

**Financial Crises, Capital Liquidation  
and the Role of International Reserves**

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The views presented in the presentation and accompanying paper are personal. They do not necessarily represent those of the IMF.

Table 1. Selected Sudden Stops: Decline in US Dollar GDP

Country	Year	Decline in \$GDP (percent)	Reserves/GDP at end 2007 (percent)
Argentina	2002	64.0	17.4
Brazil	1999	30.5	13.7
Indonesia	1998	55.8	12.8
Kazakhstan	1999	21.6	15.5
Korea	1998	33.9	26.5
Malaysia	1998	27.9	53.4
Mexico	1995	32.0	9.7
Philippines	1998	20.5	21.6
Russia	1998	33.1	34.5
Russia	1999	27.7	34.5
Thailand	1997	17.1	33.6
Thailand	1998	26.0	33.6
Turkey	1994	27.6	10.4
Turkey	2001	27.3	10.4
Ukraine	1998	16.5	22.0
Ukraine	1999	24.6	22.0
Uruguay	2002	34.9	15.1
<i>Memo Item:</i>			
China			47.1

Source: IMF

## Origins of Capital Account Crises in Emerging Markets

- Capital account crises are different from traditional BOP crises in which loose fiscal and credit policies cause gradual RER appreciation which makes it harder to finance the growing CADs, eventually forcing an adjustment.
- Capital account crises are large, infrequent shocks, often originating in the private sector. During such crises, emerging market countries experience large capital outflows, after a benign period of large inflows and high credit and income growth.
- The crises cause a sharp current account reversal with much lower domestic absorption and income.

$$\mathbf{Y - A = S - I = CAB = - FI + \Delta Res > 0,}$$

- The severe (but often V-shaped) recessions cause extreme economic dislocations as the real exchange rate depreciates sharply, firms and banks go bankrupt and capital is liquidated, unemployment spikes and/or workers experience large real wage cuts.

## Capital Account Crises in Emerging Markets

### Vulnerabilities

- Most severely affected by capital account crises are economies with currency and maturity mismatches. But relatively well-managed economies, with low public debts and deficits, can also be affected through contagion.
- As the name suggests, capital account crises require open capital accounts, in which banks based in emerging market rely on short-term (wholesale) funding to fund long-term investments, often denominated in foreign-currency (Original sin).

### Triggers

- Crises are triggered by bad news: political or economic prospects much weaker than previously thought, risk premia spike, and lenders refusing to roll over loans

## **Policy Responses to Capital Account Crises**

- Support from International Financial Institutions is helpful, but funds are limited, and support packages takes time to arrange and deliver.
- Hence, the need for emerging markets to self-insure by establishing large cushions of international reserves (Martin Feldstein's influential 1998 article in Foreign Affairs).
  - Large accumulations of international reserves followed.
  - Attempts at regional pooling of reserves in Asia
  - Ongoing rethinking of IMF programs
  - Better safety nets for workers

## Our setup

- A simple neoclassical model of investment modified to include signals that can trigger liquidation of capital (fire sales) before projects are completed.
  
- We ask:
  - What are the causes and triggers of crises, and what are their effects?
  - What are the costs and benefits of reserves?
  - What are the terms of government bailout loans in a crisis?
  - Are reserve requirements on debt-generating inflows useful?

## The story

### **Fire Sales of Capital during rare disasters...**

- Fire sales of capital triggered by large and infrequent shocks to TFP. In good times, when the option of liquidation is not exercised, capital inflows, investment, wages, and returns to lenders are higher than in bad times, when firm bankruptcies cause capital liquidation in fire sales, reducing wages and consumption.

### **...Raise Volatility in the Real Economy**

- Fire sales of  $K$  make wages and consumption more volatile. In countries in which the government does not provide wage insurance, welfare declines.

## **How can government policy reduce liquidation?**

- In a crisis, make emergency govt loans to firms, conditional on reducing liquidation
- These loans are financed by accumulating reserves in good times
- In the simple model, reserves as high as 30 percent of GDP may be needed.
- The optimal policy is to suppress all liquidation.
- Emergency loans are inferior to direct wage support, (but may not be feasible for political economy reasons...)



## The Model

### Planning period

- Foreign borrowing, investment initiated.

### Interim period

- Future productivity of investment revealed (high or low).
- Firm has option to liquidate capital at a loss (a fire sale), pay off loans early.

### Final period

- Workers hired, investment returns realized, production, wages and consumption.

## Representative Firm's Problem

- Cobb-Douglas technology in L,K

$$Y_1 = z_1 A K^\alpha L_1^{1-\alpha} \quad Y_2 = A z_2 [(1-\psi)K]^\alpha L_2^{1-\alpha}, \quad z_1 > z_2.$$

- Total Factor Productivity (TFP)

$$\text{TFP}_1 = A z_1 \text{ with prob } 1-\Pi \quad \text{TFP}_2 = A z_2 \text{ with prob } \Pi$$

- The firm borrows from competitive, costless domestic banks. These banks borrow from risk-neutral foreign lenders who get world risk-free rate of interest on average.

## Simplest Case: Liquidation Not Allowed/Possible

➤ Firm chooses  $L_1$ ,  $L_2$ , and  $K$  to maximize expected profit

$$(1-\Pi)\left\{ z_1 A K^\alpha L_1^{1-\alpha} + (1-\delta)K - w_1 L_1 - R_1 K \right\} + \Pi\left\{ z_2 A K^\alpha L_2^{1-\alpha} + (1-\delta)K - w_2 L_2 - R_2 K \right\}$$

s.t.

$$(1-\Pi)R_1 + \Pi R_2 \geq \bar{R}.$$

➤ First-order necessary conditions:

$$(1-\alpha)z_1 A k_1^\alpha = w_1 \qquad (1-\alpha)z_2 A k_2^\alpha = w_2.$$

$$\alpha A \left[ (1-\Pi)z_1 k_1^{\alpha-1} + \Pi z_2 k_2^{\alpha-1} \right] + (1-\delta) = E[R].$$

## Result 1

➤ If liquidation is not possible, then

$$L_1 = L_2 = \bar{L}, \quad k_1 = k_2 = k^*.$$

$$k^* = \left( \frac{\alpha A E[z]}{\bar{R} - (1 - \delta)} \right)^{\frac{1}{1 - \alpha}}.$$

$$w_1^* = (1 - \alpha) z_1 A (k^*)^\alpha.$$

$$w_2^* = (1 - \alpha) z_2 A (k^*)^\alpha.$$

## Limited Liability

- No losses are allowed in the bad TFP state. So when productivity is low, firms default, and their banks get the firms' entire revenue net of wages and payments due the government.

### Result 2

- Limited liability does not affect the equilibrium  $k$  or  $w$ 's.
- (b) With limited liability, the gross return of lenders equals the marginal product of capital:

$$R_1^* = \alpha z_1 A (k^*)^{\alpha-1} + (1-\delta)$$
$$R_2^* \equiv d = \alpha z_2 A (k^*)^{\alpha-1} + (1-\delta).$$

## LIQUIDATION IS ALLOWED

- Firms can respond to bad news ( $z = z_2$ ) by liquidating capital and paying off loans early.
- A unit of capital sold in a fire sale in the interim period is worth  $x$  units of output.  $x$  is a physical parameter analogous to the rate of depreciation  $\delta$ .
- In equilibrium, banks will accept early loan payoffs if they are indifferent between the “haircut”  $x$  they obtain in the middle period and a default payoff  $d$  in the final period:

$$x(1+\bar{r})=d.$$

### Result 3. Equilibrium with Liquidation

An equilibrium with liquidation ( $0 < \psi < 1$ ) exists if the price of capital in a fire sale is “not too low” and if the adverse TFP shock is “sufficiently bad” and doesn’t occur “too often”:

$$\text{If } x(1+\bar{r}) > 1-\delta \text{ and } \frac{z_2}{z_1} \frac{\bar{R} - \left[ (1-\Pi)(1-\delta) + \Pi x(1+\bar{r}) \right]}{(1-\Pi) \left[ x(1+\bar{r}) - (1-\delta) \right]} < 1,$$

then

$$\begin{aligned} \blacktriangleright \quad \bar{k} &= \left\{ \frac{\alpha A(1-\Pi)z_1}{\bar{R} - \left[ (1-\Pi)(1-\delta) + \Pi x(1+\bar{r}) \right]} \right\}^{\frac{1}{1-\alpha}} \\ \blacktriangleright \quad 1-\bar{\psi} &= \left\{ \frac{z_2}{z_1} \frac{\bar{R} - \left[ (1-\Pi)(1-\delta) + \Pi x(1+\bar{r}) \right]}{(1-\Pi) \left[ x(1+\bar{r}) - (1-\delta) \right]} \right\}^{\frac{1}{1-\alpha}} \\ \blacktriangleright \quad R &= 1-\delta + \alpha z_1 A \bar{k}^{\alpha-1} \\ \blacktriangleright \quad d &= x(1+\bar{r}). \end{aligned}$$

### Result 4: The Economic Effects of Liquidation

Economy-wide capital intensity and real wages are higher in an equilibrium in which fire sales of capital are allowed. But at plausible values for worker risk aversion, workers' expected utility would be higher if the government could prohibit fire sales, provided the prohibition could be enforced costlessly and perfectly effectively:

$$\bar{k} > k^* \quad (1-\bar{\psi})\bar{k} < k^* \quad EU_{LNP} > EU_{LP}$$



## **International reserves policy**

### **Strategy**

- Raise a war chest of foreign exchange reserves to fight capital liquidation.

### **Financing**

- Impose reserve requirements on debt-generating inflows.
- Lend funds generated by sale of reserves to domestic firms in a crisis.

### **Conditions on emergency loans**

- Reduce liquidation dollar for dollar.

## **Why finance international reserve accumulation using reserve requirements?**

- We have to finance it somehow, and this strategy seems natural in a country running external current account deficits.
- Reserves requirements are a non-monetary representation of policies based on exchange rate manipulation that many countries use (or that people claim they use).
- Chile and some other countries have used reserve requirements partly to finance accumulation of international reserves.

## Notation

- For every dollar of foreign loans extended to domestic banks during the planning period,  $0 < g < 1$  dollars are placed at a central bank account.
- Resulting stock of international reserves in the interim period:  $L^{cb} = (1 + \bar{r})gK$ .
- In a crisis, the authorities extend  $L^{cb}$  dollars in emergency loans to firms at rate  $r^{cb}$ ,  $-1 \leq r^{cb} \leq \bar{r}$ .
- Policy targets reduction of capital liquidation to a fraction of its LF value:  $\psi^{cb} = (1 - \mu)\bar{\psi}$ .
- Funds to finance early loan repayments:  $F = x\psi^{cb}K + L^{cb}$ .

- Face value of loans firms pay off early,  $L$
- A dollar's worth of principal in the interim date is  $h$ ,  $L = \frac{F}{h}$ .
- Arbitrage relation between  $h$  and the default return,  $d$

$$d = h(1 + \bar{r}).$$

- Returns to domestic banks and their foreign lenders

$$R_1 = (1 - \lambda) \hat{R}_1 + \lambda \bar{R}$$

$$R_2 = (1 - \lambda) d + \lambda \bar{R}^{cb}$$

## Result 5

Suppose that in a crisis the central bank lends to domestic firms on condition that they reduce capital liquidation, dollar for dollar. Then

- The fraction of capital liquidated in a crisis and the capital-labor ratios are given by:

$$k = \left\{ \alpha A \frac{(1-\Pi)z_1 + (1-\psi^{cb})^\alpha \Pi z_2}{\bar{R} - [(1-\Pi)(1-\delta) + \Pi x(1+\bar{r})] + \Pi(1-\psi^{cb})[\Pi x(1+\bar{r})]} \right\}^{\frac{1}{1-\alpha}}$$

$$k_2 = (1-\psi^{cb})k \quad \psi^{cb} = \bar{\psi} - \frac{(1+\bar{r})g}{x}.$$

- The central bank must subsidize its loans if firms are to accept them voluntarily:

$$r^{cb} = \frac{1-\delta + z_2 \alpha A k_2^{\alpha-1}}{x} - 1 < \bar{r}.$$

- As  $\psi^{cb}$  decreases, the size of emergency loans (and reserves) increase,  $k$  declines while  $k_2$  and the subsidy both rise.
- Eliminating all capital liquidation in a crisis is optimal from the point of view of workers' expected utility for conventional values of capital intensity ( $\alpha$  around 0.33).

## An Example

$$\{\Pi, z_2/z_1, \alpha, A, x, \delta, r^*\} = \{0.1, 1/3, 1/3, 1, 0.9, 0.19, 0.05\}.$$

- Worker preferences: log or stronger risk aversion in CRRA class of preferences.
- Policymakers maximize worker expected utility.
- Welfare comparisons using the standard approach from the RBC literature (consumption compensation)

Table 2. Holdings of International Reserves and Worker Welfare

(in percent)

<i>g</i>	$\lambda$	$\psi_2$	<i>R/Y</i>	<i>U</i> ( $\gamma=1$ )	<i>E<sub>w</sub></i>	<i>CV<sub>w</sub></i>	<i>U</i> ( $\gamma=2$ )	<i>U</i> ( $\gamma=4$ )
<b>0</b>	0.0	33.0	0.0	0.0	0.0	0.0	0.0	0.0
<b>1</b>	1.0	31.9	1.1	0.1	0.0	-0.3	0.0	0.5
<b>5</b>	4.8	27.2	5.4	0.7	0.0	-1.2	0.2	2.2
<b>10</b>	9.1	21.4	10.7	1.3	0.0	-2.4	0.3	4.2
<b>15</b>	13.0	15.5	16.0	1.8	0.0	-3.6	0.5	6.1
<b>20</b>	16.7	9.7	21.3	2.3	-0.1	-4.6	0.6	7.8
<b>25</b>	20.0	3.9	26.6	2.7	-0.1	-5.7	0.7	9.4
<b>28.3</b>	22.1	0.0	30.1	3.0	-0.1	-6.3	0.8	10.5

Source: Authors' estimates.

**Table 1 illustrates several points**

- A policy of accumulating reserves and employing them in rare emergencies to make loans to firms conditional on reduction in capital liquidation raises welfare by substantially reducing wage variability, with little change in the average level of wages.
- The optimal policy is to suppress all capital liquidation in a crisis, reducing wage variability to the level observed when liquidation is not possible.
- In our calibration, reserves are close to  $g=28$  percent of all foreign-financed capital investment and 30 percent of GDP
- The effect of reserves on welfare depends on workers' attitude toward risk. With a coefficient of RRA  $\gamma=2$ , compensation of 3 percent of wages is needed to offset the increased wage variability associated with capital liquidation.



## Summary

- In our model, a real shock to an emerging country reduces its ability to absorb credit. This is *not* an exogenous refusal to lend by international banks and capital markets.
- The fire sales of capital tied up in uncompleted projects amplify the problems caused by the real shock.
- The model endogenizes short-term credit and provides a welfare rationale for
  - acquiring large buffer stocks of international reserves
  - imposing remunerated reserve requirements on debt-generating flows
  - providing conditional financial support to distressed firms

## Summary

- Various extensions consider imperfectly informative signals, nontraded goods and the real exchange rate, domestic saving, and domestic “bank runs” during crises.
- We also analyze a capital externality, which might help explain (1) why policies that look like emergency loans seem more popular than wage insurance and (2) the intuition that crises are self-reinforcing, because responses by some agents increase the problems of others, and so on.

## Summary: Lessons for the current crisis

- Do we need to attach conditions to “bailout” loans? This model says we do. We can show that emergency loans without conditions are ineffectual, even if they are subsidized.
- (2) Would it be better to assist distressed workers rather than bailing out firms? The model says it would. However, the output losses from this kind of assistance are much bigger than the losses from emergency loans. So it might be a hard sell politically. Also, much of the benefit from wage insurance has nothing to do with crises. It provides the same sort of benefit in an economy where liquidation is not possible.
- Low risk-free interest rates increase the vulnerability of the economy to crises. So the model may provide a little support for the claim that low interest rates in the early 2000s helped set us up for a crisis.

- Our results indicate that policies that succeed in reducing the problems created by a crisis may make the economy “look worse” during, after and even before a crisis. Both the early-payoff and the ultimate default payoff are lower under the emergency loan policy than under LF, and the non-default interest rate is higher.
- An interesting feature of the wage insurance policy is that it succeeds in reducing the amount of liquidation, even though it does not discourage liquidation in any direct way. This feature seems particularly consistent with the “European view” that if you have a good social safety net then there is much less need to intervene in other ways during a crisis.