Contagion or Inductance: Crisis 1997 Reconsidered*

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1. Introduction

Now Crisis 1997 is a thing of the past, it is time to diagnose its progression and mechanism and devise reforms to prevent its recurrence.

Crisis 1997, the last of the three exchange crises in this decade, differs markedly with its predecessors, the crisis of the European Monetary System and the Mexican shock.

Crisis first engulfed the Czechlands, May 1997. By July, Thailand was forced to devalue the baht and many Asian currencies followed. Then the Brazil economy was also hit, and the Russian currency became its last victim in 1998.

The fact that economies in different parts of the world became afflicted in quick succession is generally perceived as a system-wide malaise and not sheer coincidence. Speculative attacks played some role, but successful attacks presumably signify some underlying weakness.

The wide spread crisis is often compared with a contagion, in a bio-medical analog. This metaphor suggests contact among the afflicted, within some network, presumably bringing havoc, en route.

The theory of financial contagion has been recently developed in a stimulating paper by Allen and Gale (1999), where game-theoretic interactions cause local event to cause system-wide

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financial difficulties and the delinking of financial relationships becomes the policy remedy.

The questions for researchers on crisis 1997 are two:

First, whether the facts of that particular crisis fits the theory of Allen and Douglas, and

Second, if not, whether an alternative theoretic analysis can be found for crisis 1997.

This study is based upon the belief that the answers to these questions are no and yes, and progress may be made, by focusing on the asymmetric information along the architecture of the 'credit chain', a concept considered in Kiyotaki and Moore (1997).

Facts suggest that Crisis 1997 has the following characteristics:

(a) Investment flows which directly connect the affected economies are not very significant.

(b) Most financial linkages among the affected economies are through the markets and institutions of the developed economies, which are by far the least affected by the crisis.

(c) The affected economies were either developing or in transition.

Thus, we suggest that one should consider an alternative analog, namely, the 'inductance' phenomenon between neighboring but disjoint electric circuits.

We shall motivate our approach in the next section in broad terms before the specification of a 'refinancing game'. The incompleteness of information for certain agents may cause the spread of crisis as an equilibrium outcome of the game.

Final remarks are in Conclusion.

II. General Motivation

One common feature in the financial crisis we just observed is that debtors often borrow short-term loans for long run projects and hope that their applications for refinancing will be

granted. Oftentimes, their creditors also are indebted to other financial institutions. When crisis threatens, creditors will refuse to approve refinancing their debtors, for fear that they themselves become illiquid. The tightening of credit will then make some debtors insolvent. The waves of default invariably lead to more pessimism, credit-tightening and bankruptcy.

The key fact is that if a banking institution has suffered from much bad debt, it is more likely to tighten credit and deny refinancing. To anticipate such a prospect, those who borrowed from that bank will launch some credit-tightening of one's own.

It is a fact of life that borrowers are not in a position to find out whether their lenders have recently suffered much bad debts. Wherever credible information is scarce, speculation flies, so that the failure of a few firms may cause quite a wave of credit tightening, around the world.

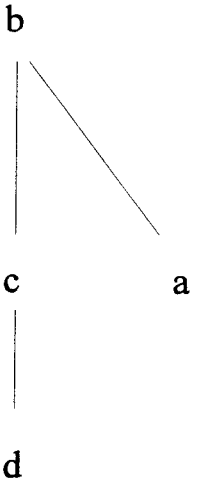
III. A Formal Model - The Isolated System

The 'flow of funds'. We start with a four party system, consisting of agents a,b,c,d, where representatiive agent, debtor d, borrows from representative agent, creditor c, who is in debt to bank b, while another agent, a, also has loans extended by b.

Chart 1 below displays the 'flow of funds' relationship among these four agents.

Chart 1

The Isolated System



The Scenario. At the initial instant, d has already borrowed from c and c has already borrowed from b. The applications for refinancing have been filed by the respective borrowers, with their approvals pending. Agent d is a 'strategical dummy', with no ability to affect other agents.

Agents c and b, each has two options. For c, it is to agree to refinance [choice Y(es)] and to decline to refinance [choice N(o)]; for b, it is to approve refinancing [choice: y(es)] or not to approve [choice: n(o)]. b and c decide simultaneously, knowing the state θ to be either $\theta = s$ (a is solvent) or $\theta = i$ (a is insolvent).

The 'pure strategy profile' σ has four possible values:

(y, Y), (y, N), (n, Y), (n, N).

One can then work out the 'outcome':

$\omega(\sigma, \theta)$

under any combination of 'pure strategy profile' and 'state', which will describe whether a particular agent faces bankruptcy, etc.

Furthermore, assumptions can be made about the payoffs of b and c, the active players of the refinancing game, $\pi(\omega) = [\pi_b(\omega), \pi_c(\omega)]$.

Assumptions on payoff as well as outcome. We may now work under the following observtions:

(1) $\pi_b[\omega(\sigma,s)] = \pi_b[\omega(\sigma,i)]$ unless $\sigma = (y, Y)$.

In the above notation, $\pi_b[\omega(\sigma,i)]$ does not take account of the bad debt loss caused by the insolvency of a.

In words, the state of a only affects whether b has suffered bad-debt loss or not. This fact has further implications only when b is committed to refinance c and c is going to exercise that option to renew loans to d. For then, a may become insolvent.

(2) $\pi_c[\omega(\sigma,s)] = \pi_c[\omega(\sigma,i)]$ for all σ.

In words, given what b and c have committed to do, whether b has suffered bad debt loss on account of a does not affect c.

We now study the two alternative states in turn.

First, consider $\theta = i$ (insolvency of a). Four subcases, each with a distinct 'strategy profile', must now be examined.

1. Profile (y, Y). b has to face the consequence of over-commitment; c can carry on unaffected.

2. Profile (y, N). Since c refuses to refinance d, the latter may default, with some possible bad debt loss to c. Presumably c would not actually borrow from b, even

though that application for refinance is approved. Hence we shall assume that b can avoid the consequence of over-commitment.

3. Profile (n, N). Both b and c have refused to roll over the loans they extended. The outcome is the same as under (y, N).

4. Profile (n, Y). b has refused to refinance c, but c becomes over-extended. In case of a default by c, b may sustain some bad debt loss.

Second, consider θ = s (solvency of a). Note that again there are four subcases, one for each particular strategy profile. In each of these, payoff of b is no longer negatively affected by any bad debt loss from its investment in a. But this should leave c's choice unaffected.

Based upon observations (1) and (2), the only difference between θ = s and θ = i is about the payoff of b for the profile (y, Y), namely, once θ = s, b has no worry about being over-committed.

The bi-matrix games. We shall introduce, for convenience, the following notations:

For b,

$\pi_b = 0$, if b becomes insolvent

$\pi_b = B'$, if b sustains some bad-debt loss due to the insolvency of c

$\pi_b = B''$, if b earns the expected returns

$0 < B' < B''$

For c,

$\pi_c = 0$ if c becomes insolvent

$\pi_c = C'$ if c sustains some bad debt loss due to the insolvency of d

$\pi_c = C''$ if c earns the expected returns.

$0 < C' < C''$.

The above information can then be displayed in the following bi-matrices, in Chart 2.

Chart 2

$\theta = i$

The Game Matrices	Choices of c	
$(\pi_b \cdot \pi_c)$	Y	N
Choices of B		
y	(0, C'')	(B'', C')
n	(B', 0)	(B'', C')

Equilibrium profile: (n, N)

$\theta = s$

The Game Matrices

	Choices of c	
(π_b, π_c)	Y	N
Choices of b		
y	(B, C'')	(B'', C')
n	(B', 0)	(B'', C')

Equilibrium profile: (y, Y)

We have now established

Proposition 1.

For the isolated system, the equilibrium outcomes are

$\sigma = (y, Y)$ for the state $\theta = s$

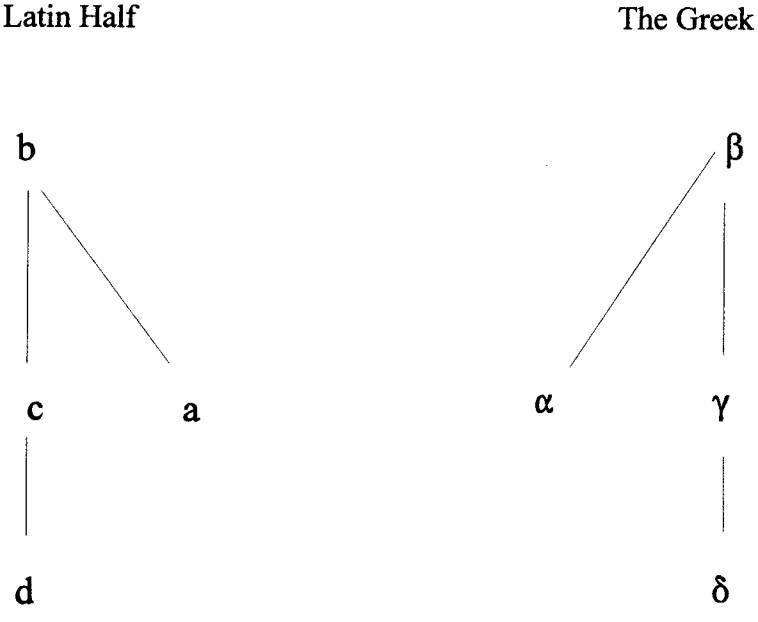
$\sigma = (n, N)$ for the state $\theta = i$.

III. The Formal Model - The Parallel Worlds

We now consider a model with two parallel worlds as displayed in Chart 3 below

Chart 3

The Parallel Worlds



The 'flow of funds' follow two disjoint systems and the 'system architecture', concerning who lends to whom are perfectly known, not only to both b and β, but also to both c and γ as well. The system is decomposable into a 'Latin half' and a 'Greek half'. There is no link between the two halves. Each has an equilibrium outcome, for the local state. We have

Proposition 2. Local shocks do not cause system-wide crisis in a decomposable net work.

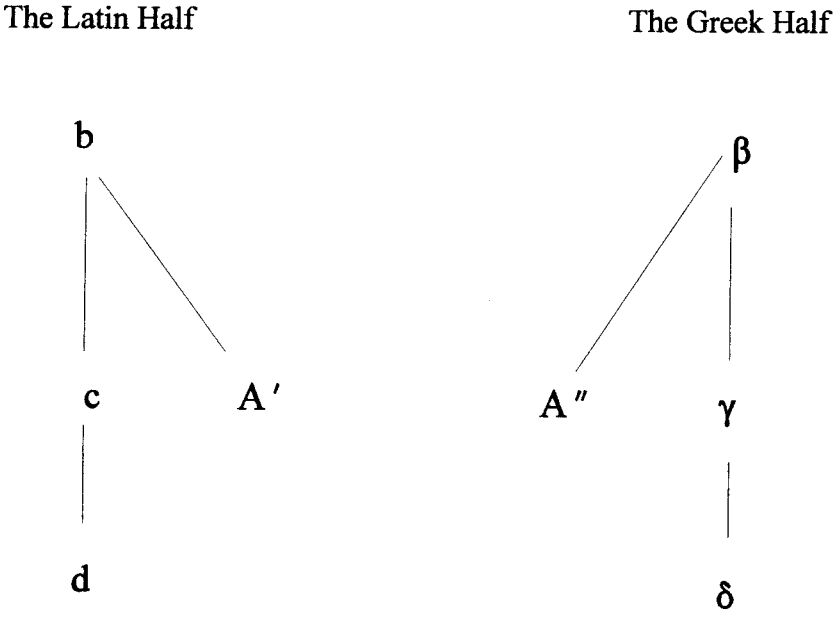
IV. The Incomplete Information World

We next display a diagram with contains two possible alternative worlds in Chart 4.

Chart 4

The Parallel Worlds

Possibility 1



Possibility 2

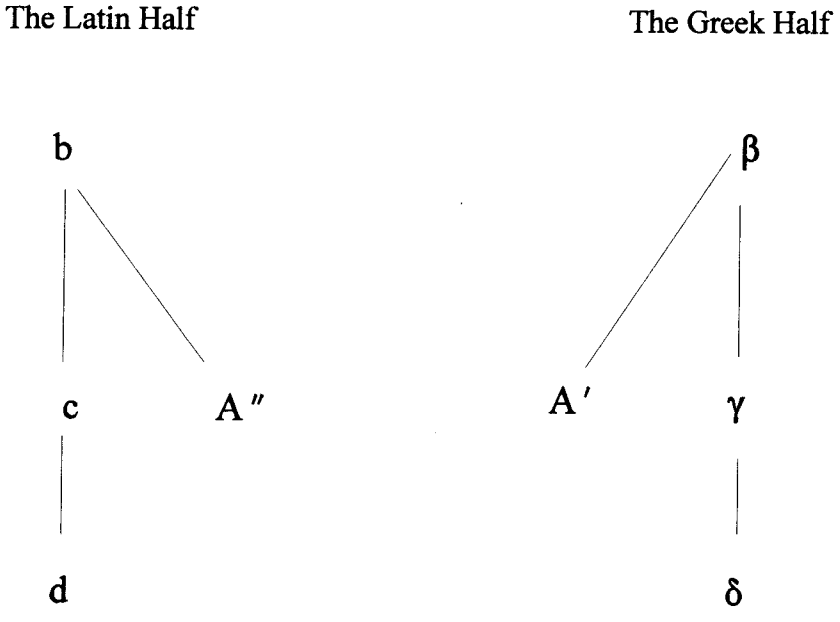


Chart 4 demonstrates our key argument that there are two alternative investments for bankers b and β, namely, A' and A". (In Latin and Greek, the upper case first alphabet is A). Observationally equivalent ex ante, but we assume that the former becomes insolvent ex post, as all can see. However, there remains the fundamental asymmetry in that:

(1) As lenders, one can monitor what the borrowers are doing with the funds being loaned,

(2) As borrowers, one is in no position to ascertain the exposure of one's lenders to other risks.

Thus, for c and γ, possibilities 1 and 2 in Chart 4 are equally likely worlds they are in, but they can never be sure which is reality and which is imagination.

In such a case, one can invoke the classical analysis of Harsanyi (1967-8), treating players c and γ as playing a two-stage game. They must decide to play Y or N, before Nature is going to pair them off against the banker making sound alternative investment, or the one who is over-

exposed and caught by the insolvent alternative borrower.

We can analyze the situation in the following steps.

First, in Chart 2, the equilibrium choice of b is a '(weakly) dominant' strategy. b cannot do better by changing the chosen action, irrespective the simultaneous choice by c. Therefore, from the viewpoint of c, the choice of b is uniquely predictable, given the observed state of θ.

Second, the above statements apply to an isolated system. For a situation displayed in Chart 4, both b and β know whom among them two is sustaining the bad debt loss, due to the insolvency of one of the two alternative borrowers, A' and A". But such flow of fund architecture is unknown to c and γ. They can only assume that with equal chance, the party lending them funds (b or β) is that one sustaining bad debt loss. In short, they will find the choice of their lender is equally likely to be a y or a n.

Third, after referring back to Chart 2, it is clear that the expected payoff of c or γ is:

C"/2 for choice Y

C' for choice N

That is, to approve the refinancing of their own debtor, (d or δ), c or γ will have half a chance of regular profit for now, but also half a chance to be wiped out in bankruptcy. The alternative is to disapprove refinancing and take the chance of facing some bad debt now. Under the additional

Assumption

$C''/2 < C'$,

which seems to be reasonable, supposing that agents are risk averse, then, one has established:

Proposition 3.

A local shock on an alternative borrower may cause a system-wide crisis by inducing credit tightening at the middle stream of the flow of funds.

From the viewpoint of institutional reform, 'linkage cutting' can contain the crisis, under the financial contagion thesis but not in our model.

V. Concluding Remarks

Although Crisis 1997 is finally over, it is important to draw the appropriate conclusions from its record, for the sake of institutional reform.

It is well understood that for economies with a heavy burden of foreign debt, any exchange rate devaluation makes the servicing of external debt more difficult.

It is also obvious that when two economies export similar goods, the devaluation of one currency exerts strong pressure to the other currency to devalue as well.

Thus it is not surprising that the devaluation of the Thai baht threatens the exchange rates of Malaysia and Indonesia and the crisis in Korea led to speculators to raid the New Taiwan Dollar. However, the interaction between Latin America, East Europe and East/Southeast Asia in their exchange rates are quite unexpected.

It is against this background that both the contagion theory and the inductance theory are proposed.

In our introduction, we have proposed three characteristics for Crisis 1997 and suggested that they seem more consistent with the inductance theory than with the contagion theory.

It would be desirable to design formal statistical procedures to study the relative merits of these two theories as explanations of Crisis 1997.

Still another line of related inquiry is to relate real world events in the Crisis to the theoretical constructs of our inductance model.

For example, before the crisis, several Asian economies were engaged in infra structure investment and real estate development. Although the aforementioned projects have led to the cumulation of external debt, it is generally believed that the continued inflow of foreign investment will bring in enough foreign currency to service the outstanding debt. This scenario is parallel to our simpler constructs in the inductance model.

Still another aspect deserves some comment. As economic crisis afflicted many economies, the International Monetary Fund became, for many economies', the Last Resort. The Fund has only finite resources, and the rescue of Indonesia made the uncommitted resources of the Fund to plunge to very modest levels. Such news encourage speculators throughout the world to raid weak currencies. This sequence of events seem to parallel our model in certain key aspects. Suffice to say, much more work needs to be done, in such factual research.

References

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