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The Financial and Economic Crisis Interpreted in a CC-LM Model

Summary: In this handout, the importance of the banking (as well as the overall financial) system is discussed. First, some historical context is provided. Second, a formal model incorporating a credit channel is provided. Third, bank losses in the current financial crisis are discussed in the context of bank balance sheets.

1. Schematic: Typical Financial Crisis

FIGURE 2   Sequence of Events in U.S. Financial Crises
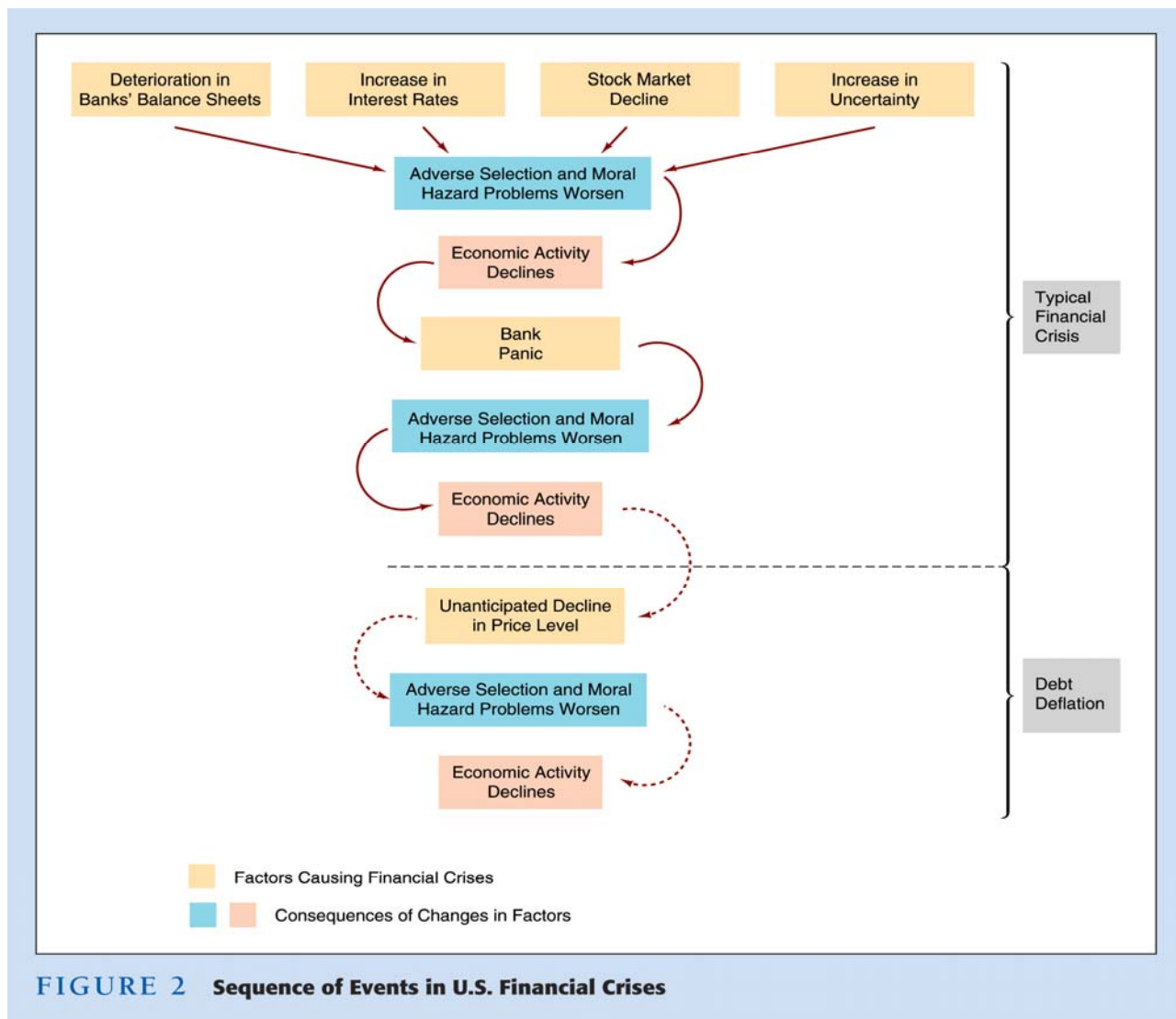
Source: Mishkin (2006).

2. Theory: Interaction between Financial Sector and Real Sector (CC-LM)

Consider an economy where bank credit is imperfectly substitutable for bond finance, as in Bernanke and Blinder (1988), augmented by allowing the credit supply to depend on a shift variable, the "riskiness" of the marginal investment project. The key is to make the real side of the economy depend upon both the interest rate on deposits (which will equal essentially the interest rate set by the Federal Reserve, and be denoted by the familiar variable i), and the interest rate at which banks lend, or the lending rate, denoted by a new variable ρ.

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In order to accomplish the goal of modeling a role for the lending interest rate, we will need to model the banking sector more closely than what was laid out in the textbook.

2.1 Loan demand and supply

Banks hold liabilities of deposits. On the asset side, the banks hold loans, reserves and either domestic government debt.

Loan demand is given by:

$$\frac{\ell^d}{P} = \Omega_0 - \Omega_1 \rho + \Omega_2 i + \Omega_3 Y \tag{1}$$

Loan supply is given by:

$$\frac{\ell^s}{P} = \frac{(\lambda_0 + \lambda_1 \rho - \lambda_2 i - \lambda_3 Z)D(1-\theta)}{P} \tag{2}$$

where Z is a measure of riskiness of the marginal investment project, and is exogenous, D is deposits, and θ is the reserve ratio. The credit market equilibrium is given by equating loan supply and demand.

The money market equilibrium is given by equating the demand for deposits with the supply; hence the LM schedule is:

$$\mu_0 + Y - hi = (1/\theta) \times R/P \tag{3}$$

where $(1/\theta)$ is the money multiplier, and R is the stock of reserves. (Excess reserves are ignored in this analysis.) The money multiplier is assumed constant. Allowing it to depend positively on the interest rate does not change the qualitative conclusions.

2.2 LM curve and CC curve

Notice that (3) leads to a slightly different formulation of the LM curve than before:

$$i = \frac{\mu_0}{h} - \frac{1}{h}\left(\frac{(1/\theta)R}{P}\right) + \frac{1}{h}Y \tag{4}$$

The CC curve is a conventional IS curve, except that it depends upon the bank lending rate as well as the interest rate:

$$Y = \bar{\gamma}(\Lambda_0 - b_2 i - b_3 \rho) \tag{5}$$

Where $\bar{\gamma} = \dfrac{1}{1 - c_1(1 - t_1) - b_1}$

To determine what ρ is, one has to substitute money market equilibrium into the loan market equilibrium to obtain:

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$$\Omega_0 - \Omega_1\rho + \Omega_2 i + \Omega_3 Y = (\lambda_0 + \lambda_1\rho - \lambda_2 i - \lambda_3 Z)\frac{D(1-\theta)}{P} \qquad (6)$$

Solving for the equilibrium loan rate, ρ, one obtains the following relationship, where linearity is assumed for simplicity:

$$\rho = \varphi_0 + \varphi_1 i + \varphi_2 Y - \varphi_3\left(\frac{(1/\theta)R(1-\theta)}{P}\right) + \varphi_4 Z \qquad (7)$$

Where φ_0 depends negatively on λ_0, which is the constant in the loan, or credit, supply equation, and Ω_0, which is the constant in the loan, or credit, demand equation. In this formulation, the spread between the bank loan rate and the risk free rate, ρ-i, is a positive function of Z, the riskiness of the marginal project.

The CC schedule (commodity and credit equilibrium) is obtained by substituting (7) into (5), which is the IS curve, allowing a role for interest rates (and implicitly, the determinants of the lending rate, ρ). Instead of working this out, just note that the factors that increase ρ according to equation (7) decrease Y according to equation (5). Hence, an increase in i or Z will, ceteris paribus, decrease output.

Notice that i and Y are in (7), so the CC curve only represents equilibrium (in this case both the goods and credit markets, instead of just the goods market, as in the IS curve).

2.3 Solving for equilibrium income

Let's substitute the LM curve in (4) as well as (7) into (5). First, rearrange (5):

$$Y(1 - c_1(1-t_1) - b_1) = \Lambda_0 - b_2\left(\frac{\mu_0}{h} - \frac{1}{h}\left(\frac{(1/\theta)R}{P}\right) + \frac{1}{h}Y\right) - b_3(\varphi_0 + \varphi_1 i + \varphi_2 Y - \varphi_3[(1/\theta)R(1-\theta)] + \varphi_4 Z)$$

(8)

Notice the R is still present on the RHS, and so the LM curve has to be substituted in again:

$$Y(1 - c_1(1-t_1) - b_1) = \Lambda_0 - b_1\left(\frac{\mu_0}{h} - \frac{1}{h}\left(\frac{(1/\theta)R}{P}\right) + \frac{1}{h}Y\right)$$

$$- b_3\left(\varphi_0 + \varphi_1\left(\frac{\mu_0}{h} - \frac{1}{h}\left(\frac{(1/\theta)R}{P}\right) + \frac{1}{h}Y\right) + \varphi_2 Y - \varphi_3[(1/\theta)R(1-\theta)] + \varphi_4 Z\right)$$

Notice Y shows up two places on the RHS, and $(1/\theta)R$ in two places. Factoring, and solving for Y:

$$Y(1 - b(1-t) - b_1) = \Lambda_0 - \left(\frac{(b_2 + b_3\varphi_1)}{h} + b_3\varphi_2\right)Y + \left(\frac{b_2 + b_3\varphi_1}{h} + b_3\varphi_3(1-r)\right)\left(\frac{(1/\theta)R}{P}\right) - b_3\varphi_4 Z - \left[\frac{(b_2 + b_3\varphi_1)\mu_0}{h} + l\right]$$

Bringing the Y terms over to the LHS, and then solving yields:

$$Y_0 = \frac{1}{\Theta}\left\{\Lambda_0 + \left(\frac{b_2 + b_3\varphi_1}{h} + b_3\varphi_3(1-\theta)\right)\left(\frac{(1/\theta)R}{P}\right) - b_3\varphi_4 Z - \left[\frac{(b_2 + b_3\varphi_1)\mu_0}{h} + b_3\varphi_0\right]\right\} \quad (10)$$

Where $\Theta = (1 - c_1(1-t_1) - b_1) + \left(\frac{(b_2 + b_3\varphi_1)}{h} + b_3\varphi_2\right).$

The multipliers are given below:

1. *For a change in real reserves:* $\dfrac{\Delta Y}{\Delta[(1/\theta)R/P]} = \dfrac{\left(\dfrac{b_2 + b_3\varphi_1}{h} + b_3\varphi_3(1-\theta)\right)}{\Theta} > 0$

2. *For a change in real money demand:* $\dfrac{\Delta Y}{\Delta\mu} = -\dfrac{\left(\dfrac{b_2 + b_3\varphi_1}{h}\right)}{\Theta} < 0$

Note: $\dfrac{\Delta Y}{\Delta\varphi_0} = -\dfrac{b_3}{\Theta} < 0$

3. *For a change in real credit supply:* $\dfrac{\Delta Y}{\Delta\lambda_0} = \left(\dfrac{\Delta Y}{\Delta\varphi_0}\right)\times\left(\dfrac{\Delta\varphi_0}{\Delta\lambda_0}\right) > 0$ since $\left(\dfrac{\Delta\varphi_0}{\Delta\lambda_0}\right) < 0$

4. *For a change in real credit demand:* $\dfrac{\Delta Y}{\Delta\Omega_0} = \left(\dfrac{\Delta Y}{\Delta\varphi_0}\right)\left(\dfrac{\Delta\varphi_0}{\Delta\Omega_0}\right) < 0$ since $\left(\dfrac{\Delta\varphi_0}{\Delta\Omega_0}\right) > 0$

5. *For a change in commodity demand/gov't. spending:* $\dfrac{\Delta Y}{\Delta GO} = \dfrac{1}{\Theta} \equiv \dfrac{1}{1 - c_1(1-t_1) - b_1 + \dfrac{(b_2 + b_3\varphi_1)}{h} + b_3\varphi_2} > 0$

An additional multiplier is *for a change in the risk of the marginal investment project:*
$\dfrac{\Delta Y}{\Delta Z} = \dfrac{b_3\varphi_4}{\Theta} < 0$

Comparative statics (i.e., for the impacts on the 5 shocks above, on four variables, namely Y, M, L, and R) are summarized in the table below.

Table 1

Effects of Shocks on Observable Variables

	(1) Income	(2) Money	(3) Credit	(4) Interest Rate (on bonds)
1. Rise in bank reserves	+	+	+	−
2. Rise in money demand	−	+	−	+
3. Rise in credit supply	+	+	+	+
4. Rise in credit demand	−	−	+	−
5. Rise in commodity demand	+	+	+	+

Source: Bernanke and Blinder (1988)

In the Figure below, shocks to the riskiness of the marginal investment project (Z increases) or to the money multiplier ($(1/\theta)$ and hence $(1/\theta)R$ declines) are shown:
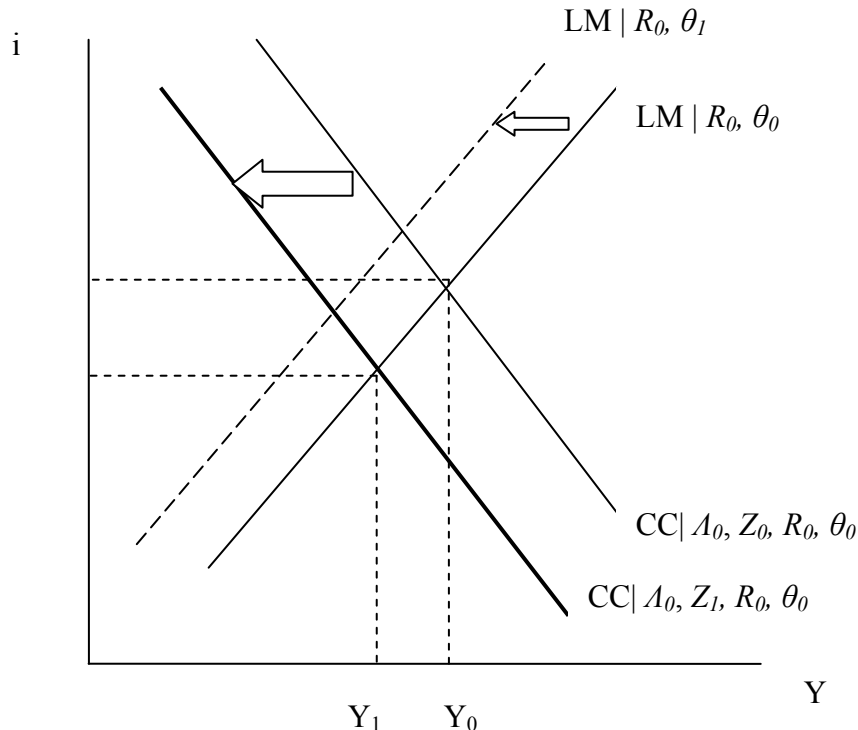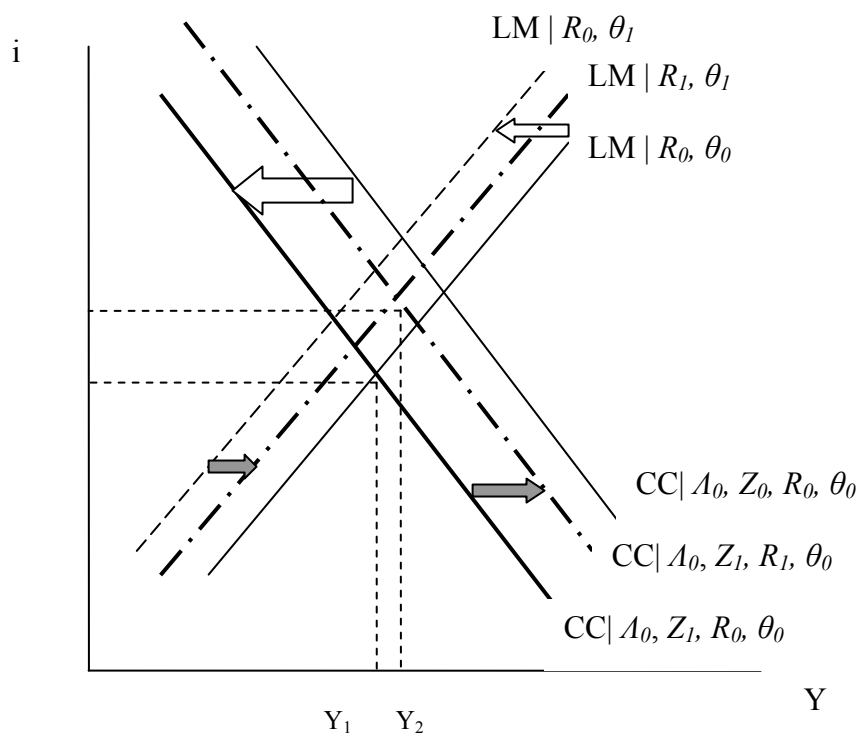

- If riskiness of the marginal investment project rises (Z), the CC curve shifts in.
- If some financial institutions fail, or wish to lend less, then λ_0 falls, and the CC shifts in.
- If the money multiplier ($1/\theta$) falls, both the CC *and* LM curves shift in.

Here, we take Z as exogenous. But if Z depends upon the level of economic activity, then one could have an adverse feedback loop, wherein the initial shift inward of CC results in an additional increase in Z and hence further inward shift of CC.

If either financial institutions fail, or the monetary multiplier falls, then the monetary authorities can either increase Reserves, or directly lend to the financial institutions. This is shown below as a shift outward of the LM curve, and of the CC curve (gray arrows).

The gray arrows show the impact of the Fed responses in the Figure below.

i

LM | R_0, θ_1

LM | R_1, θ_1

LM | R_0, θ_0

CC| $\Lambda_0, Z_0, R_0, \theta_0$

CC| $\Lambda_0, Z_1, R_1, \theta_0$

CC| $\Lambda_0, Z_1, R_0, \theta_0$

Y

Y_1 Y_2

- If the Fed increases Res holding m constant, then both the CC *and* LM curves shift out.

One complication is that since October 2008, the Fed pays interest on both required and excess reserves, and so it can control both ($1/\theta$) and R to hit a desired money base, and hence money supply. Recently, it has paid a sufficiently high interest rate such that the money multiplier has shrunk considerably, and the resulting expansion in money supply (either M1 or M2) relatively muted.

3. Balance Sheets, Leverage, Losses

A little more detail on the balance sheet of the United States pre-crisis.

3.1 Reading Balance Sheets of a typical bank before and after a negative shock to assets

Commercial Bank (Before)			
Assets		Liabilities	
Reserves	$10M	Deposits	$90M
Loans (Mortgages, CRE) T-Bills Other bonds (GSEs)	$90M	Bank Capital (or "equity"	$10M

Commercial Bank (After)			
Assets		Liabilities	
Reserves	$10M	Deposits	$90M
Loans (Mortgages, CRE) T-Bills Other bonds (GSEs)	$80M	Bank Capital (or "equity")	$00M

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3.2 Balance sheets of the financial sector before the collapse of Lehman

| Exhibit 4.5 Leverage of Various Financial Institutions				
	Assets ($bn)	Liabilities ($bn)	Capital ($bn)	Leverage
Commercial banks	10793	9693	1100	9.8
Savings Inst	1914	1687	227	8.4
Credit Unions	748	659	89	8.4
Brokers/hedge funds	5397	5226	171	31.6
GSEs	1633	1567	66	24.7
Leveraged Sector	20485	18804	1681	12.2

Source: Authors' calculations based on Flow of Funds, FDIC Statistics on Banking, Adrian and Shin (2007), and balance sheet data for Fannie Mae, Freddie Mac, and broker-dealers under Goldman Sachs equity analysts' coverage.

Source: Greenlaw et al. (2008)

3.3 Loan loss magnitudes

Figure 1.12. Bank Writedowns or Loss Provisions by Region
(In billions of U.S. dollars unless indicated)
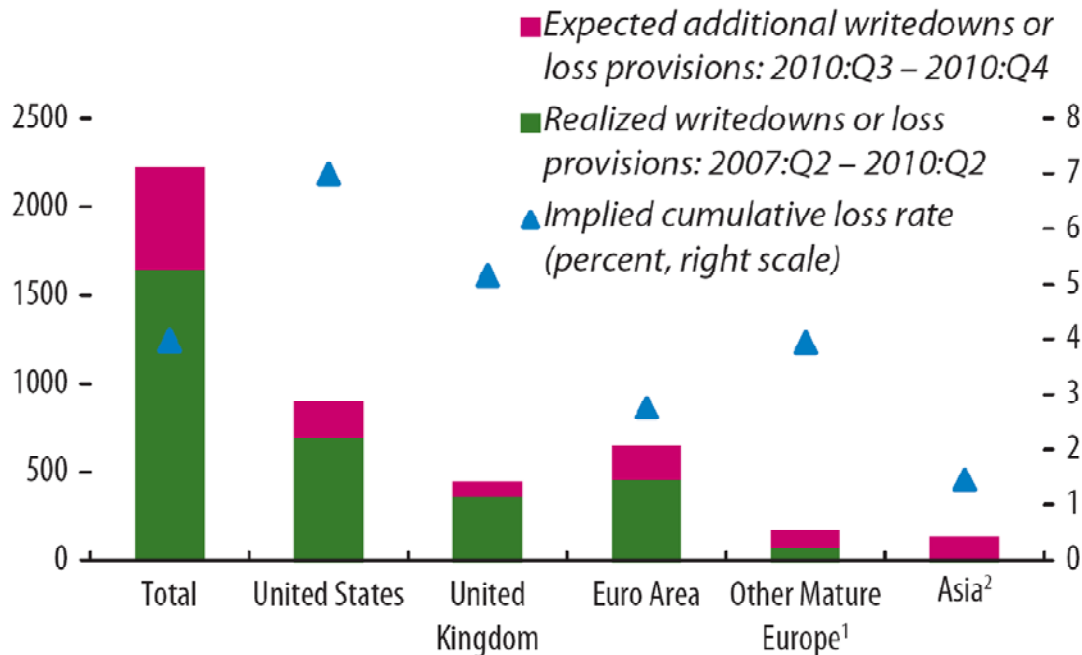
Source: IMF staff estimates.
[1]Includes Denmark, Iceland, Norway, Sweden, and Switzerland.
[2]Includes Australia, Hong Kong SAR, Japan, New Zealand, and Singapore.

Source: IMF, 2010, *Global Financial Stability Report* (Washington, DC: October).

References

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