07-10 Recession
- wealth in homes for families
- banks covered loans

74-75 oil
90-91 consumer confidence
01 recession

banks amplify
fin system transfer household → companies

Balance Sheet

Assets = Liabilities + Equity

$\text{leverage} = \frac{\text{Assets}}{\text{Equity}}$

Households - morgage highly leveraged
- so small movements in price big deal

Also Flexible rate morgages - bad as prices ↑

Might still can make payments, but owes more than what house is worth

If non-recourse loan - bank broke
Can't take more than house

Who has $ usually worst to do project
Give $ to people w/ ideas
Make balance sheet for all sectors of econ
Many loan to each other
Since banks have diff skills + roles in econ

Small investors can't ensure ent. work
① lack of trust overcome if ent. have "skin in the game"
banks can also monitor
banks also transform maturities
② + providing liquidity

① Holmestrom/Tirole Small investors + monitor

Ents
idea cost I
have $A < I$
idea will $R > 0$ w/ prob p
0 w/ prob $(1-p)$

14.02 Exam 3

Investors could do $0 < \gamma I < R$
in a gov bond

Ents need outside funding
Ents set p w/ effort, depending on private Benefit B
if $B = 0 \to p = p_H$
if $B = B \to p = p_L$

Inv only gets return if high effort
$p_H R > \gamma L$
$p_L R + B < \gamma L$

So Inv must make sure Ent works hard
If project succeeds, produces $R; R_E, R_S$
R_E must satisfy
$p_H R_E \geq p_L R_E + B$
$R_E \geq \frac{B}{p_H - p_L} = \frac{B}{\Delta p}$

So not all returns go to outside investor
$R_S \leq (R - R_E) < R$

And inv could just inv in bonds, so
$p_H R_S \geq \gamma(I - A)$

Combine the 2 cond
$A(B) \geq I - \frac{p_H}{\gamma}\left(R - \frac{B}{\Delta p}\right)$

Competition brings return to γ

Banks can also monitor, reducing benefit to $b < B$ at a cost c
Now Inv gets $R_E \geq \frac{b}{\Delta p}$
Bank $p_H R_B - c \geq p_L R_B$
$R_B \geq c/\Delta p$ to get involved

I_B = bank's investment
So gross return $\beta = \frac{p_H R_B}{I_B} \geq \frac{p_H c}{I_B \Delta p}$

So min amt bank must contribute
Bank uses own capital

Monitoring costs A. So $\beta > \gamma$
R_S w/ bank: $p_H R - \frac{(b+c)}{\Delta p}$
Inv contribute $I - A - I_S$ so
$\gamma\left[I - A - I_S(B)\right] \leq p_H\left[R - (b+c)/\Delta p\right]$

Issues/Risks

A could fail, now needing banks
Bank could claim c is small - after inv made, no incentive to actually monitor
$I_B(B)$ could fall, and bank can't cover cost of monitoring

② Transforming Maturities

- Smoothing out returns
- 3 periods

Skip rest
for now

Do practice test

5/5

Leverage

Banks broke if value of assets tomorrow not enough to pay for deposits

Oh value at risk chart

Very little on exam
But I should know it perfectly then
But it will prob be mostly math anyway!
Focus on the real #s part
Practice exam!

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

$$p_H R_E - p_L R_E \geq B$$

$$R_E(p_H - p_L) \geq B$$

$$R_E \geq \frac{B}{p_H - p_L}$$

when flip?
(when · / by 0 #?

Otherwise just treat like any other equality!

---

a $R_S \leq \frac{R - R_F}{\Delta p}$

$$R_S \geq \frac{\gamma(I - A)}{p_H}$$

So $\frac{\gamma(I-A)}{p_H} \leq R_S \leq \frac{R - R_F}{\Delta p}$

(2)

Then what to solve for:

A:

L ~~invest~~ money investors have

Well what is goal:

How much Uncle ents need to invest, so A good idea

try solving

Ci How do w/ 3

- treat one at a time:

$$\$I - \$A \leq R_S P_{H1}$$

$$\$A \geq -R_S P_{H1} - \$I$$

$$A \geq \frac{-R_S P_{H1} - \$I}{\$}$$

They have

$$A \geq I - \frac{P_{H1}}{\$\left(R - \frac{B}{\Delta P}\right)}$$

I did not include other part:

(3) Loading online - act on both halves
- well all 3 parts at once

try again, solve for A

$$\frac{\gamma(I-A)}{P_H} \leq R_S \leq \frac{R-R_F}{\Delta P}$$

$$\gamma(I-A) \leq R_S P_H \leq \frac{(R-R_F)}{\Delta P} P_H$$

$$\gamma I - \gamma A$$

$$-\gamma A \leq R_S P_H - \gamma I \leq \frac{(R-R_F)P_H}{P_H-P_L} + \gamma I$$

$$\frac{}{-\gamma}$$

$$A \geq \frac{R_S P_H - \gamma I}{-\gamma} \geq \frac{(R-R_F)P_H}{-\gamma(P_H-P_L)} - I$$

$$A \geq \frac{R_S P_H}{-\gamma} + I$$

Closer

Ans $A \geq I - \frac{P_H}{\gamma(R-\frac{R}{\Delta P})}$

"How did they get?"

Ah urg - I won't figure this out

- odds are test will want you to know

(4)

Focus on skills/understanding model
Not memorizing parameters

Banks lower req capital
isoly since $b < B$

Exam Now

---

2 again

why? oh of course ~~he expects it to work out~~ expects Ent to work hard is risk adjusted ← important

← How bank Ent realize this upfront

PH $\gamma(I - A) \leq R_S$

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

$\gamma(I - A) \leq R_S \leq R - \frac{B}{\Delta p}$

Now A
- What us tick
See above one only

$\gamma I - \gamma A \leq R_S$

$-\gamma A \leq R_S - \gamma I$

$A \geq -\frac{R_S}{\gamma} \frac{PH}{} + I$

$A \geq I - \frac{R_S}{\gamma}$

Now plug in R_S

$A \geq I - \frac{PH}{\gamma}\left(R - \frac{B}{\Delta p}\right)$

(5)

keep getting them wrong!

They should give enough info to recreate models
- But I am bad at that

$$\frac{\Gamma_k}{\alpha\lambda}$$

↑ leverage

~~bad sheet uses L~~

No

$$\frac{l_k}{\alpha L} = \frac{1}{\alpha\lambda}$$

$$\lambda = \frac{L}{k}$$

L = loans + risky investments

Leverage $\lambda = \dfrac{\text{Assets} = \text{Liabilities}}{\text{equity}}$

$$P\left(\rho < 1 - \frac{k}{\alpha L}\right) \leq 5\%$$

$$P\left(\rho < 1 - \frac{1}{\lambda\alpha}\right) \leq 5\%$$

Return RV

14.02 Principles of Macroeconomics

Quiz 3

May 6th, 2010

1. Consider the balance sheet of a bank. Deposit accounts are part of:

   (a) Assets.

   (b) Equity.

   (c) Debt.

   (d) None of the above.

Liabilities
they call same thing I guess

2. Banks are subject to bank runs because:

   (a) They borrow short and lend long.

   (b) They borrow long and lend short.

   (c) They usually have low leverage.

   (d) None of the above.

3. Consider the Holmstrom Tirole model we saw in class. Suppose that a financial crisis hits the economy. As a result, banks lose some of their capital. The proportion of projects that are financed

   (a) does not change

   (b) decreases because small investors can now get a lower return on their funds

   (c) decreases because banks have a harder time convincing small investors that they will monitor

   (d) increases because small investors can now get a higher return on their funds

4. A new government has been voted into power.This government inherits some positive stock of debt and keeps the primary balance at zero ($G_t = T_t$) as long as it stays in power. The growth rate of real output is constant and higher than the real constant interest rate $g > r$. At the end of the government's mandate:

   (a) the debt to GDP ratio in the country is higher than it was at the beginning of the mandate

   (b) the debt to GDP ratio in the country is lower than it was at the beginning of the mandate

   (c) the debt to GDP ratio in the country is the same as it was at the beginning of the mandate

   (d) This information does not enable me to say anything about the debt to GDP ratio.

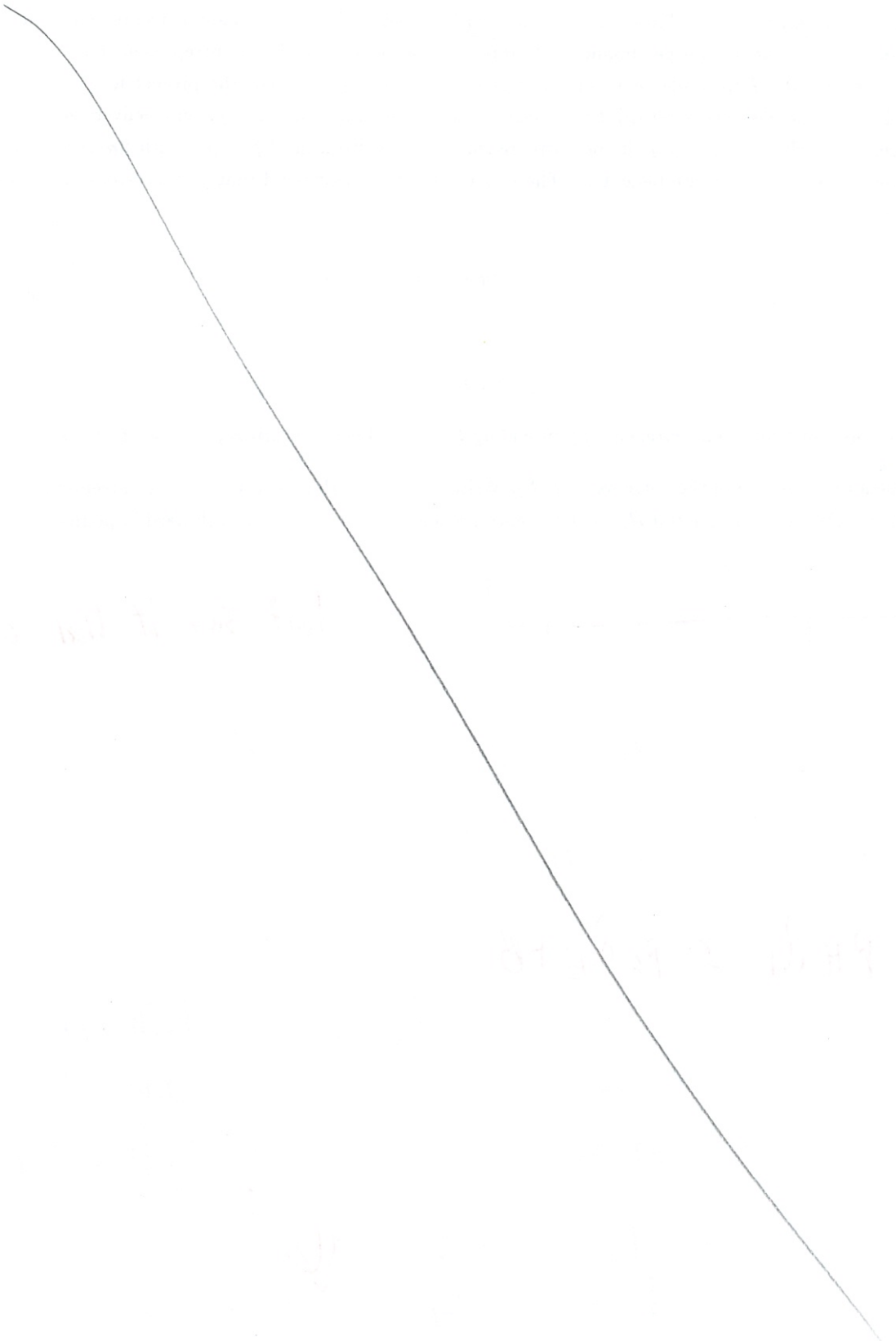
5. Consider the Diamond Dybvig model we saw in class. The bank is offering the following contract. You give them 1 in $t = 0$. Then in $t = 1$ you can choose to either withdraw c_1^* or withdraw nothing. If you don't withdraw c_1^*, you get c_2^* in $t = 2$. Recall that $c_1^* > 1$ and $c_2^* < R$, where R is the gross return on the long-term technology. Suppose there is some guy who chooses not to deposit his one unit of money in the bank (we'll call him *storage guy*). He puts it in the "long-term" technology that yields R instead. Then at time $t = 1$, when everybody finds out about their types:

   (a) the bank should be worried about patient depositors claiming to be impatient. This is because patient depositors can trade c_1^* with a storage guy who turns out to be impatient and consume $R > c_2^*$.

   (b) the bank should be worried about impatient depositors claiming to be patient. This is because impatient depositors can trade c_1^* with a storage guy who turns out to be impatient and consume $R > c_2^*$.

   (c) the bank should be worried about patient depositors claiming to be impatient. This is because patient depositors can trade c_1^* with a storage guy who turns out to be patient and consume $R > c_2^*$.

   (d) the bank should be worried about impatient depositors claiming to be patient. This is because impatient depositors can trade c_1^* with a storage guy who turns out to be patient and consume $R > c_2^*$.



2 Holmstrom and Tirole (1997) [25 points]

Consider the Holmstrom and Tirole (1997) model without banks. There are many entrepreneurs and many investors. Entrepreneurs can get finance only directly from investors. Each entrepreneur has an idea for a project that costs I to implement, and cash $A < I$. Once implemented, the project is successful with probability p, and delivers a return R; or unsuccessful with probability $1 - p$, and delivers zero. If the entrepreneur works hard $p = p_H$; if the entrepreneur does not work hard $p = p_L$, with $p_H > p_L$, and the entrepreneur receives a private benefit B. There is a safe government bond that pays a (gross) interest rate γ. Assume

Straight out of book

$$p_H R > \gamma I$$

and

$$p_L R + B < \gamma I \quad .$$

Investors can finance entrepreneurs by providing $I - A$, and get a return R_S in case of success.

1. Denote the return of the entrepreneur R_E. Write a condition that ensures that the entrepreneur works hard. Derive the minimum R_E that the entrepreneur needs in order to work hard [5 points].

there wasn't two in model

$R_E = p_H R_{E\text{Hard}} + p_L 0$ — don't say it that way

R_E must be large enough for investor to get, instead B

$p_H R_{E\text{Hard}} < B$

$p_H R_E \geq p_L R_E + B$

but aren't these 2 different — through me off

Oh p_H, p_L both that will succeed and at same amts - just diff prob

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

2. Denote the return of the entrepreneur R_S. Derive, showing the steps, the minimum amount of cash A an entrepreneur needs in order to get finance [10 points].

Needs to invest $I - A$

Must be more than bond

$$R_s \cdot I \geq \gamma(I - A)$$

Other constraint:

Gets whats left

$$R_s = (R - R_E) \rightarrow R_s \leq R - \frac{B}{\Delta_p} < R$$

(↙ why ≤, ↙ plug in)

$R_s \leq \frac{R - R_E}{\Delta_p}$ Oh duh just write it!

$$\gamma(I-A) \leq R_s \leq R - \frac{B}{\Delta p}$$

Now that A part, I can't do

Sub into (1)

$$A \geq I - \frac{P_H}{\gamma} R_s \quad \text{← so I only in one section}$$

$$A \geq I - \frac{P_H}{\gamma}\left(R - \frac{B}{\Delta_p}\right) \equiv \bar{A}(\gamma)$$

(sub in - much better than what I did!

3. Suppose now that the probability of success when the entrepreneur does not work hard is $p = p'_L$, with $p'_L > p_L$. Assume that

still less than bond

$$p'_L R + B < \gamma I \quad .$$

Is the increase in this probability a good or a bad thing for the economy? To answer this question, study the effect of this increase on the threshold $\bar{A}(\gamma)$. What is the intuition for your result? [5 points]

Good thing?

- better chance of ✓ back
  but still low

Or bad thing since effect on I

$$A \geq I - \frac{p_H}{\gamma}\left(R - \frac{B}{p_H - p_L}\right)$$

$\Delta p \downarrow$ than

fraction denom ↓

fraction ↑

but sum from R ↑ (minus less)

A ↑ overall

This is bad - higher leverage, more risk

harder to finance

$R_L \uparrow$ $R_S \downarrow$

Another one wrong!

4. Suppose now that the probability of success when the entrepreneur does not work hard is $p = p''_L$, with $p''_L > p'_L > p_L$. Assume that

even higher

$$p''_L R + B > p_H R > \gamma I \quad .$$

now better for ent

and

~~still a bad deal~~

$$p''_L R > \gamma I \quad .$$

And for inv

Will the entreprepreneur work hard? Will entrepreneurs be able to get finance? To answer this question, compute a lower bound for the amount of cash A needed to get finance. [5 points]

No will not work hard - higher return

$p''_L + B > p_H R$ ✓

But still good for ~~ent~~ inv ✓ type, will make more than bond $p''_L R > \gamma I$ ✓

~~$A \geq I - \frac{p_H}{\gamma}\left(R - \frac{B}{p_H - p_L}\right)$~~

A ↑ further;

Need to finance even more cash

But what I have is upper bound

Inv will finance $p''_L R_S = \gamma (I - A)$

$$A(\gamma) = I - \frac{p''_L}{\gamma} R_S$$

was kinda thinking this but need to make it explicit

Inv ~~needs~~ can to demand $R_S = R_B$ ($R_E = 0$) $A(\gamma)$ would be -, 0, so ent get all financing

need to see + realize + get qu correct!

↓ Gov debt, last test I believe

3 A plan to rescue the Greek economy [45 points]

Let Y_t denote real GDP at time t, B_t the real public debt at time t, D_t the real deficit at time t ($D_t \equiv B_t - B_{t-1}$), $PB_t \equiv G_t - T_t$ the primary deficit. Please note that we will refer to the quantity PB_t as the "primary balance" at time t. Hence we let $\Delta_t PB \equiv PB_t - PB_{t-1}$ be the change in the primary balance between t and $t+1$. Assume that interest rates are constant and that output grows at a constant rate, $g > 0$.

1. Write down the dynamic equation for real government debt B_t (i.e. the debt measured in units of goods) as a function of interest rates, the past value of debt and the primary balance. What interest rate should you be using? [3 points]

2. You are told that real GDP in Greece in 2009 was $Y_{2009} = 238$ billion euros. Real interest payments were 5% of real GDP, $r_{2009}B_{2008}/Y_{2009} = 5\%$. Finally, the deficit to GDP ratio was 12.7% so

$$Y_{2009} = 238 \quad \frac{r_{2009}B_{2008}}{Y_{2009}} = 5\%. \quad \frac{B_{2009}-B_{2008}}{Y_{2009}} = 12.7\%$$

What was the Greek real primary balance in 2009, as a share of real GDP? [6 points]

3. Using the expression that you found in part (1) and the identity $D_t \equiv B_t - B_{t-1}$ derive a dynamic equation for the ratio of deficit to GDP as a function of the past ratio of deficit to GDP and the change in the primary balance, i.e. solve for D_t/Y_t as a function of D_{t-t}/Y_{t-1} and $\Delta_t PB/Y_t$ [6 points]

4. Suppose Greece wants to have a deficit of 3% of GDP from 2010 onwards(this is the level it would need to achieve in order comply with EU laws on fiscal policy). Greece can borrow from other EU countries at a nominal interest rate of 5%. Assume that Greek real output grows at a constant rate g such that $g = 1\%$ a year. Assume that the Greek inflation rate is $\pi = 2\%$.

   (a) Use the dynamic equation for the deficit to GDP ratio to find the value of the primary balance to GDP ratio in 2010 that it would need to do so [6 points].

(b) The ratio of debt to GDP in 2009 was 113.4%. Assume Greece implements the correction you have just solved for in part (a). Continue to assume that $i = 5\%$, $\pi = 2\%$ and $g = 1\%$. Assume that from 2011 onwards, the primary balance is zero. Compute the ratio of debt to GDP in 2010 [6 points].

5. Suppose Greece goes ahead and implements the fiscal consolidation ($\Delta T > 0$ and $\Delta G < 0$). Use an IS-LM diagram combined with the interest parity condition graph to show what would happen to output, nominal interest rates and nominal exchange rates. Describe intuitively [6 points].

6. You are going to figure out what E should be.

   (a) Suppose $E > 1$. Assume the Marshall Lerner condition holds. Use an IS-LM graph to show: What happens to Greek net exports? What happens to the nominal and real money supply in Greece? What happens to GDP? What happens to Greek nominal interest rates? Provide verbal intuition for each of your answers [5 points].

(b) Suppose $E < 1$. Assume the Marshall Lerner condition holds. Use an IS-LM graph to show: What happens to Greek net exports? What happens to GDP? What happens to the money supply in Greece? Greek nominal interest rates? Provide verbal intuition for each of your answers [5 points]

(c) Based on your results in (a) and (b), should the Greek central bank set $E > 1$ or $E < 1$? [2 points]

14.02 Principles of Macroeconomics

Quiz 3

May 6th, 2010

1 Short Questions [30 points]

Please mark the right answer. Each of these is worth 6 points.

1. Consider the balance sheet of a bank. Deposit accounts are part of:

   (a) Assets.

   (b) Equity.

   (c) Debt.

   (d) None of the above.

   Answer: C.

2. Banks are subject to bank runs because:

   (a) They borrow short and lend long.

   (b) They borrow long and lend short.

   (c) They usually have low leverage.

   (d) None of the above.

   Answer: A.

3. Consider the Holmstrom Tirole model we saw in class. Suppose that a financial crisis hits the economy. As a result, banks lose some of their capital. The proportion of projects that are financed

   (a) does not change

   (b) decreases because small investors can now get a lower return on their funds

   (c) decreases because banks have a harder time convincing small investors that they will monitor

   (d) increases because small investors can now get a higher return on their funds

   Answer: C

4. A new government has been voted into power.This government inherits some positive stock of debt and keeps the primary balance at zero ($G_t = T_t$) as long as it stays in power. The growth rate of real output is constant and higher than the real constant interest rate $g > r$. At the end of the government's mandate:

   (a) the debt to GDP ratio in the country is higher than it was at the beginning of the mandate

   (b) the debt to GDP ratio in the country is lower than it was at the beginning of the mandate

   (c) the debt to GDP ratio in the country is the same as it was at the beginning of the mandate

   (d) This information does not enable me to say anything about the debt to GDP ratio.

   Answer: B

5. Consider the Diamond Dybvig model we saw in class. The bank is offering the following contract. You give them 1 in $t = 0$. Then in $t = 1$ you can choose to either withdraw c_1^* or withdraw nothing. If you don't withdraw c_1^*, you get c_2^* in $t = 2$. Recall that $c_1^* > 1$ and $c_2^* < R$, where R is the gross return on the long-term technology. Suppose there is some guy who chooses not to deposit his one unit of money in the bank (we'll call him *storage guy*). He puts it in the "long-term" technology that yields R instead. Then at time $t = 1$, when everybody finds out about their types:

   (a) the bank should be worried about patient depositors claiming to be impatient. This is because patient depositors can trade c_1^* with a storage guy who turns out to be impatient and consume $R > c_2^*$.

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   (d) the bank should be worried about impatient depositors claiming to be patient. This is because impatient depositors can trade c_1^* with a storage guy who turns out to be patient and consume $R > c_2^*$.

   Answer: A

2 Holmstrom and Tirole (1997) [25 points]

Consider the Holmstrom and Tirole (1997) model without banks. There are many entrepreneurs and many investors. Entrepreneurs can get finance only directly from investors. Each entrepreneur has an idea for a project that costs I to implement, and cash $A < I$. Once implemented, the project is successful with probability p, and delivers a return R; or unsuccessful with probability $1 - p$, and delivers zero. If the entrepreneur works hard $p = p_H$; if the entrepreneur does not work hard $p = p_L$, with $p_H > p_L$, and the entrepreneur receives a private benefit B. There is a safe government bond that pays a (gross) interest rate γ. Assume

$$p_H R > \gamma I$$

and

$$p_L R + B < \gamma I \quad .$$

Investors can finance entrepreneurs by providing $I - A$, and get a return R_S in case of success.

1. Denote the return of the entrepreneur R_E. Write a condition that ensures that the entrepreneur works hard. Derive the minimum R_E that the entrepreneur needs in order to work hard [5 points].

   Answer:

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

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

2. Denote the return of the entrepreneur R_S. Derive, showing the steps, the minimum amount of cash A an entrepreneur needs in order to get finance [10 points].

   Answer: The investor will provide funding if his expected return is higher that what he gets on the bond market:

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

   which is equivalent to

   $$A \geq I - \frac{p_H}{\gamma} R_S \qquad (1)$$

   Now notice that

   $$R_S = R - R_E$$

   Substituting in this expression the expression for R_E:

$$R_S = R - \frac{B}{\Delta p}$$

Substitute into (1)

$$A \geq I - \frac{p_H}{\gamma}\left(R - \frac{B}{\Delta p}\right) \equiv \bar{A}(\gamma)$$

3. Suppose now that the probability of success when the entrepreneur does not work hard is $p = p'_L$, with $p'_L > p_L$. Assume that

   $$p'_L R + B < \gamma I \quad .$$

   Is the increase in this probability a good or a bad thing for the economy? To answer this question, study the effect of this increase on the threshold $\bar{A}(\gamma)$. What is the intuition for your result? [5 points]

   Answer: Bad thing. $\bar{A}(\gamma)$ has increased, harder to get finance than before.

   Intuition: The constraint that makes sure the entrepreneur works hard is harder to satisfy, R_E needs to be higher, R_S goes down.

4. Suppose now that the probability of success when the entrepreneur does not work hard is $p = p''_L$, with $p''_L > p'_L > p_L$. Assume that

   $$p''_L R + B > p_H R > \gamma I \quad ,$$

   and

   $$p''_L R > \gamma I \quad .$$

   Will the entreprepreneur work hard? Will entrepreneurs be able to get finance? To answer this question, compute a lower bound for the amount of cash A needed to get finance. [5 points]

   Answer: Notice

   $$p''_L R_E + B > p_H R_E$$

   for all $R_E \leq R$ and therefore the entrepreneur will not work hard, for any R_E. However, since

   $$p''_L R > \gamma I$$

   we have that the investor will provide finance for high enough R_S:

   $$p''_L R_S = \gamma(I - A)$$

   from which you can get the lower bound:

$$\bar{A}(\gamma) = I - \frac{p_L''}{\gamma} R_S$$

Since entrepreneurs will be happy to provide low effort regardless of R_E, investors can always demand $R_S = R$. From the assumption that $p_L'' R > \gamma I$, $\bar{A}(\gamma)$ would be negative so entrepreneurs can get finance for all positive A.

3 A plan to rescue the Greek economy [45 points]

Let Y_t denote real GDP at time t, B_t the real public debt at time t, D_t the real deficit at time t ($D_t \equiv B_t - B_{t-1}$), $PB_t \equiv G_t - T_t$ the primary deficit. Please note that we will refer to the quantity PB_t as the "primary balance" at time t. Hence we let $\Delta_t PB \equiv PB_t - PB_{t-1}$ be the change in the primary balance between t and $t+1$. Assume that interest rates are constant and that output grows at a constant rate, $g > 0$.

1. Write down the dynamic equation for real government debt B_t (i.e. the debt measured in units of goods) as a function of interest rates, the past value of debt and the primary balance. What interest rate should you be using? [3 points]
   ANS:
   $$B_t = (1 + r_t) B_{t-1} + G_t - T_t$$
   The real interest rate $r_t \approx i_t - \pi_t$.

2. You are told that real GDP in Greece in 2009 was $Y_{2009} = 238$ billion euros. Real interest payments were 5% of real GDP, $r_{2009} B_{2008} / Y_{2009} = 5\%$. Finally, the deficit to GDP ratio was 12.7% so
   $$Y_{2009} = 238 \quad \frac{r_{2009} B_{2008}}{Y_{2009}} = 5\%. \quad \frac{B_{2009} - B_{2008}}{Y_{2009}} = 12.7\%$$
   What was the Greek real primary balance in 2009, as a share of real GDP? [6 points]
   ANS
   We can get the primary balance in 2009 from the deficit to GDP ratio equation :
   $$\frac{B_{2009} - B_{2008}}{Y_{2009}} = \frac{r_{2009} B_{2008}}{Y_{2009}} + \frac{PB_{2009}}{Y_{2009}}$$
   so
   $$\begin{aligned} \frac{PB_{2009}}{Y_{2009}} &= +12.7\% - 5\% \\ &= 7.7\% \end{aligned}$$

3. Using the expression that you found in part (1) and the identity $D_t \equiv B_t - B_{t-1}$ derive a dynamic equation for the ratio of deficit to GDP as a function of the past ratio of deficit to GDP and the change in the primary balance, i.e. solve for D_t / Y_t as a function of D_{t-t} / Y_{t-1} and $\Delta_t PB / Y_t$ [6 points]
   ANS:

Using the dynamic equation for debt we

$$\begin{aligned} B_t &= (1 + r_t) B_{t-1} + G_t - T_t \\ B_{t-1} &= (1 + r_{t-1}) B_{t-2} + G_{t-1} - T_{t-1} \end{aligned}$$

we get that

$$D_t \equiv B_t - B_{t-1} = (1 + r_t) B_{t-1} + G_t - T_t - (1 + r_{t-1}) B_{t-2} - (G_{t-1} - T_{t-1})$$

Since we are told to assume $r_t \equiv r$, we have that

$$\begin{aligned} D_t &= (1 + r) D_{t-1} + G_t - T_t - (G_{t-1} - T_{t-1}) \\ &= (1 + r) D_{t-1} + \Delta_t PB \end{aligned}$$

Then the deficit to GDP ratio is given by

$$\frac{D_t}{Y_t} = \frac{1 + r}{1 + g} \frac{D_{t-1}}{Y_{t-1}} + \frac{\Delta_t PB}{Y_t}$$

We are now going to think more about Greece. In 2009, Greece had a deficit to GDP ratio and a debt to GDP ratio given by

$$\frac{D_{2009}}{Y_{2009}} = 12.7\% \quad \frac{B_{2009}}{Y_{2009}} = 113.4\%$$

This high debt ratio generated fear that the country may default in the near future. This increased the interest rate at which the Greek government is able to borrow. As a result, the deficit increased even more. Greece is now trying to figure out a way to improve its fiscal outlook and placate financial markets.

One possibility is to improve fiscal policy i.e. use a combination of tax increases and spending cuts that would decrease the deficit and slow down debt growth.

4. Suppose Greece wants to have a deficit of 3% of GDP from 2010 onwards(this is the level it would need to achieve in order comply with EU laws on fiscal policy). Greece can borrow from other EU countries at a nominal interest rate of 5%. Assume that Greek real output grows at a constant rate g such that $g = 1\%$ a year. Assume that the Greek inflation rate is $\pi = 2\%$.

   (a) Use the dynamic equation for the deficit to GDP ratio to find the value of the primary balance to GDP ratio in 2010 that it would need to do so [6 points].
   ANS:
   There were two alternative ways to solve for this, both equally valid. The first way is the following:
   From the dynamic equation for the deficit, we have that
   $$\frac{D_{2010}}{Y_{2010}} = \left(\frac{1 + r}{1 + g}\right) \frac{D_{2009}}{Y_{2009}} + \frac{\Delta_{2010} PB}{Y_{2010}}$$
   Hence we have that
   $$0.03 = \left(\frac{1 + r}{1 + g}\right) \frac{D_{2009}}{Y_{2009}} + \frac{\Delta_* PB}{Y_*}$$

which implies that

$$\begin{aligned}\frac{\Delta_{2010}PB}{Y_{2010}} &= 0.03 - \left(\frac{1+0.03}{1+0.01}\right) * 0.127 \\ &= -0.1\end{aligned}$$

Hence we have that

$$\begin{aligned}\frac{PB_{2010}}{Y_{2010}} &= \frac{PB_{2009}}{(1+g)\,Y_{2009}} - 0.1 \\ &= \frac{0.077}{1.01} - 0.1 \\ &= -0.02\end{aligned}$$

so Greece needs to run a primary surplus of about 2% of real GDP in 2010.

Alternatively, you could have realized that you already had all the information you needed to solve even before solving for part 3 above. You were given the target deficit to GDP ratio in 2010, the debt-to-gdp ratio in 2009, the constant growth and real interest rate (g and r). All you had to do was use the dynamic equation for the debt to solve for $\frac{PB_{10}}{Y_{10}}$

$$\begin{aligned}B_{10} &= (1+r)\,B_{09} + PB_{10} \\ \frac{B_{10} - B_{09}}{Y_{10}} &= \frac{r}{1+g}\frac{B_{09}}{Y_{09}} + \frac{PB_{10}}{Y_{10}}\end{aligned}$$

The two approaches would have gotten different answers because the solution to this method was $\frac{PB_{10}}{Y_{10}} = -0.003$.

(b) The ratio of debt to GDP in 2009 was 113.4%. Assume Greece implements the correction you have just solved for in part (a). Continue to assume that $i = 5\%$, $\pi = 2\%$ and $g = 1\%$. Assume that from 2011 onwards, the primary balance is zero. Compute the ratio of debt to GDP in 2010 [6 points].

ANS:

The dynamic equation for the debt to GDP ratio is given by

$$\frac{B_t}{Y_t} = \left(\frac{1+r}{1+g}\right)\frac{B_{t-1}}{Y_{t-1}} + \frac{G_t - T_t}{Y_t}$$

Hence,

$$\begin{aligned}\frac{B_{2010}}{Y_{2010}} &= \left(\frac{1.03}{1.01}\right)\frac{B_{2009}}{Y_{2009}} - 0.02 \\ &= \frac{1.03}{1.01} * 1.134 - 0.02 \\ &= 1.1364\end{aligned}$$

As you have figured out, in order to improve its fiscal outlook Greece may need to implement a combination of tax increases and spending cuts(fiscal consolidation). Since Greece is using the Euro, it has no control over its exchange rates. So we are now going to think about Greece as a small open economy with fixed exchange rates. Consumption only depends on current net income, so the economy does not satisfy Ricardian equivalence (this may be unnecessary).

5. Suppose Greece goes ahead and implements the fiscal consolidation ($\Delta T > 0$ and $\Delta G < 0$). Use an IS-LM diagram combined with the interest parity condition graph to show what would happen to output, nominal interest rates and nominal exchange rates. Describe intuitively [6 points].

   ANS:

   The fiscal consolidation is going to be recessionary, since it depresses aggregate demand. The IS curve shifts inwards. At the same time, Greek money demand falls. Under the Euro, nominal exchange rates are given, so nominal interest rates are also given and equal to i^*. They don't change. Since aggregate activity falls, equilibrium in the money market now requires that real money balances in Greece be lower. The LM curve shifts outwards until it crosses the new IS curve at i^*.

Greek authorities are concerned about the implications of fiscal consolidation on output. Under the Euro, there's not much they can do. But they have another option. They could decide to leave to Euro thereby gaining control of their exchange rate. Suppose Greece decided to go back to the *drachma*, the currency they used to use before they joined the Euro. To re-introduce the drachma, the Greek Central Bank needs to set an initial nominal exchange rate, the price of 1 drachma in euros. Let E be the euro-drachma exchange rate.

6. You are going to figure out what E should be.

   (a) Suppose $E > 1$. Assume the Marshall Lerner condition holds. Use an IS-LM graph to show: What happens to Greek net exports? What happens to the nominal and real money supply in Greece? What happens to GDP? What happens to Greek nominal interest rates? Provide verbal intuition for each of your answers [5 points].

   ANS:

   This amounts to a real appreciation. Greek imports become cheaper and exports more expensive. Under the MLC, the trade balance worsens. Therefore demand falls, and the IS curve shifts in.

   To solve for the real money supply you need to make an assumption about prices. If you assume that the prices in Euro translate 1-for-1 with drachma prices (what used to cost one Euro now costs one drachma) then the following happens: Since the nominal money supply is now given by $M_{drachma} = M_{euro}/E$, $M_{drachma}/M_{euro} < 1$. The nominal money supply falls, and given the assumption about prices, real money balances decrease putting upward pressure on nominal interest rates. The LM shifts up. Equilibrium output falls, both because of the deterioration in the trade balance and the decrease in real money balances. The impact on interest rates is ambiguous.

   If on the other hand, you assumed that prices adjust in such a way that real money balances stay constant, then the LM doesn't shift. Output falls due to the shift in the IS and the interest rate decreases.

   (b) Suppose $E < 1$. Assume the Marshall Lerner condition holds. Use an IS-LM graph to show: What happens to Greek net exports? What happens to GDP? What happens to the money supply in

Greece? Greek nominal interest rates? Provide verbal intuition for each of your answers [5 points]
ANS:
This amounts to a real depreciation. Greek imports become more expensive and exports cheaper. Under the MLC, the trade balance improves. Therefore demand tends to increase and the IS shifts out. With the assumption of drachma prices translating 1-for-1 as above, the nominal money supply rises, and since prices are given, real money balances increase putting downward pressure on nominal interest rates. The LM shifts down. Alternatively, if real money balances are constante the LM does not shift. Equilibrium output increases, both because of the improvement in the trade balance and the increase in real money balances (with the first assumption and not the second). The impact on interest rates is positive (with the first assumption) and ambiguous (with the second).

(c) Based on your results in (a) and (b), should the Greek central bank set $E > 1$ or $E < 1$? [2 points]
ANS
It should set $E < 1$.

14.02 Problem Set 7

Due on May 4, 2011

April 27, 2011

1 Leverage

This problem investigates the importance of reserve and leverage requirements for the health of the banking sector.

Imagine there is a bank with deposits worth $D = 100$, and capital worth $K = 100$. This bank lends a fraction α of its assets as loans to entrepreneurs, and keeps the rest as reserves. The projects for which the bank lends are risky, so that each dollar invested pays p dollars, and p is a random variable that can take several values.

During normal times, the distribution of returns is the following:

p	-5	0	1	2	5
prob	$\frac{1}{10}$	$\frac{2}{10}$	$\frac{3}{10}$	$\frac{2}{10}$	$\frac{2}{10}$

During times of upheaval, overall risk in the economy increases, and the distribution of returns becomes:

p	-10	-5	0	1	2	5	10
prob	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{2}{12}$	$\frac{3}{12}$	$\frac{2}{12}$	$\frac{2}{12}$	$\frac{1}{12}$

Thus, during upheaval times some very extreme events can happen.

a. What is the expected value of investing one dollar, during normal times and during upheaval times?

b. How does the bank's balance sheet look like before and after the risky projects have delivered their returns?

c. What is the initial leverage λ of this bank?

d. Assume the economy is going through normal times. What is the maximum fraction of assets that the government should allow the bank to lend if the government wants the bank to go bankrupt with a probability of at most 10%?

e. What α is required if the government doesn't want the bank to go bankrupt in any circumstance?

f. Now assume that upheaval times arrive to the economy, and that the government had imposed α to be slightly lower than $\frac{1}{12}$ so that during normal times the bank never went bankrupt. Does the bank still not go bankrupt in upheaval times under any circumstance?

g. Suppose that the government wants to set a new α so that the bank can never go bankrupt under the upheaval times. What should the maximum allowed α be?

h. What is the probability that the bank goes bankrupt during normal times?

i. Suddenly the economy becomes more volatile and goes to upheaval times. What is the probability that the bank goes bankrupt, if the bank does not alter its leverage?

j. Assume that the bank owners think this new probability of bankruptcy is too high and decide to adjust their leverage so that the probability of going bankrupt is zero. What can they do? Show what two different things the bank can do to adjust its leverage, and find the new value of capital and liabilities in each case.

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Due on May 4, 2011

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During times of upheaval, overall risk in the economy increases, and the distribution of returns becomes:

p	-10	-5	0	1	2	5	10
prob	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{2}{12}$	$\frac{3}{12}$	$\frac{2}{12}$	$\frac{2}{12}$	$\frac{1}{12}$

Thus, during upheaval times some very extreme events can happen.

a. What is the expected value of investing one dollar, during normal times and during upheaval times?

A/ During normal times,

$$E(p) = (-5)\frac{1}{10} + (0)\frac{2}{10} + (1)\frac{3}{10} + (2)\frac{2}{10} + (5)\frac{2}{10} = \frac{12}{10} > 1$$

During upheaval times,

$$E(p) = (-10)\frac{1}{12} + (-5)\frac{1}{12} + (0)\frac{2}{12} + (1)\frac{3}{12} + (2)\frac{2}{12} + (5)\frac{2}{12} = \frac{12}{12} = 1$$

b. How does the bank's balance sheet look like before and after the risky projects have delivered their returns?

A/ The balance sheet today is

Assets	Liabilities
Loans= $\alpha(D+K) = 200\alpha$	Deposits= $D = 100$
Reserves= $(1-\alpha)(D+K) = 200(1-\alpha)$	Capital= $K = 100$

The balance sheet tomorrow is

Assets	Liabilities
Loans= $\alpha(D+K) = 200\alpha$	Deposits= $D = 100$
Reserves= $(1-\alpha)(D+K) = 200(1-\alpha)$	Capital= $K + (p-1)\alpha(D+K) = 100 + 200\alpha(p-1)$
Returns= $(p-1)\alpha(D+K) = 200\alpha(p-1)$	

c. What is the initial leverage λ of this bank?

A/

$$\lambda = \frac{D+K}{K} = \frac{200}{100} = 2$$

d. Assume the economy is going through normal times. What is the maximum fraction of assets that the government should allow the bank to lend if the government wants the bank to go bankrupt with a probability of at most 10%?

A/ The bank goes bankrupt if it becomes insolvent (i.e., if his capital is negative). This happens with probability:

$$Pr(K + (p-1)\alpha(D+K) \leq 0) \Leftrightarrow$$

$$Pr(p \leq 1 - \frac{K}{\alpha(D+K)}) \Leftrightarrow$$

$$Pr(p \leq 1 - \frac{1}{\alpha\lambda})$$

Replacing $\lambda = 2$, α must be such that

$$Pr(p \leq 1 - \frac{1}{2\alpha}) \leq \frac{1}{10}$$

For this probability to be at most 10%, looking at the distribution of returns during normal times, it is clear that $Pr(p \leq -5) = \frac{1}{10}$ while $Pr(p \leq 0) = \frac{1}{10} + \frac{2}{10} = \frac{3}{10}$. Thus, α must be such that the bank goes bankrupt ONLY if the realized return happens to be -5, and DOES NOT go bankrupt if the realized return happens to be 0. So we need that

$$K + (p-1)\alpha(K+D) > 0$$

if $p = 0$:

$$100 + (0-1)\alpha(100+100) > 0 \Leftrightarrow$$

$$100 - 200\alpha > 0 \Leftrightarrow$$

$$\alpha < 50\%$$

So the government can allow the bank to lend any fraction of his assets below 50%, and this will be enough to make the bank go bankrupt only 10% of the time.

e. What α is required if the government doesn't want the bank to go bankrupt in any circumstance?

A/ Then α has to be such that even when the projects yield their worst return of -5, the bank is still solvent:

$$K + (p-1)\alpha(K+D) > 0 \Leftrightarrow$$

$$100 + (-5-1)\alpha(100+100) > 0 \Leftrightarrow$$

$$100 + 200(-6)\alpha > 0 \Leftrightarrow$$

$$100 - 1200\alpha > 0 \Leftrightarrow$$

$$\alpha < \frac{1}{12} = 8.3\%$$

If the government forbids lending 8.3% of the banks assets or more, it is making sure that the bank will never go bankrupt.

f. Now assume that upheaval times arrive to the economy, and that the government had imposed α to be slightly lower than $\frac{1}{12}$ so that during normal times the bank never went bankrupt. Does the bank still not go bankrupt in upheaval times under any circumstance?

A/ Notice that if the extreme event $p = -10$ happens, then

$$K + (p-1)\alpha(K+D) = 100 + (-10-1)\frac{1}{12}(100+100)$$

$$= 100 - \frac{11}{12}200 = -83.3$$

So that the bank would go bankrupt with probability $\frac{1}{12}$. (Notice that if the event -5, or any other better event happens, the bank does not go bankrupt).

g. Suppose that the government wants to set a new α so that the bank can never go bankrupt under the upheaval times. What should the maximum allowed α be?

A/ For the bank to never go bankrupt, it must be that α is such that even when the worst event $p = -10$ occurs, the bank is still solvent:

$$K + (-10-1)\alpha(K+D) > 0 \Leftrightarrow$$

$$100 + (-10-1)\alpha(100+100) > 0 \Leftrightarrow$$

$$100 + -2200\alpha > 0 \Leftrightarrow$$

$$\alpha < \frac{1}{22} = 4.5\%$$

The bank cannot be allowed to lend more than 4.5% of his assets.

Assume that the government sets $\alpha = \frac{1}{12} = 8.3\%$ and does not change it from normal to upheaval times.

h. What is the probability that the bank goes bankrupt during normal times?

A/ From the result in point e., the probability that the bank goes bankrupt in normal times is

$$= Pr(p \leq 1 - \frac{1}{2\frac{1}{12}}) = Pr(p \leq 1 - 6)$$

$$= Pr(p \leq -5) = \frac{1}{10} = 10\%$$

i. Suddenly the economy becomes more volatile and goes to upheaval times. What is the probability that the bank goes bankrupt, if the bank does not alter its leverage?

A/

$$= Pr(p \leq 1 - \frac{1}{2\frac{1}{12}}) = Pr(p \leq 1 - 6)$$

$$= Pr(p \leq -5) = Pr(p = -10) + Pr(p = -5) = \frac{1}{12} + \frac{1}{12} = \frac{1}{6} = 16.6\%$$

If the bank does not adjust its leverage or its reserve ratio, it will go bankrupt with higher probability.

j. Assume that the bank owners think this new probability of bankruptcy is too high and decide to adjust their leverage so that the probability of going bankrupt is zero. What can they do? Show what two different things the bank can do to adjust its leverage, and find the new value of capital and liabilities in each case.

A/ The bank needs to change λ so that

$$Pr(p \leq 1 - \frac{1}{\alpha\lambda}) \leq 0$$

This means that even if the realization of returns is $p = -10$ they want the bank to survive. Thus, λ must be such that

$$1 - \frac{1}{(\frac{1}{12})\lambda} < -10 \Leftrightarrow$$

$$11 < \frac{1}{(\frac{1}{12})\lambda} \Leftrightarrow$$

$$11 < \frac{12}{\lambda} \Leftrightarrow$$

$$\lambda < \frac{12}{11} = 1.09$$

Because $\lambda = \frac{K+D}{K}$, this can be achieved in two ways: raising more capital, or liquidating assets to reduce liabilities.

1. If the bank owners decide to increase their capital, for example by making an emission of new shares, the new capital K' must be such that

$$\frac{K' + 100}{K'} = \frac{12}{11} \Leftrightarrow$$

$$11K' + 1100 = 12K' \Leftrightarrow$$

$$K' = 1100$$

Notice that the bank originally has a capital of only $K = 100$, so the owners will have to raise 1000 more of capital. From being the full owners of the bank, they now own less than 10% of it!

2. Instead of raising capital, the bank owners can decide to liquidate assets and reduce liabilities to D'. In this case, to achieve a leverage of $\frac{12}{11}$ the bank must satisfy

$$\frac{100 + D'}{100} = \frac{12}{11} \Leftrightarrow$$

$$(100)11 + 11D' = (100)12 \Leftrightarrow$$

$$1100 + 11D' = 1200 \Leftrightarrow$$

$$D' = \frac{100}{11}$$

$$D' = 9.09$$

Since the bank originally had $D = 100$ in loans, it must liquidate 90.91 of them!

14.02 Exam 3

Solutions

May 11, 2011

Professor: Francesco Giavazzi.

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

Student Name:_____Section:_____

1 True or False Questions (Circle only one) (5 points each)

1. Consider the Holmstrom-Tirole model. Suppose banks do not have any equity and the only thing they do is to lend deposits to entrepreneurs. Banks are still useful intermediaries because they can perform a monitoring role.

T FF

2. In the Holmstrom-Tirole model, entrepreneurs would prefer to be fully financed by banks rather than by both banks and investors.

T FF

3. In the Holmstrom-Tirole model, only inefficient projects are not funded.

T FF

4. The Holmstrom-Tirole model implies that banks with high leverage are likely to have little incentive to monitor projects.

TT F

5. In the Diamond-Dibvig model with trade (i.e., the market economy), the price of the bond that impatient agents sell at time $t = 1$ can be lower than $1/R$ but never higher than $1/R$.

T FF

6. In the Diamond-Dibvig model, banks can only improve over the market allocation if they provide insurance against being impatient.

TT F

7. In the Diamond-Dibvig model, suspension of convertibility is a better solution than narrow banking to avoid bank runs

TT F

8. A bank with a high leverage ratio can have a lower probability of bankruptcy than another bank with a lower leverage ratio

TT F

9. Facing a crisis, increasing the equity of banks is a better option for the economy than selling assets because it prevents leverage cycles.

TT F

2 Short Long Question: Leverage (20 points)

Imagine there is a bank with deposits worth $D = 1000$, and equity worth $K = 100$. This bank lends a fraction α of its assets as loans to entrepreneurs, and it keeps the rest as reserves. Entrepreneurs demand loans to finance risky projects. Each dollar invested pays p dollars, and p is a random variable that can take several values with different probabilities.

The distribution of returns is the following:

p	-10	-5	0	5	10
prob	$\frac{1}{10}$	$\frac{2}{10}$	$\frac{2}{10}$	$\frac{3}{10}$	$\frac{2}{10}$

(5 points) a. Write down the bank's balance sheet both before and after the risky projects have delivered their returns.

A/ The balance sheet today is

Assets	Liabilities
Loans= $\alpha(D+K) = 1100\alpha$	Deposits= $D = 1000$
Reserves= $(1-\alpha)(D+K) = 1100(1-\alpha)$	Equity= $K = 100$

The balance sheet tomorrow is

Assets	Liabilities
Loans= $\alpha(D+K) = 1100\alpha$	Deposits= $D = 1000$
Reserves= $(1-\alpha)(D+K) = 1100(1-\alpha)$	Equity= $K + (p-1)\alpha(D+K) = 100 + 1100\alpha(p-1)$
Returns= $(p-1)\alpha(D+K) = 1100\alpha(p-1)$	

(5 points) b. Compute the initial leverage λ of this bank.

A/

$$\lambda = \frac{D+K}{K} = \frac{1100}{100} = 11$$

(5 points) c. Compute the maximum fraction of assets α that the government should allow the bank to lend out if it wants the bank to go bankrupt with a probability of at most 30%.

A/ The bank goes bankrupt if it becomes insolvent (i.e., if his equity is negative). This happens with probability:

$$Pr(K + (p-1)\alpha(D+K) \leq 0) \Leftrightarrow$$

$$Pr(p \leq 1 - \frac{K}{\alpha(D+K)}) \Leftrightarrow$$

$$Pr(p \leq 1 - \frac{1}{\alpha\lambda})$$

Replacing $\lambda = 11$, α must be such that

$$Pr(p \leq 1 - \frac{1}{11\alpha}) \leq \frac{3}{10}$$

For this probability to be at most 30%, looking at the distribution of returns during normal times, it is clear that

$$Pr(p \leq -5) = Pr(p = -10) + Pr(p = -5) = \frac{1}{10} + \frac{2}{10} = \frac{3}{10}$$

Thus, α must be such that the bank goes bankrupt ONLY if the realized return happens to be -5 or -10, and DOES NOT go bankrupt if the realized return happens to be 0 or more. So we need that

$$K + (p-1)\alpha(K+D) > 0$$

if $p = 0$:

$$100 + (0-1)\alpha(100+1000) > 0 \Leftrightarrow$$

$$100 - 1100\alpha > 0 \Leftrightarrow$$

$$\alpha < \frac{100}{1100} = \frac{1}{11} = 0.09$$

So the government can allow the bank to lend any fraction of his assets below 9%, and this will be enough to make the bank go bankrupt only 30% of the time.

NOTE: Some of you followed the definition in lecture using a strict inequality, in which case the required α would be different. As long as I saw that you understood the idea of the exercise, I gave you credit for this. If you have any additional concern, let me know.

(5 points) d. Assume that the government sets $\alpha = \frac{1}{11}$. Nevertheless, the bank owners decide to adjust their leverage so as to go bankrupt with a probability of 10%. How can they achieve this? Show that the bank has two different options to adjust its leverage, and find the new value of equity and liabilities in each case.

A/ The bank needs to change λ so that

$$Pr(p \leq 1 - \frac{1}{\alpha\lambda}) \leq \frac{1}{10}$$

This means that the bank should only go bankrupt if the worst possible returns of $p = -10$ happen, while still surviving if returns are $p = -5$. Thus, λ must be such that

$$Pr(p \leq 1 - \frac{1}{\alpha\lambda}) \leq \frac{1}{10}$$

$$1 - \frac{1}{(\frac{1}{11})\lambda} < -5 \Leftrightarrow$$

$$6 < \frac{1}{(\frac{1}{11})\lambda} \Leftrightarrow$$

$$\frac{6}{11} < \frac{1}{\lambda} \Leftrightarrow$$

$$\lambda < \frac{11}{6} = 1.83$$

Because $\lambda = \frac{K+D}{K}$, this can be achieved in two ways: raising more equity, or liquidating assets to reduce liabilities.

1. If the bank owners decide to increase equity, for example by making an emission of new shares, the new equity K' must be such that

$$\frac{K' + 1000}{K'} = \frac{11}{6} \Leftrightarrow$$

$$6K' + 6000 = 11K' \Leftrightarrow$$

$$K' = \frac{6000}{5} = 1200$$

Notice that the bank originally has a equity of $K = 100$, so the owners will have to raise 1100 more of capital.

2. Instead of raising equity, the bank owners can decide to liquidate assets and reduce liabilities to D'. In this case, to achieve a leverage of $\frac{11}{6}$ the bank must satisfy

$$\frac{100 + D'}{100} = \frac{11}{6} \Leftrightarrow$$

$$(100)6 + 6D' = (100)11 \Leftrightarrow$$

$$600 + 6D' = 1100 \Leftrightarrow$$

$$D' = \frac{500}{6} = 83.3$$

Since the bank originally had $D = 1000$ in loans, it must liquidate 916.7 of them.

NOTE: Some of you followed the definition in lecture using a strict inequality, in which case the required α would be different. As long as I saw that you understood the idea of the exercise, and mentioned that one possibility was to increase equity and the other to reduce assets, I gave you credit for this. If you have any additional concern, let me know.

3 Long Long Question: Holmstrom-Tirole and the Welfare State (35 points)

In this question we are going to consider an economy similar to Holmstrom-Tirole, without investors. There are banks, entrepreneurs, workers about to retire, and a government that provides welfare for the poor. Banks finance entrepreneurs and they also offer retirement accounts to workers. Let us begin with the workers. Workers need to save for their retirement, and they have two options. They can either buy a government bond which yields γ, or they can open a retirement account.

The contract between the worker and the bank is as follows. The worker puts F dollars in the retirement account, which the bank then directs to a project run by an entrepreneur. If the project succeeds, the bank pays Q to the worker. If the project fails, the bank gives nothing to the worker. As a result, by opening the retirement account, workers risk ending up without money for their retirement. The welfare state, however, provides some insurance. If the project fails, the government pays σF dollars to the worker, where $\sigma \leq \gamma$. Thus, σ can be seen as a measure of how generous the welfare state is.

Regarding entrepreneurs, assume that if the entrepreneur who gets financed from the retirement account works hard, the project succeeds with probability p_H. If the entrepreneur goes to the beach instead, the success probability is p_L. Further assume that $1-p_H = p_L$ and that the bank makes sure that the entrepreneur does not go to the beach.

(4 points) a. Write down the condition that Q must satisfy for the worker to be willing to open a retirement account and thus help finance a project.

A/ The worker must expect to do better in his retirement by opening the account than by buying the government bond:

$$p_H Q + p_L \sigma F \geq \gamma F \Leftrightarrow$$

$$p_H Q \geq (\gamma - p_L \sigma) F \Leftrightarrow$$

$$Q \geq \frac{\gamma - p_L \sigma}{p_H} F$$

(4 points) b. Suppose the government sets $\sigma = \gamma$. What happens to the condition you have found in part(a)? Provide an interpretation.

A/ For $\sigma = \gamma$ the government is promising that if the project fails, the worker will de as well as he would do if he just bought the bond:

$$Q \geq \frac{\gamma - p_L\gamma}{p_H}F \Leftrightarrow$$

$$Q \geq \gamma\frac{1 - p_L}{p_H}F \Leftrightarrow$$

$$Q \geq \gamma\frac{p_H}{p_H}F \Leftrightarrow$$

$$Q \geq \gamma F$$

As a result, the worker faces no risk by opening the retirement account, and he is willing to do it as long as what it pays when the project succeeds is better than what the bond pays.

Assume that $\sigma < \gamma$ from now on.

Now that we have dealt with the workers, let us worry about entrepreneurs and banks. Entrepreneurs are as usual: they have a project that costs I dollars to implement, but they only have $A < I$ dollars, so they need to finance the difference $(I - A)$. As we have mentioned before, if they work hard, the project succeeds with probability p_H, and yields a return R. If the entrepreneurs go to the beach, the project succeeds with probability $1 - p_H = p_L < p_H$. Assume now that banks have to pay a cost c if they monitor a project. The contract between the entrepreneur and the bank takes the form (R_E, R_B), so the bank receives R_B and the entrepreneur receives R_R if the project succeeds, and nothing if the project fails. Of course, $R_E + R_B = R$.

(4 points) c. Assume the retirement account pays the least that workers are willing to take while still agreeing to put their savings in the account (their "reservation deposit"). Write the condition that the bank's share of the returns on the project, R_B, must satisfy in order for the bank to be willing to monitor the project.

A/ The bank obtains R_B and has to pay Q when the project succeeds, and has to pay c if it monitors. If the bank monitors, the project succeeds with probability p_H, whereas if it doesn't monitor, the project succeeds with probability p_L:

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

$$p_H R_B - p_H\frac{\gamma - p_L\sigma}{p_H}F - c \geq p_L R_B - p_L\frac{\gamma - p_L\sigma}{p_H}F \Leftrightarrow$$

$$p_H R_B - (\gamma - p_L\sigma)F - c \geq p_L R_B - \frac{p_L}{p_H}(\gamma - p_L\sigma)F \Leftrightarrow$$

$$\Delta p R_B \geq c + (1 - \frac{p_L}{p_H})(\gamma - p_L\sigma)F \Leftrightarrow$$

$$\Delta p R_B \geq c + \frac{\Delta p}{p_H}(\gamma - p_L\sigma)F \Leftrightarrow$$

$$R_B \geq \frac{c}{\Delta p} + \frac{\gamma - p_L \sigma}{p_H} F$$

Assume that the entrepreneurs obtain value b from going to the beach rather that putting effort on their projects.

(4 points) d. Write the condition that must be satisfied for an entrepreneur to be willing to put effort in his project.

A/ What the entrepreneur receives if the project succeds must be more than what he receives if he puts no effort and instead goes to the beach:

$$p_H R_E \geq p_L R_E + b \Leftrightarrow$$

$$\Delta p R_E \geq b \Leftrightarrow$$

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

(4 points) e. Assume that the contract between the entrepreneur and the bank is such that the entrepreneur gets exactly the minimum amount he is willing to take while still willing to put effort (his "reservation share" of the return). Write an expression for what is left for the bank, R_B.

A/ Since $R = R_E + R_B$,

$$R_B = R - \frac{b}{\Delta p}$$

Assume that banks are willing to lend only if their gross return (that is, not counting the monitoring cost) is at least β.

(3 points) f. Assume that the contract gives the bank the least it is willing to take while still monitoring (the bank's "reservation share" of the return on the project). Write an expression for the amount of money F that a worker should put in the retirement account.

A/

$$R - \frac{b}{\Delta p} = \frac{c}{\Delta p} + \frac{\gamma - p_L \sigma}{p_H} F \Leftrightarrow$$

$$R - \frac{b+c}{\Delta p} = \frac{\gamma - p_L \sigma}{p_H} F \Leftrightarrow$$

$$F = \frac{p_H}{\gamma - p_L \sigma} \left[R - \frac{b+c}{\Delta p} \right]$$

(3 points) g. For a given rate of return β and a given bank share R_B, write down an expression for I_B, the amount of financing that a bank is willing to give to an entrepreneur (the expression you find should depend on the following: γ, σ, β, p_H, p_L, R_B, and F).

A/ If the bank is putting I_B of its own money, then the rate of return on this investment is given by

$$\frac{p_H(R_B - Q)}{I_B} = \beta \Leftrightarrow$$

$$I_B(\beta) = \frac{p_H(R_B - \frac{\gamma - p_L\sigma}{p_H}F)}{\beta} \Leftrightarrow$$

$$I_B(\beta) = \frac{p_H R_B - (\gamma - p_L\sigma)F}{\beta} \Leftrightarrow$$

(3 points) h. Re-write the expression you have found in part (g) so it does not depend on R_B (hint: use a previous result). How does the amount of financing that a bank is willing to give to an entrepreneur in this version of the Holmstrom-Tirole model compare to the one in the original model that we saw in lecture? How does it depend on the amount of money F that the worker puts into the retirement account?

A/ The minimum share of the project's returns the bank can receive to be willing to monitor is $R_B = \frac{c}{\Delta p} + \frac{\gamma - p_L\sigma}{p_H}F$. Hence, the minimum amount of own capital the bank can put is

$$I_B(\beta) = \frac{p_H(\frac{c}{\Delta p} + \frac{\gamma - p_L\sigma}{p_H}F) - (\gamma - p_L\sigma)F}{\beta} \Leftrightarrow$$

$$I_B(\beta) = \frac{p_H c}{\Delta p \beta}$$

which is just as in the original model. The minimum amount the bank can put of its own money does not depend on how much money the worker is putting in the retirement account.

(3 points) i. How large does A need to be for the bank to be willing to finance the entrepreneur's project?

A/ Recall that $I = A + I_B(\beta) + F$, so that

$$A = I - I_B(\beta) - F$$

Replacing the conditions above,

$$A(\beta, \gamma, \sigma) = I - \frac{p_H c}{\Delta p \beta} - \frac{p_H}{\gamma - p_L\sigma}\left[R - \frac{b + c}{\Delta p}\right]$$

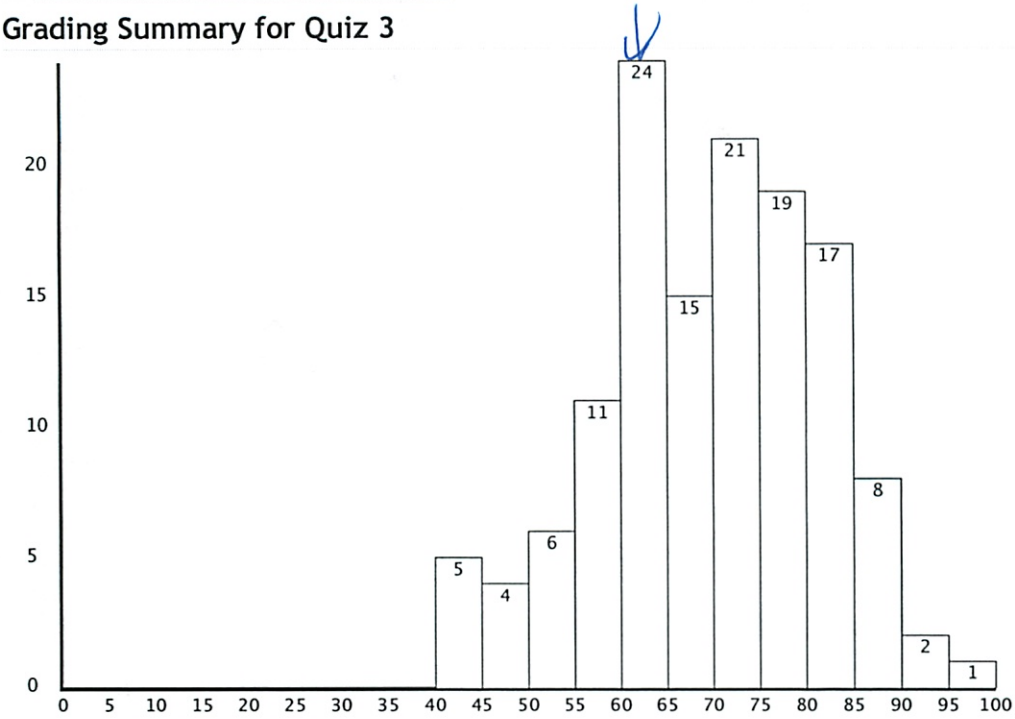
(3 points) j. What does this tell us about how the generosity of the welfare state affects the ability of the economy to finance investment projects?

A/ Notice that in this case, the wealth that the entrepreneur needs to be able to go to the bank is decreasing in σ, so that a more generous welfare state allows poorer entrepreneurs to access the financial system. This is because a more generous welfare state makes workers be more willing to put their money in risky projects, since they know that in case the projects fail, they will still be able to have a decent retirement.

14.02 Principles of Macroeconomics

Dashboard | Students | Assignments

Grading Summary for Quiz 3



Number of Scores:	133
Average:	68.74
Standard Deviation:	11.91

Won't be getting it back

14.02 Principles of Macroeconomics

Grade Report

Grade Report for Michael E. Plasmeier

Assignment/Exam Name	Graph	Due Date	Points	Max Pts	Weight
Problem Set #1		02.11.2011	81.00	100.00	0.00%
Problem Set #2		02.25.2011	72.00	100.00	0.00%
Problem Set #3		03.04.2011	86.00	100.00	0.00%
Problem Set #4		03.11.2011	85.00	100.00	0.00%
Quiz 1		03.17.2011	67.00	100.00	0.00%
Problem Set #5		04.06.2011	70.00	100.00	0.00%
Quiz 2		04.20.2011	80.00	100.00	0.00%
Problem Set #6		04.29.2011		100.00	0.00%
Quiz 3		05.07.2011	63.00	100.00	0.00%
Problem Set #7		05.09.2011		100.00	0.00%

Instructor's Comments

No sections on last week
Can't make it to lecture