   i. If all of the other patient depositors try to withdraw, what is the best thing for a patient depositor to do? [5 points]

   ii. Does this policy solve the problem of bank runs? [5 points]

14.02 Leverage

2 functions for banks

- monitoring
- transforming maturity

- These functions are good things usually
- banks are amplification mechasims
  - exasterbate issues
- banks are subject to bank runs
- in a big bank run, no bank can survive

Banks' Balance Sheet

$$L = D_0 + \bar{k}$$

Liabilities = Deposits + Capital = Equity

Assets = Reserves + Loans

α = Fraction of assets invested in loans

Assets = $(1-\alpha)L + \alpha L$

Assets = Liabilities

(2)

Reserves are like short term - are liquid

Loans are long-term, can't take $ out earlier

$$\text{Leverage} = \lambda = \frac{\text{assets}}{\text{equity}} = \frac{L}{k}$$

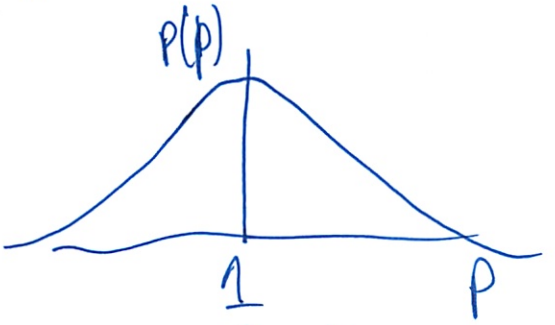
Loans are risky

For every $1 in loans, get $ρ back

$ρ > 1$ made $

$ρ < 1$ lost $ } sometimes

ρ follows a normal dist



could center around 1 + profit
but not to keep it simple
or perfectly competitive brings profit to 0

$$\rho \begin{cases} \rho < 1 & \text{w/ prob } \frac{1}{2} \\ \rho > 1 & \frac{1}{2} \end{cases}$$

(3)

Then tomorrows's balance sheet

Assets	Liabilities
Reserves $(1-\alpha)L$ ≈ don't change	Do
Loans $p(\alpha L)$ ↑ now here	$\bar{k} + (p-1)\alpha L$ ↑ must reflect the gains or losses

How bad do things need to get before bankrupcy?

bankrupcy ≤ 0 or negitive equity

$$\bar{k} + (p-1)(\alpha L) \leq 0$$

Actually will define just as "negitive" equity

$$\bar{k} + (p-1)(\alpha L) < 0$$

Assuming bank does not pay interest - to simplify

(4)

What is prob bank will go broke?

$= P(\bar{k} + (p-1)(\alpha L) < 0)$

p is the only variable here; αL other stuff constant

$= P\left(p < 1 - \frac{\bar{k}}{\alpha L}\right)$

→ if α is 0 - can never go bankrupt
b/c not taking any risk

Remember can't tell if bank loaning its capital or reserves
- (was thinking from earlier last model i monitoring)
- TA: we weren't really looking at deposits at this point

→ If $\alpha = \frac{1}{2}$ $P\left(p < 1 - 2\frac{\bar{k}}{L}\right)$ =

area under curve

5

Say $P(l < l - \frac{2\bar{k}}{L}) = 2\%$

Banks in real life pick prob of bankrupcy - then that gives them α

Value at Risk

$$VAR = |(p-1)(\alpha L)|$$

pick α such that $P(p < 1 - \frac{\bar{k}}{\alpha L}) \leq 5\%$

$P(p < 1 - \frac{1}{\alpha L}) \leq 5\%$

So for prob 5%, can find threshhold

Can compute over any period, but usually yearly

High α or high λ $\uparrow$ prob of going bankrupt

Reserve ratio = $1 - \alpha$

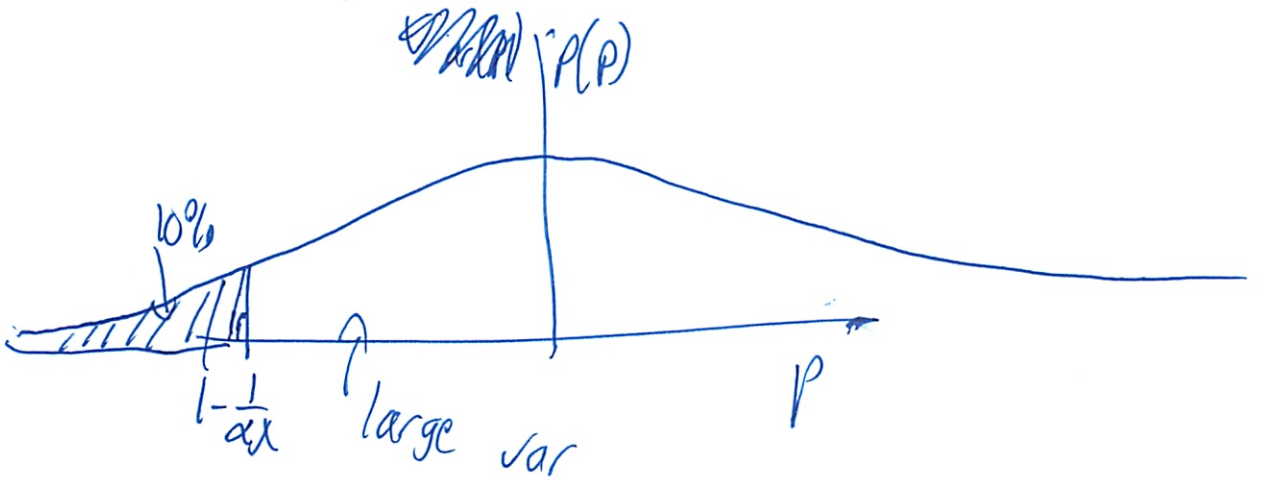
Gov picks reserve ratio

Big debate today about what it should be

If gov sets high reserve ratio, can take a lot of risk by keeping λ high

(6)

Or something w/ a lot of var



If var(p) ↑, but keep prob constant ≤ 5%
(bankruptcy)

α ↓

λ ↓

What can you do?

α → ↑ reserves

α → sell loans

λ → ↑ capital
raise

assume $\alpha = 1$ initially

assets	liabilities
110	$D_0 = 99$
	$E_K = 11$

$\lambda = \frac{110}{11} = 10$

(5)

Say value of loan portfolio ↓ to 109

Need to ↑k or ↑D_0 since ↓ assets means it falls off equity
↑ to keep same leverage ↓

When had a loss, λ ↑, so p(bankruptcy) ↑

Want keep P(bankruptcy) same so sell deposits or raise capital

↳ must raise 1 units

assets	equity
109	$D_0 = 99$
	$\bar{k} = 10 \rightarrow 10.9$

But had to raise $ in bad econ!

↓ Value of your capital

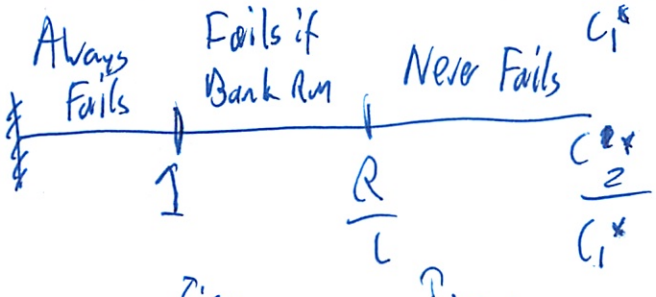
Exam Thur
- The 4 things in the slides
- Balance Sheet
- T|T (Monitoring)
- DD (Bank Runs)
- ~~B~~ Leverage

Corrections to notes

Slides: bank runs why they can happen

Diamond Before: If everyone withdraws at $t=1$, bank is gone

Now: Only true if $1 < \frac{C_2^*}{C_1^*} < \frac{R}{L}$



↑ if bank run never happens bank survives

↑ if bank run bank survives

$\frac{C_2^*}{C_1^*}$ is close to 1

$1 < C_1^* < C_2^* < R$

Increase utility from market outcome

Occurs if utility is strictly concave

(2)

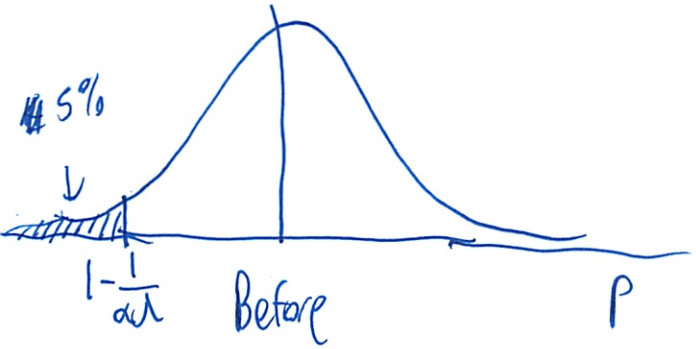
OH today 7PM 1-247

Review

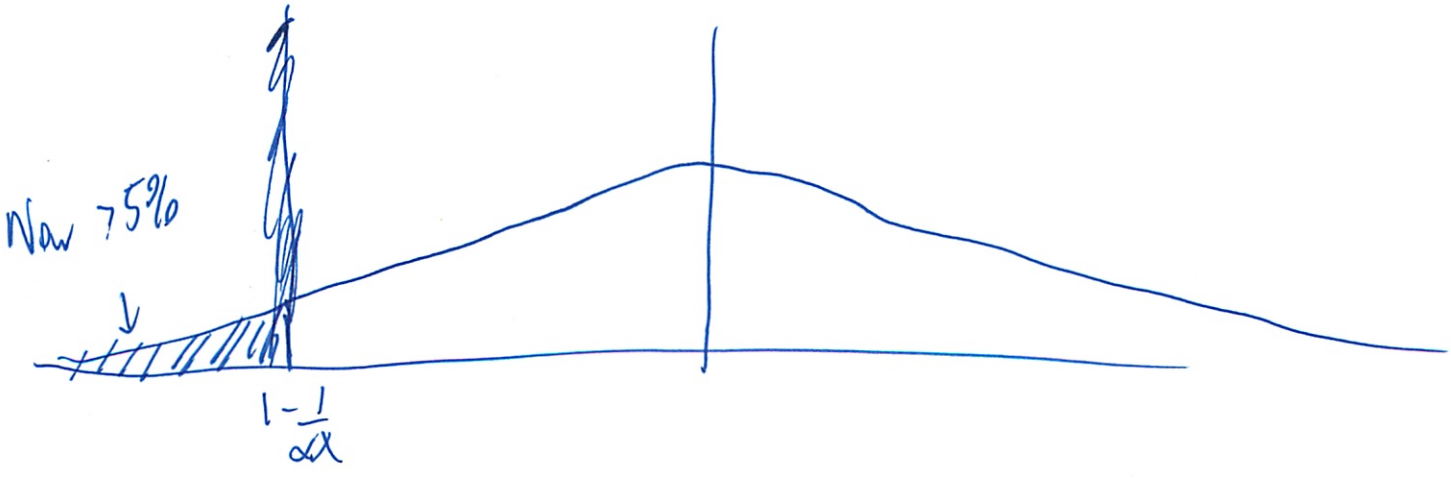
Var(P) is exogenous

When var(P) ↑ to keep prob (bankruptcy) < .05

You need to either sell risky assets ⇓ or raise capital ⇑ or both



So now Var(P) exogenously ↑

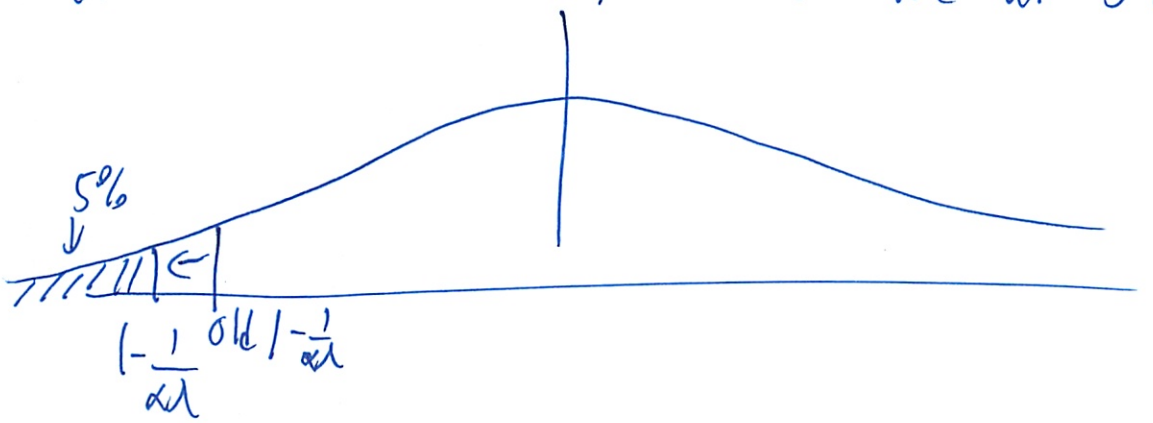


(3)

But not taking into account anything else

$P(\text{bankrupt}) = P\left(p < 1 - \frac{1}{\alpha L}\right) = 5\%$

Need to shift the line, to keep line at 5%



When var(p) ↑, L must ↓ for given α

(Correction to notes)

Assets		Liabilities	
Loans	αL	D_0	
Res	$(1-\alpha)L$	$\bar{k}$	

$$Var = \left|\frac{(p-1)\alpha L}{\bar{k}}\right|$$

↑ proportion of initial equity

$\text{Prob}\left((1-p)\alpha L \geq \bar{k}\right) = P(\text{bankruptcy})$

Initial equity not enough to cover equity losses

(4) $P\left(\frac{(1-p)\alpha L}{\bar{k}} > 1\right)$

$= P\left((1-p)\alpha L > \bar{k}\right)$

$= P\left((1-p) > \frac{\bar{k}}{\alpha L}\right)$

$= P\left(p < 1 - \frac{\bar{k}}{\alpha L}\right)$

Another correction made in slides

One more in 1st model

Since $R_B = \frac{c}{\Delta p}$

$R_I = \frac{b}{\Delta p}$

$R_S = R - \frac{(b+c)}{\Delta p}$ not $R_S = p_H\left[R - \frac{(b+c)}{\Delta p}\right]$

Always want investor to work hard, since otherwise it would be better to invest in the safe asset.

$p_H R > \gamma I$

$p_L R + B < \gamma I$

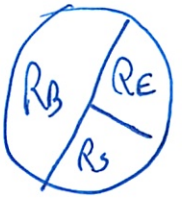
(5) $R_B = \frac{C}{\Delta P}$ ensures you are happy as a banker

$R_S = R - \frac{(b+c)}{\Delta p}$

If ent works hard → big pie

not hard → small pie

Then have to split pie



↑ So they won't invest!

If $p_L = p_H$ both of the conditions can not hold

$p_L R + b < \gamma I$

The b has to come from somewhere

- from the returns to the project
- b is considered waste
- always goes to entpreneur