# Macroeconomics

## Financial Crisis in Theoretical Perspectives

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# Basic Mechanism of the Crisis

Blanchard (2009) - triggers of the financial crisis:

- intransparency of assets and balance sheets
- reliance on short-term funding
- forced deleveraging
- coordination problems

This lecture: a simple model of banking crisis
Starting point: the balance sheet of an investment bank

# Balance Sheet of an Investment Bank

| Assets | Liabilities and Equity |
|---|---|
| A | E |
| - | L |

$A =$ Assets (book value) - claim on investment project - generate a constant dividend $d$
$E =$ Equity (book value) -
$L =$ Liabilities (book value) - short term debt which has to be refinanced every period at an interest rate equal to $r_t$

Rifinancing always possible if

$$(A - E)\, r_t \leq d$$

# Introducing Uncertainty (1)

- Investment bank borrows from intermediaries on the money market (http://en.wikipedia.org/wiki/Money_market) - market for short-term debt instruments
- The intermediaries have access to money from outside investors who demand interest rate $R$
- With Probability $P$ they will be repaid, with Probability $(1-P)$ they wil loose both the principal and the interest

What Interest will the intermediary charge?

The intermediary (for each dollar borrowed and lended to the investment bank) will make a profit if:

$$P\left(1+r_t\right)+\left(1-P\right)\left(0\right)\geq 1+R$$

solving for $r_t$ gives

$$r_t \geq \frac{1+R-P}{P}$$

# Introducing Uncertainty (2)

Competitive Market

$$r_t = \frac{1 + R - P}{P}$$

- $P = 1, ....r_t = R$
- $P \rightarrow 0, ...r_t \longrightarrow \infty$

Higher the risk of the investment, higher the cost

# Introducing Intransparency (1)

Assume that there is two types of assets: good and bad (or "toxic") assets

- the good asset pays $d$ (dividends) in perpetuity (forever)
- the bad assets disappear in each period with probability $q$ (subprime mortages, for example)

Pricing of the loan with perfect knowledge

- For banks with good assets

$$r_t^g = R$$

- For Banks with bad assets

$$r_t^b = \frac{R+q}{1-q}$$

# Introducing Intransparency (2)

What if the intermediaries in the money market cannot disinguish between good assets and bas assets? What if they know only the proportion $(p)$ of bad assets in the market but not their location? What is the expected profit for lending to investment banks?

- Probability of incuring a loss : $p * q$ (the probability of lending to a bank with bad assets times the probability that those assets disappear)

Expected Profits on each dollar lended if

$$(1 - p * q)(1 + r_t) + (p * q)(0) \geq 1 + R$$

Optimal Price of the Loan

$$r_t = \frac{R + p * q}{1 - p * q}$$

## Implications

Due to intransparency, financing of bad assets becomes more attractive, financing of good assets becomes less attractive.

# Bad Assets Dominance

Notice that:

$$r_t = \frac{R + p * q}{1 - p * q} < r_t^b = \frac{R + q}{1 - q}$$

and

$$r_t = \frac{R + p * q}{1 - p * q} > r_t^g = R$$

Good assets pay part of the cost of having bad assets around - the price of a loan increase for everybody, independently of the quality of the assets (unknown).

# Intransparency and Interest Rate (1)

$$r_t = \frac{R + p * q}{1 - p * q}$$

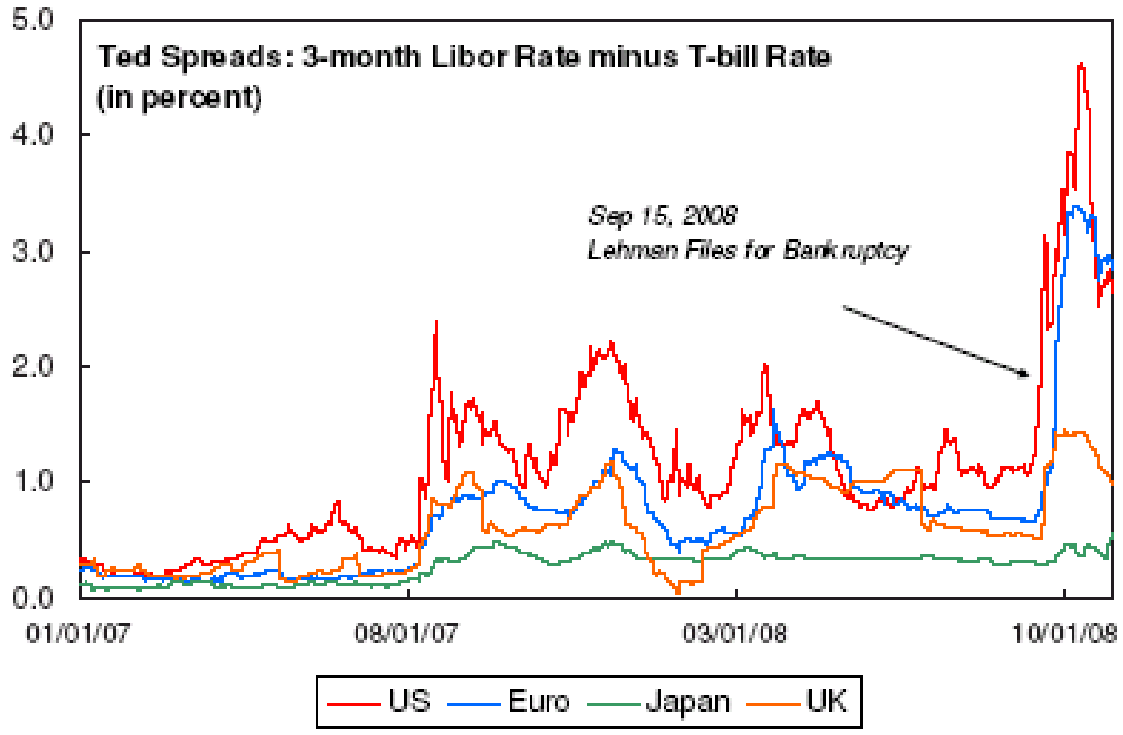
- Increased uncertainty about the proportion of good and bad assets drives up the interest rate.

$$\frac{\delta r_t}{\delta p} = \frac{q}{1 - p * q} + \frac{(R + p * q)\, q}{(1 - p * q)^2} = \frac{1 + R}{(1 - p * q)^2} > 0$$

- Refinancing loans becomes more difficult, also for banks with only good assets.

# Intransparency and Interest Rate (2)

- Example - the collapse of Lehman Brothers



# Intransparency and Interest Rate (3)

- If $(A - E)\, r_t > d$ both, the investment banks with good assets and the investment banks with bad assets will run intro trouble.
- They may have to sell their assets if they cannot refinance the loan.
- But, a bank with good assets would have been able to refinance if the market was transparent.
- Note that the high interest rate and the refinancing problem do not arise because of a lack of liquidity.
- Problems created by intransparency and refinancing will not be solved by the central bank injecting liquidity (at least as long as the investment banks do not have the required collateral and restore their financing - reducing the perceived risk for the lender).

# Intransparency and market price of assets (1)

Assume
$G$ = Price of good assets (A normal mortage)
$B$ = Price of bad assets (Subprime mortage)
$B < G$

What would be the price that the bank can extract from the market if it is not possible to distinguish good from bad?

$$(1 - p)\, G + pB$$

Increase uncertainty about the proportion of good and bad assets drives down the price. A change in evaluation of the amount of "toxic" assets present in the market will change the prices of all assets in proportion to the increase in risk

# Intransparency and market price of assets (2)

Implications:

- If markets are illiquid (i.e. when a too large supply meets a too small demand), prices may go down even further because of the bargaining power of buyers, i.e. both $B$ and $G$ decline.
- Adverse Selection (Akerlof 1970 "lemon problem"): If the price $(1-p)\,G + pB$ is lower than what banks with good assets would voluntarily want to sell them for, we can expect that on the market an over-proportion of bad assets will be sold (say $\widetilde{p} > p$), and thus the market price for the asset drops even further to$(1-\widetilde{p})\,G + \widetilde{p}B < (1-p)\,G + pB$

# Amplification (1) : Mark to Market Pricing

Consider two banks who have the same amount of assets at market value $A$ but different structures of liabilities:

Bank 1 - Low leverage

| Assets | Liabilities and Equity |
|---|---|
| $A$ | $E_1$ |
| - | $L_1$ |

Bank 2 - High Leverage

| Assets | Liabilities and Equity |
|---|---|
| $A$ | $E_2$ |
| - | $L_2$ |

with $E_1 > E_2$, and $L_1 < L_2$
Regulators requires banks to maintain a minimal capital ratio

$$\frac{E}{A} \geq 4\%$$

evaluated at market prices of assets
Under these conditions a forced sale of assets by the more leveraged bank may trigger a forced sale of assets by the less leveraged bank

# Amplification (1) : Mark to Market Pricing

Assume an exogenous increase in $p$ (Lehman Brother Fails, for examlple) - $r_t$ will go up to $r_t^c$. How does the increse of $r_t$ affect the solvency of the two banks?
Before the increse in $p$ both banks are solvent

$$L_1 r_t < L_2 r_t \leq d$$

after only bank one is

$$L_1 r_t^c \leq d < L_2 r_t^c$$

Bank 2 needs to sell a part of its assets to be able to meet its short term liabilities.
As a consequence of this bank de-leveraging, the market price of the assets drops to $A - \Delta$.
Bank 1 would still be able refinance $L_1 = (A - E_1)$ because $L_1 r_t^c \leq d$.
How does regulation affects this solution?

# Amplification (1) : Mark to Market Pricing

However, the regulator requires a minimum capital ratio and since it uses mark-to-market pricing, the drop in value from $A$ to $A - \Delta$ can force even bank 1 to sell parts of its assets.
The drop in value makes the minimal capital ratios binding for Bank 1 if for instance

$$\frac{E_1}{A} \geq 4\% > \frac{E_1}{A - \Delta}$$

In this case, bank 1 has to sell assets only due to regulatory reasons.
Implications:

- If, due to fire sale prices, the bank is forced to sell assets below what they are worth, the bank is in a worse condition after the sale than before.
- If the sale of assets by bank 1 leads to further price drops, other banks with even lowerleverage ratios might also get into trouble. A downward spiral occurs.

# Amplification (2) : Coordination Problem

Defintion of coordination problem: Situations in which all parties can realize mutual gains, but only by making mutually consistent decisions
(http://en.wikipedia.org/wiki/Coordination_game)
Example: Battle of Sexes

| | Party | Home |
|---|---|---|
| Party | 10,5 | 0,0 |
| Home | 0,0 | 5,10 |

Both parties are better off if they can coordinate on their actions: why is this relevant for the crisis? Liquidity might disappear from the market even for the safe bank because all investor have incentive to follow the same strategy and flee to safety. (buy Treasury bonds, i.e. lend to the state instead than individual investment banks)

# Amplification (2) : Coordination Problem

Scenario
Each lender only lends a fraction $L/k$ of $L$.
So, each investment bank has to find $k$ lenders in each period.
If the bank does not find $k$ lenders, it fails and nobody is paid.
What is the interest rate that each lender should ask? depends on the probability that the bank will find $k-1$ other lenders (call it $z$)
Expected Profits on each dollar lended if

$$\begin{aligned} z\left[(1-pq)(1+r_t)+(pq)(0)\right]+(1-z)0 &\geq 1+R \\ z(1-pq)(1+r_t) &\geq 1+R \end{aligned}$$

Optimal Price of the Loan

$$r_t = \frac{1+R-(z-zpq)}{(z-zpq)}$$

Decrease in $z$ increase the interest rate charged by the lender

# Amplification (2) : Coordination Problem

- If $r_t$ increases sufficiently, then the inequality $(A - E)\, r_t > d$ implies that the bank fails.In this case, no rational lender would lend to the bank, thus the probability $z$ must be low.
- On the other hand if $r_t$ is low, then the inequality $(A - E)\, r_t < d$ implies that the bank does not fail. In this case, a rational lender would lend to the bank, thus the probability $z$ must be high.
- Circularity between $r_t$ and $z$. If few people lend interest rate goes up and even less people will lend. Two possible solutions - everybody lends or nobody does! (very simplified)

# Amplification (2) : Coordination Problem

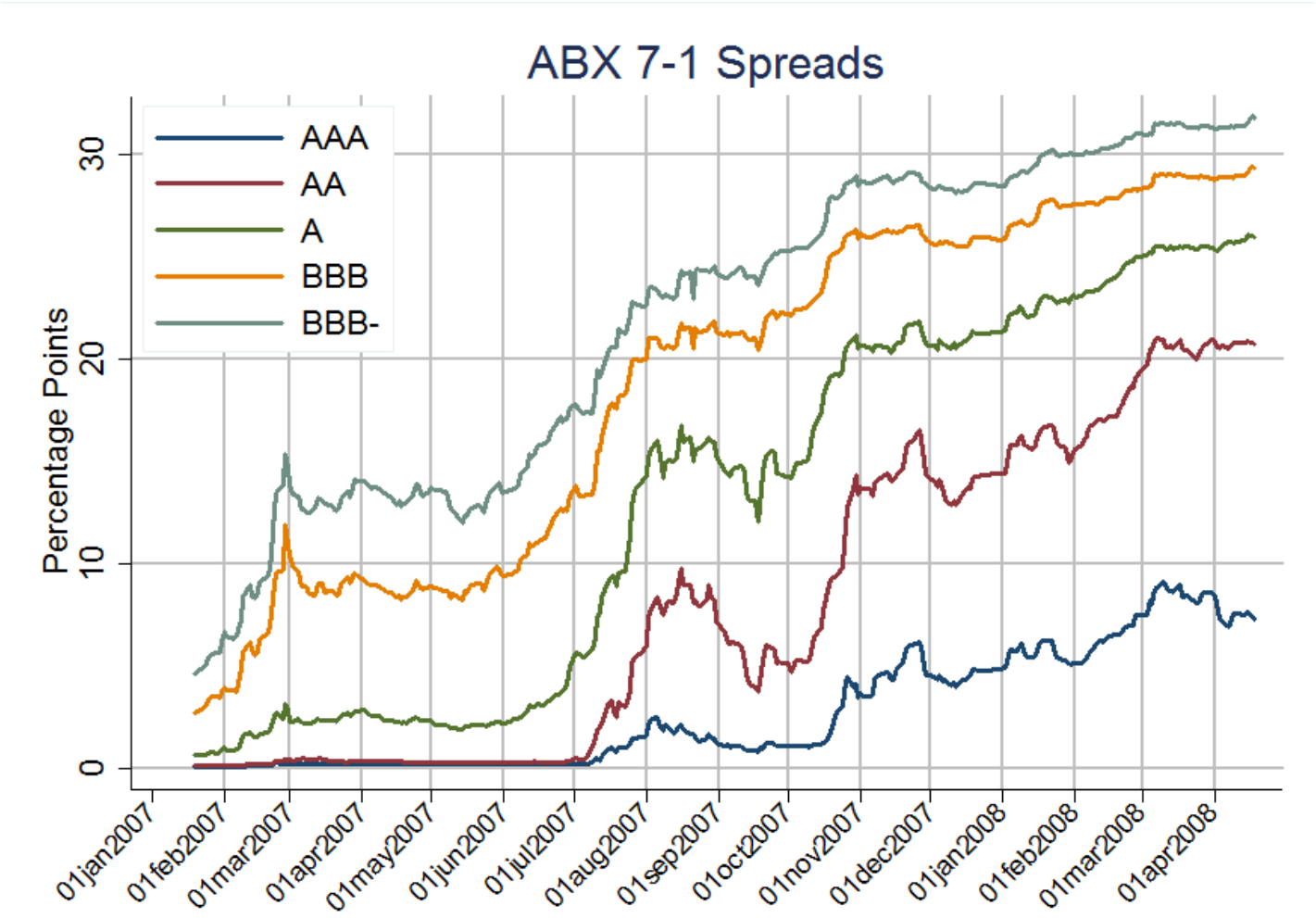
Define Strategies and Pay-offs

| | Many Lend | Few Lends |
|---|---|---|
| Lend | 0 with zero profit condition | $-1-R$ (loose principal) |
| No lend | Fed rate $(-1)$ | Fed Rate $(-1)$ |

- Two equlibriums - Lend if Many lend and No lend if few lend

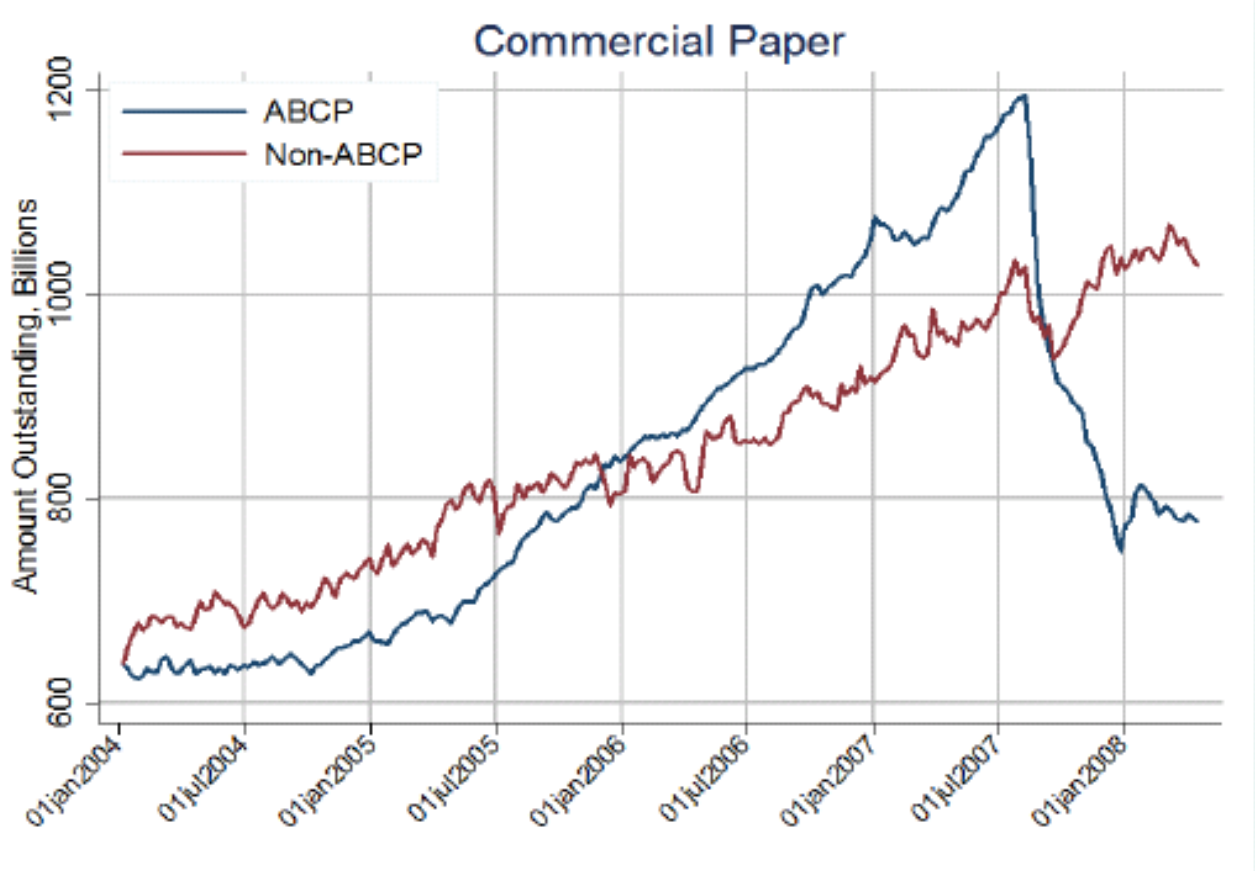
# Evidence

Uncertainty on the risk evaluation of assets



# Evidence

Money Market Dries up



# Summary

The simple model gives us a framework to interpret the financial crisis

- intransparency of assets and balance sheets: the complexity of financial innovation and the inadequacy of regulators and credit rating agency made the system vulnarable to spreeding of panic
- reliance on short-term funding: the credit boom was relying on short term financing, making the system very sensitive to external shocks
- forced deleveraging: when the crisis arrive, mark-to market rules forced every financial institution to try reducing their debt position
- coordination problems: liquidity in the market dried up because everybody was uncertain about what every other market partecipant position was going to be, preferring to park liquidity in government treasury bonds.

# From Finanacial Crisis to Economic Crisis

- Model of Interaction between financial sector and the economy
- Review of the policy responses
- Problems ahead: credibility of monetary policy and fiscal sustainability

# Interaction Between Financial and Real Sector: The CC-LM Model

Bernanke - Blinder (1988): adaptation of a simple IS-LM framework to incorporate financial intermediaries - CC stands for commodity-credit

Assumptions

- IS - LM +
- Bank credit is imperfectly substitutable for bond finance. $\rho$ interest rate on loans, $i$ interest rate on Bonds
- Credit supply to depend on a shift variable $(Z)$, the "riskiness" of the marginal investment project.
- Banks hold liabilities of deposits $(D)$.
- Banks hold assets in Loans $(L)$, Reserves $(\tau D)$ and domestic government debt.

# The CC-LM Model

Loan Demand

$$L^d = L\left(\underset{-}{\rho}, \underset{+}{i}, \underset{+}{y}\right) \tag{1}$$

Loan Supply

$$L^s = \lambda\left(\underset{+}{\rho}, \underset{-}{i}, \underset{-}{Z}\right) D\left(1-\tau\right) \tag{2}$$

Loan Market Equlibrium

$$L^d = L^s = L \tag{3}$$

Money Market Equilibrium

$$D\left(\underset{-}{i}, \underset{+}{y}\right) = mR \tag{4}$$

Goods Market equlibrium

$$y = Y\left(\underset{-}{i}, \underset{-}{\rho}\right) \tag{5}$$

# The CC-LM Model

Substituting the money market equilibrium in the loan market equilibrium we have

$$L(\rho, i, y) = \lambda(\rho, i, Z)(1 - \tau) mR \tag{6}$$

From where I can derive the equilibrium loan rate

$$\rho^* = \left( \underset{+}{i}, \underset{+}{y}, \underset{-}{R}, \underset{+}{Z} \right) \tag{7}$$

The Spread $\rho - i$ is a positive function of $Z$ (loan riskness)

CC Shedule

$$y = Y\left( \underset{-}{i}, \underset{-}{\rho^*} \right) \tag{8}$$

# The CC-LM Model

TABLE 1—EFFECTS OF SHOCKS ON OBSERVABLE VARIABLES

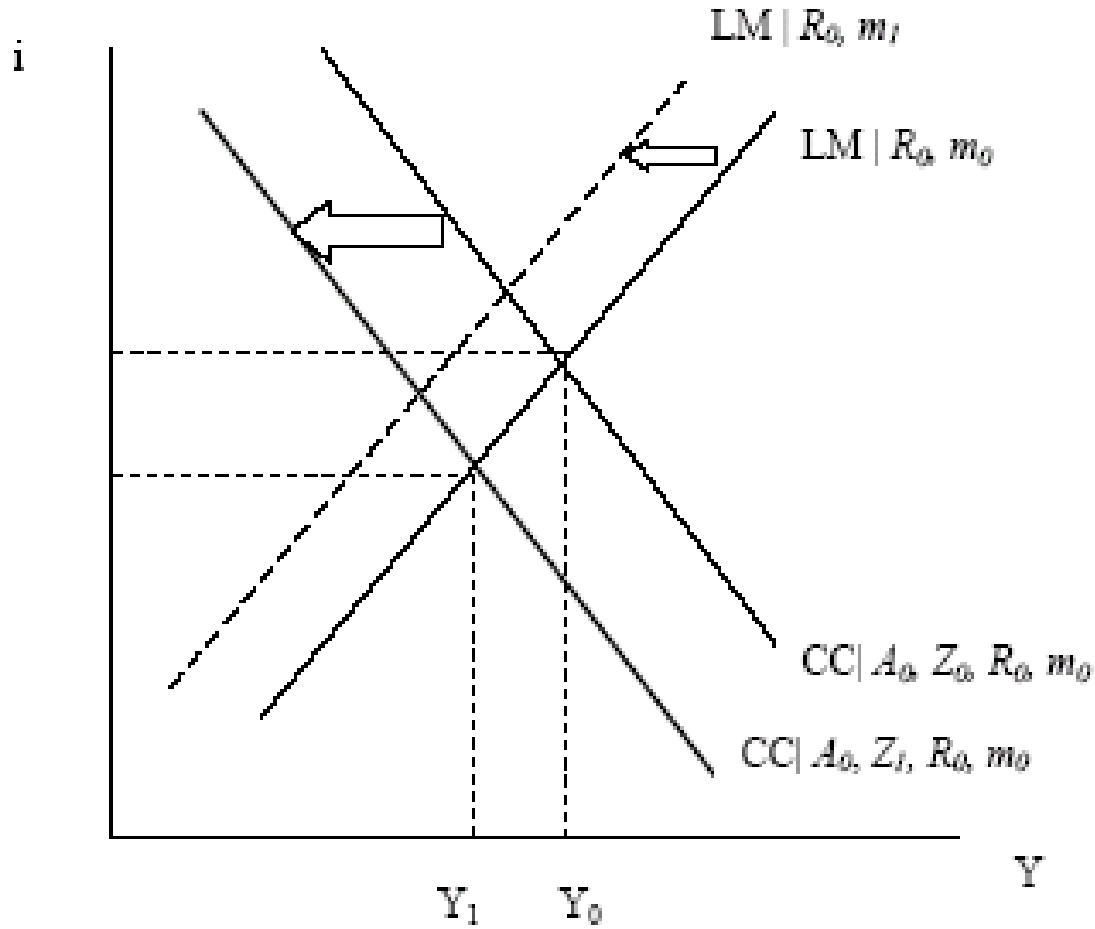
| Rise in: | (1) Income | (2) Money | (3) Credit | (4) Interest Rate[a] |
|---|---|---|---|---|
| Bank Reserves | + | + | + | − |
| Money Demand | − | + | − | + |
| Credit Supply | + | + | + | + |
| Credit Demand | − | − | + | − |
| Commodity Demand | + | + | + | + |

[a] On bonds.

# The CC-LM Model

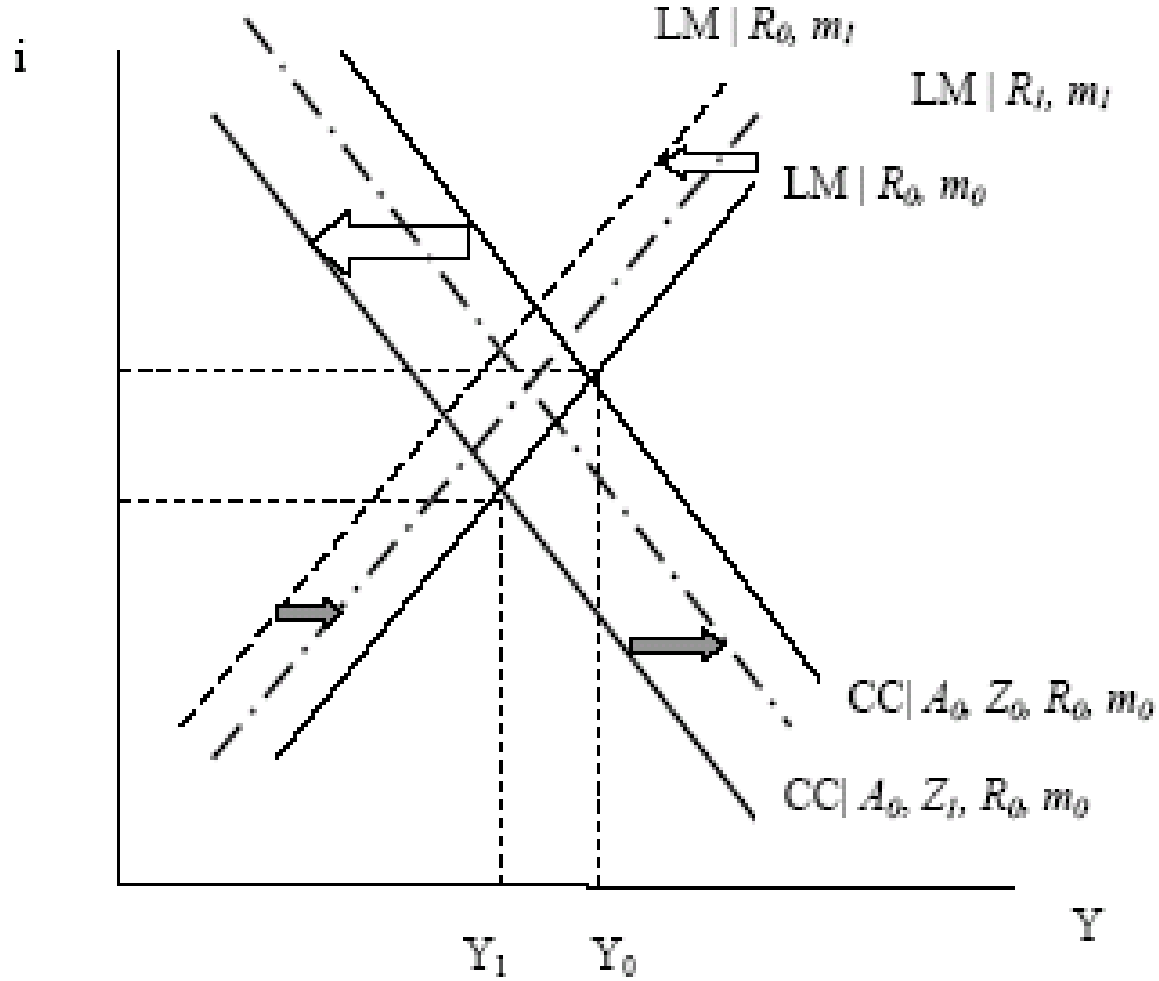
- If riskiness of the marginal investment project rises (Z), the CC curve shifts in.
- If the money multiplier (m) falls, both the CC and LM curves shift in.
- If some financial institutions fail, both the CC and LM curves shift in.

# The CC-LM Model - Graph



# The CC-LM Model - Graph

Endogenous $Z(Y)$ - Adverse feedback loop



# The CC-LM Model with Liquidity Trap

Keynes Liquidity Trap - Bonds and Money are perfect substitute (zero lower bound of interest rate is a case in point) - how does liquidity trap work in CC-LM model? Monetary policy can work via credit market

Three questions:

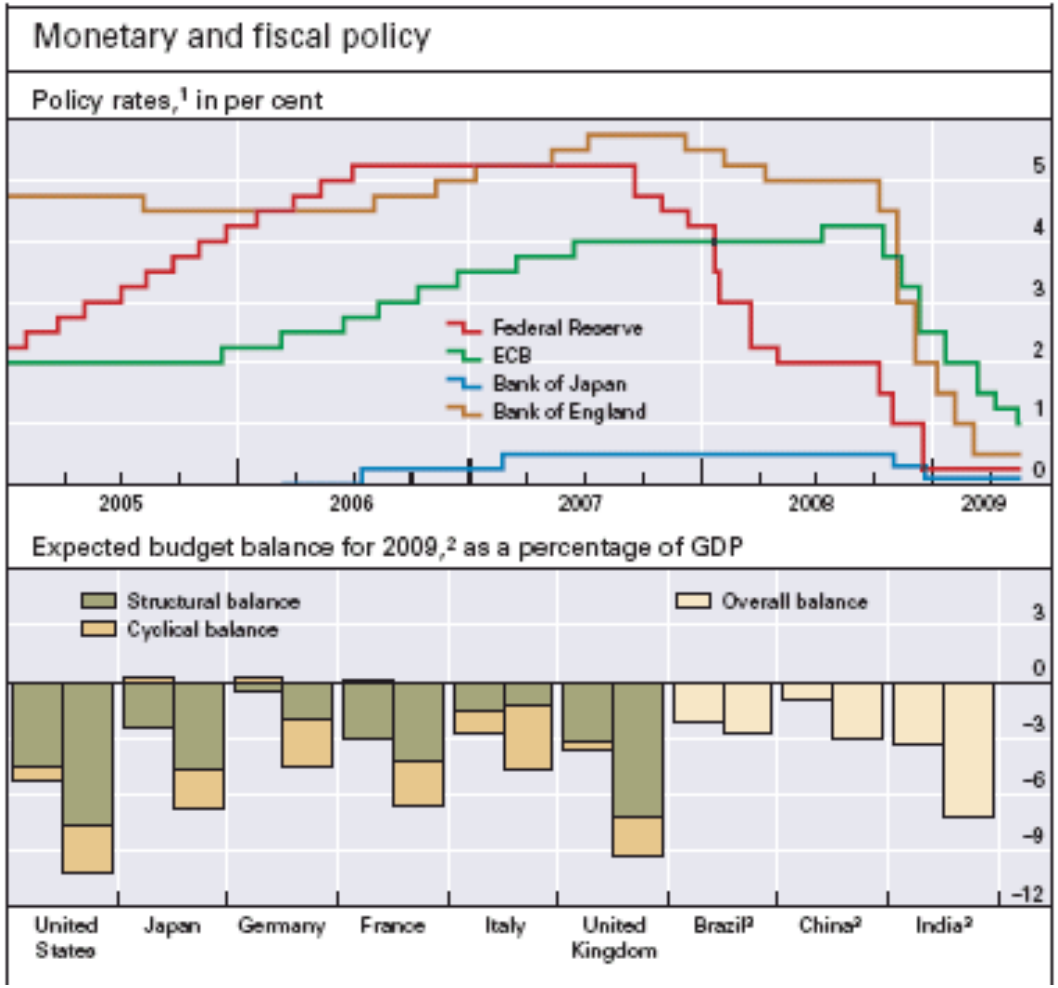
- Introduce liquidity trap in the CC-LM model
- Shows how monetary policy can influence economic activity without effect on interest rate
- Discuss what other instrument can be used to boost the economy

# Policy Response to the Crisis

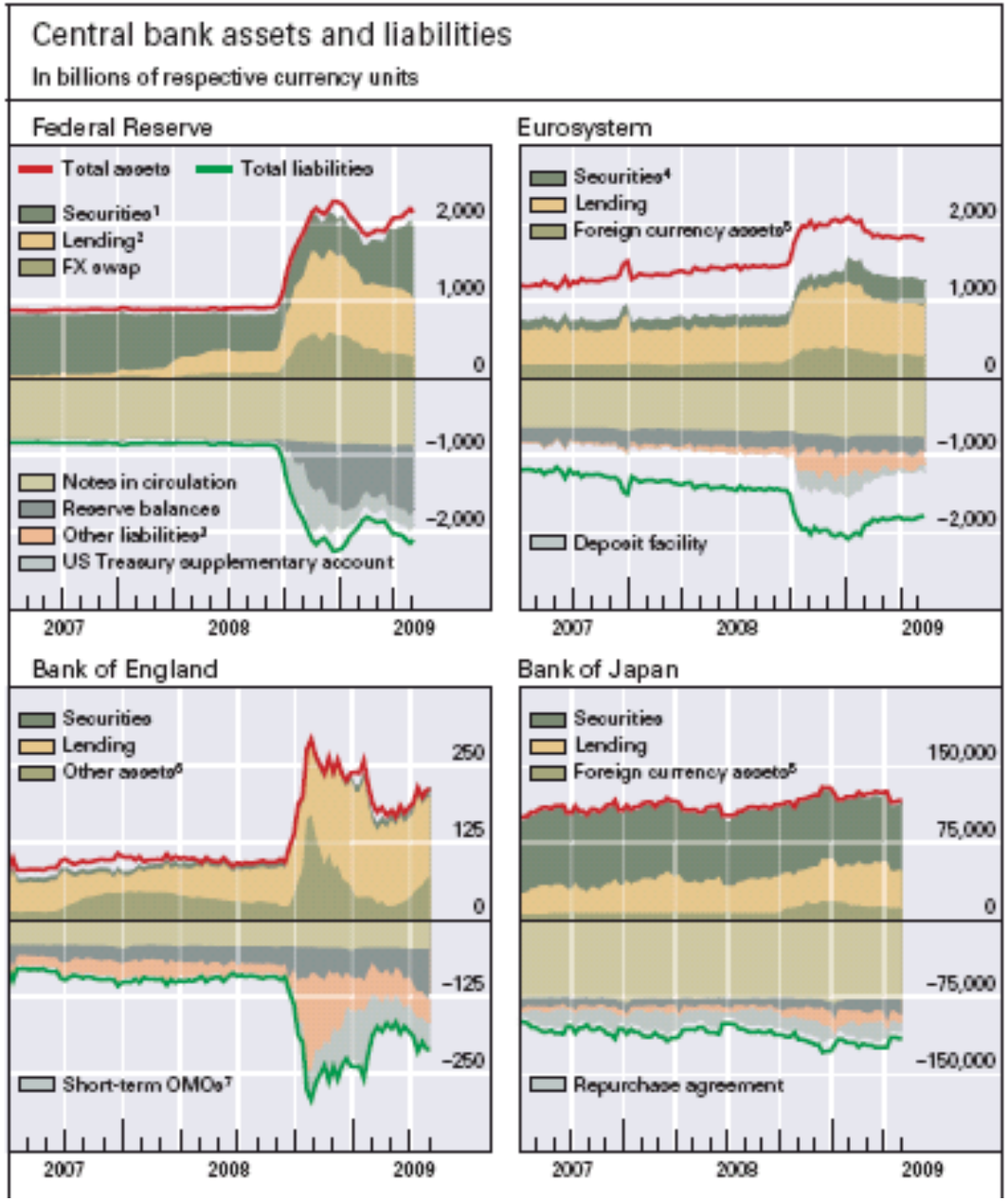
BIS 2009

- Monetary Policy - Reducing interest rate is a limited instrument (zero bound) provide liquidity enlarging central bank balance sheet (quantitative easing)
- Fiscal Policy - avoid demand deflation, substituting private debt with public debt - sustaining demand - limited by problems of sustainability

# Traditional Policy Mix



# Quantitative Easing



# Limits of Policy Response

- Excessive money creation can induce higher inflation tomorrow (when risk reduces) - but not yet
- Monetary Policy credibility could be compromised
- Fiscal policy could become unsustainable (Intertemporal budget constraint not satisfied)

Next time
Theory of Monetary Policy in Normal Times