Academic Views of Capital Flows: An Expanding Universe

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1.   Introduction

Recent crises in emerging markets have generated a fundamental re-appraisal of theoretical models of international capital flows. It is now generally recognised that crises have occurred in circumstances that cannot be explained by first generation models of speculative attacks that seemed quite acceptable only a few years ago. First generation models (Krugman 1979; Flood and Garber 1980) and their descendants dominated thinking about capital flows and crises partly because they explained several important features of balance of payments crises based on very simple behavioural assumptions about governments and private investors.

In these models, governments are assumed to follow, stubbornly and naively, an inconsistent policy regime. In contrast, private investors are well informed and act on rational, forward-looking expectations. As we have observed one crisis after another in recent years, the predictive power of the model has diminished to the point where it has not been a serious factor in recent discussions of the crises in Asia. The failure of this theoretical framework to help anticipate crises has proven extremely costly. Governments that followed the rules of the game suggested by first generation models have suffered costly recessions following crises. We are in the midst of a crisis for the theory of crises.

To bring some order to the current debate, four important departures from first generation models are discussed in the following pages. In the next section, second generation models are reviewed. These models are based on more complicated assumptions about governments' behaviour. This is followed by two approaches that incorporate assumptions about private speculative behaviour that are fundamental departures from the rational expectations or efficient market framework. The first is based on a variety of capital market imperfections that have been associated with crises in closed economies. The second is based on the assumption that speculative behaviour is inherently destabilising and that behaviour varies across types of investors. Finally, we discuss an alternative first generation insurance model.

2.   First and Second Generation Models

The primary accomplishment of first generation models is that they relate fundamentals that evolve smoothly to discrete changes in regimes and asset holdings. The mechanism that accomplishes this is an anticipated sequence of yields on real or financial assets that shapes the behaviour of competitive and rational investors. Salant and Henderson (1978) consider a situation in which the government distorts the real interest rate earned on stocks of gold by fixing its nominal price. As

long as the return on holding gold is below the risk-free alternative, private investors are happy to let the government hold the buffer stock. But investors know that if a speculative attack exhausts the buffer stock, the price of the commodity will henceforth rise at the real interest rate. At this time private investors will buy the entire stock of government holdings in a speculative attack.

Krugman (1979) adapted this idea to a fixed exchange rate system. In Krugman's model, the driving force is a conflict between the government's exchange rate commitment and its fiscal policy. As long as the fixed exchange rate regime survives, a deficit is financed by gradual reductions in the government's reserves. On the day the attack occurs, the government's reserves fall discretely to zero and the exchange rate is allowed to float. There is nothing apparently special about that day in terms of the fiscal deficit, but there is something special about yields on assets, in this case on money balances.

Because the exchange rate regime ends when reserves go to zero, subsequent deficits are financed by money creation. The associated increase in expected inflation and nominal interest rates reduces the real return on, and demand for, real money balances. This is accommodated by the discrete sale of international reserves (the foreign part of the monetary base) to the private sector.

Like its antecedents, this model teaches the important lesson that rational economic behaviour driven by fundamentals that evolve smoothly over time can involve dramatic attacks (asset exchanges between the government and the private sector) and changes in regimes that seem to be unrelated to contemporaneous changes in the fundamentals.

Because first generation models are driven by observable policy rules, we would not expect crises in countries where the policy conflict is clearly absent. Yet this has been the case in most recent crises. The natural response has been to re-examine the simple behavioural assumptions behind the model.

Second generation models retain the assumption of rational private investors but assume governments recognise and exploit trade-offs among policy objectives. This quite modest extension of the analysis suggests that crises are more difficult to predict because the government acts on forecasts of future developments. Moreover, because private investors have to guess the government's future policies, changes in private expectations can generate self-fulfilling, multiple equilibria.

These models provided a better understanding of the 1992 ERM crises but, as with first generation models, do not seem to provide a convincing story for the events that followed, particularly in Asia. Their primary lasting contribution to the debate over capital flows is the idea that under certain conditions, regimes can be vulnerable to shifts in private expectations. The nature of the circumstances is, of course, specific to each model. The stringent condition for a self-fulfilling attack is that a shift in private expectations about government behaviour generates a change in the *optimal* policy regime. Calvo (1988) summarises the implications of the argument as follows: 'The implications for policy could be staggering: for our results suggest that postponing taxes (i.e. falling into debt) may generate the seeds of indeterminacy; it may, in other words, generate a situation in which the effects of policy are at the

mercy of people's expectations – gone would be the hopes of leading the economy along an optimal path'.

Flood and Garber (1984) and Obstfeld (1986) showed that if a government is expected to follow more expansionary monetary policies following a successful speculative attack on the fixed exchange rate regime, policy regimes that would otherwise be viable can be forced to collapse by self-fulfilling private expectations.

Obstfeld (1994) refines the argument by specifying the political economy that might account for the government's behaviour before and after an attack. The analysis sets out a rational government that seeks to maximise a plausible objective function. Since the government's objectives are the same in any exchange rate regime, it follows that policy-setting under different regimes must reflect changes in the economic environment rather than arbitrary assumptions concerning the government's behaviour.

Eichengreen and Wyplosz (1993) argue that self-fulfilling models offer a better interpretation of the ERM crises in 1992 compared with the first generation models. Their general point is that the ERM members that were forced to abandon their exchange rate commitments played by the rules of the game for a viable system as long as entry into the European Monetary Union was a feasible objective. To buttress this interpretation, Eichengreen, Rose and Wyplosz (1994) offer empirical evidence that the fundamentals behaved differently in the months leading up to the ERM crisis compared with a sample of crises in other fixed exchange rate regimes. In particular, they argue that the ERM crisis was not preceded by excessive money growth, growth in domestic assets, fiscal deficits, or a number of other variables usually associated with inconsistent policies.

More recently, several papers have examined crises in emerging markets and concluded that shifts in private expectations are important elements in an attack sequence. Calvo and Mendoza (1995) argue that the crisis in Mexico in 1994 is consistent with the idea that the government's short-term debt and the anticipation of a bailout for a weak banking system made it vulnerable to a shift in private expectations. Cole and Kehoe (1996) also argue that events in Mexico are consistent with a self-fulfilling crisis. Sachs, Tornell and Velasco (1996) examine characteristics of 20 countries that seem to contribute to their vulnerability to speculative attacks following the Mexican crisis in 1994. They find that prior lending booms, overvalued exchange rates and low levels of reserves relative to M2 explain a large part of this experience. They also find that fiscal and current account deficits seem to be unrelated to a country's vulnerability to attack.

Another interesting approach seeks to extend second generation models by expanding the empirical counterpart of government finance to include implicit assets and liabilities. An important branch of this research is developed by Guillermo Calvo. In a series of papers, he has argued that debt service on the *stock* of government liabilities that might be subject to self-fulfilling shifts in private expectations is much larger than the explicit debt numbers usually considered. Calvo (1996) adds a banking system and a domestic market for government bonds and shows that a more realistic balance sheet for the government and the private

sector is important in evaluating the vulnerability of the regime to shifts in private expectations. In this model, if the government acts as a lender of last resort, it takes on liquid liabilities and illiquid bank assets. This generates an interesting link between banking and balance of payments crises. The domestic bond market is also a source of vulnerability since debt service costs are probably reduced by short-term debt, but such debt is an immediate fiscal problem if a shift in inflationary expectations causes domestic interest rates to rise. This paper also offers an explanation of why expectations might shift, a topic we will return to in Section 3 below.

In retrospect, the striking feature of first- and second-generation models is that they are models of government finance rather than international finance. The private sector is composed of representative, competitive, rational, well-informed, utility maximising speculator/households. There are no financial intermediaries, no incomplete contracts or information asymmetries, and certainly no noise traders. In terms that will please readers of a certain age, Friedman's speculators had clearly driven Kindeleberger and Mackay's speculators from the academic playing field.

3.   Alternative Models of Private Speculative Behaviour

Two quite different approaches to modelling private behaviour have emerged in the past year or so. Both are modern adaptations of models with a rich historical background. Our main objective in the following pages is to offer a very preliminary review and assessment of these recent contributions to the analysis of capital flows and crises.

The first approach maintains the assumption that investors are rational, but emphasises the fact that capital markets do not offer a complete menu of contracts and that investors are not uniformly informed. Thus, both domestic and international financial markets are subject to important distortions. This approach draws on a rich literature developed in the context of a closed economy that attempts to explain crises and the role of governments in stabilising financial markets.

The second approach attributes behavioural peculiarities to different types of private investors and attempts to interpret the data as manifestations of that behaviour. This analysis is very closely related to the traditional view in international finance that types of flows reported in the balance of payments statistics, such as direct investment or short-term capital flows, are useful behavioural aggregates. In general, this approach asserts that there are such things as noise traders and focuses on the empirical content of the model of the assumed behaviour.

The distinction between these approaches is more than an academic issue. If some types of speculators are inherently destabilising, the appropriate policy response is to curtail the behaviour of these speculators. This was the approach favoured by the founding fathers of the Bretton Woods system. If decisions of normal speculators are distorted by market failures, the policy response is to minimise the distortions. More importantly, curtailing the activities of one set of investors that are motivated by a distortion will not solve the problem because others will take their place. The stakes,

therefore, are much higher since direct controls over capital flows will have to be comprehensive in order to be effective.

3.1 Behavioural finance

The idea that private capital flows are inherently unstable even in the context of a perfectly sound policy regime is a very old one. In fact, it was the dominant view at the inception of the Bretton Woods system, a system that not so long ago required IMF member countries to control capital movements. The idea that the perfectly informed competitive speculator might be a bit of a stretch has received considerable support in the modern analysis of domestic financial markets. The equity market crash in the United States in 1987 generated renewed interest in the idea that the behaviour of investors or particular groups of investors might account for changes in market conditions that seemed unrelated to fundamentals. This approach is once again threatening to dominate analysis of international capital movements. In our view, this line of research is like a virus that cannot attack a healthy theoretical framework, but is opportunistic when we are confused about what is going on.

The idea that private behaviour destabilises international financial markets has a long history. In part, the problem is that the balance of payments data condition us to believe that the motivation for a capital flow is related to the type of transactor and the type of financial instrument traded. Thus, direct investors' purchases of shares in emerging market firms are thought to have entirely different motivation compared to foreign banks' purchases of short-term deposits in emerging market banks. Clearly the founding fathers of the Bretton Woods system believed in what is now called behavioural finance and designed the balance of payments statistics so that we could keep careful track of, and control over, poorly motivated capital flows.

These arguments seem plausible. Aggressive hedge funds seem to destabilise virtuous regimes. Moreover, they profit at the expense of honest governments. Direct investment seems to be associated with capital formation. Short-term capital flows seem to be associated with investors that focus on the dynamics of the market rather than fundamentals.

Dooley (1996) provides a review of the arguments in support of a 'Tobin Tax'. This literature argues that investors with short holding periods tend to destabilise prices, while investors with long holding periods stabilise prices near fundamental values. The conclusion of this review is that there is no convincing evidence from either domestic or international markets that such a correlation between holding periods and speculative behaviour has been found in the data.

There are, of course, many alternative hypotheses about the nature of destabilising speculation. Kim and Wei (1999) examine data on positions of non-residents in the Korean equity market in the 18 months surrounding the recent crisis. Using measures of herding and positive feedback speculation, the authors conclude that non-resident institutional investors were subject to herding and sold equities that performed relatively badly in the preceding month. While we have considerable misgivings about the power of such tests, they clearly suggest that more empirical research is warranted.

In contrast, Claessens, Dooley and Warner (1995) find that balance of payments labels do not help in predicting the time-series behaviour or the predictability of different types of capital flows. It is, of course, possible that more carefully defined data sets could find predictable behaviour missed by the balance of payments accounts. In general, it now seems pretty clear that we cannot rule out destabilising speculation as irrational, or assume that such speculators will always suffer losses that leads to their disappearance. This is an empirical issue.

The obvious problem with interpreting the data is that we can never be sure whose behaviour we are observing when we look at transaction data. Friedman's observation that new information changes prices, and differences of opinion generate trades, remains an important insight. A complete analysis must consider interactions among different types of capital flows. Indeed, it can be argued that all the detailed accounting for international capital flows is of little use in understanding the economics behind capital flows. The possibility of sovereign default means that if trouble comes, all foreign claims on residents of the emerging market are thrown into a pool and renegotiated. It is this anticipated aggregation of claims that is at the heart of the problem in interpreting types of capital flows. Where default is a possibility, the nature of individual claims is important to the extent that it determines the place in line for repayment during a renegotiation of debt.

3.2   Incomplete contracts and capital flows

Before taking on this new literature, it is worth reviewing how thoroughly the behaviour of private investors had been simplified in the standard model of sovereign debt. The first step in submerging the private investor is to aggregate all capital flows. Total private and official net capital flows must equal the current account imbalance. The current account balance is the difference between domestic output and absorption, so the net capital flow must augment or diminish current consumption or investment. Either can provide a rational expectation for repayment. Models of sovereign default focused on the interaction between net capital inflows and net service payments to creditors as the problem of international finance. Max Corden's famous consenting adults model focuses on the optimality of this intertemporal trade among countries. The message from the models is that as long as private incentives are not distorted, private net capital flows are not a policy problem. Notice that it has nothing to say about the structure of financial capital flows or the structure of financial intermediation in the country.

There are many distortions that have made their way into the Corden model. The most important is the difficulty in enforcing cross-border claims. But we think a fair reading of this literature is that it has not provided a compelling explanation for recent crises in emerging markets. External debt and debt service were not so large relative to capacity to pay that default could have been an optimal strategic policy for governments.

The Corden model has recently been extended by incorporating a very sensible insight – the transformation of foreign savings into productive capital or deferred consumption might generate the same liquidity problems for the international

monetary system as are generated for domestic financial systems. This brings the structure of markets, contracts, and financial intermediation to centre stage. An important focus of this literature is the trade-off between liquidity and the productivity of capital. In an ideal world financial intermediation and contingent contracts can provide both. Investors that want to liquidate can do so as long as the financial intermediary can satisfy aggregate liquidity needs while the bulk of the economy's savings can be transformed into illiquid, but high return capital. The problem, of course, is that an unusual or unexpected demand for liquidity can generate forced sales of assets at a loss for the community. The possibility that a crisis can be caused by a self-fulfilling shift in private expectations lies behind many recent interpretations of crises in emerging markets.

Related work focuses on the idea that financial intermediation is an inherently risky business and may be prone to crises. An important part of the story leading up to crises in Asia was liberalisation of both domestic financial markets and the access of residents of these countries to international financial markets. While the implications of capital mobility for macroeconomic policy are the bread and butter of international economists, the implications of capital mobility for the efficiency and stability of financial markets are much less a part of the standard tool kit. Models that fit international capital flows into models in which financial intermediation is explicitly considered may hold the key to a better understanding of international capital flows.

3.3   Sources of financial fragility

Economists have developed and studied a range of models that provide insights into the structure of financial markets, the sources of financial fragility, and the role that policies might have on both the efficiency of financial markets and their stability. By and large, these have been closed economy models, not designed to address directly the issues associated with international capital flows. Typically, theory deals with broad classes of agents – lenders versus borrowers, consumers versus firms, entrepreneurs versus savers. These categories do not necessarily correspond to whether the market participants are foreign or domestic residents. However, economic theory does highlight important sources of credit market imperfections and their implications for financial instability.

A useful starting point for an analysis of financial fragility is the Diamond-Dybvig (1983) model of bank runs. This model provides a well-defined environment in which there is a demand for liquidity, and banks can perform a maturity transformation function that, in equilibrium, is welfare-improving. However, there is a second equilibrium in which a bank run occurs. In this second equilibrium, all depositors attempt to withdraw their funds from the bank. Losses are suffered as the bank liquidates its assets to meet these withdrawals.

The basic Diamond-Dybvig model focuses on two key factors. First, investments normally require that funds be committed for some period of time. This can be thought of as reflecting higher expected returns on long-term investments, or simply the costs of liquidating asset holdings. Assets held to maturity offer higher returns than assets sold before maturity. Second, individuals are uncertain as to when they

will need their funds. There is a chance an investor will need to liquidate before maturity.

In the absence of aggregate uncertainty, a bank can provide liquidity risk insurance to individual agents, accepting deposits and investing in the long-term asset. The deposit contract specifies the amount a depositor may withdraw prior to the asset's maturity. Because there is no aggregate uncertainty, banks can always hold exactly the level of reserves necessary to meet withdrawals by impatient consumers. Patient consumers will be better off if they leave their funds in the bank and receive a higher payout when the investment asset matures.

A bank run can take place, however, if patient depositors believe that other patient depositors will withdraw their deposits. If all patient depositors attempt to withdraw their funds from the bank, the bank will, even after liquidating its assets, have insufficient funds to meet withdrawals – the bank falls. So if a patient depositor expects others to withdraw early, it is individually rational to try to withdraw early as well.

The basic insights of this model have focused attention on two issues. First, what might cause panic runs on the bank? This is essentially a question about equilibrium selection. What determines whether the good (no-run) equilibrium or the bad (run) equilibrium occurs? The role of information as a generator of runs is of particular interest here, a subject we will discuss below. Second, can the deposit contract offered by the bank be restructured to eliminate the possibility of a bank run? This question is of particular relevance for an analysis of capital flows. Can the nature of domestic liabilities held by foreign investors be altered via regulations in ways that reduce the possibility of a panic? Four basic solutions that focus on the nature of the deposit contract have been examined.

The first is narrow banking. A bank could be required to hold a level of reserves sufficient to meet withdrawals in all possible circumstances. While narrow banking eliminates the possibility of a run, it does so by eliminating the ability of banks to offer maturity transformation services. Since this was the benefit to be derived from banks in the first place, narrow banking essentially returns the economy to an inefficient, autarchic equilibrium.[1]

Diamond and Dybvig offer a second solution – suspension of convertibility. If the bank can predict perfectly the number of impatient consumers, it can hold reserves sufficient to meet the withdrawals of impatient consumers. If additional depositors attempt to withdraw funds, the bank simply suspends convertibility. All the impatient consumers are able to withdraw their funds, and the patient consumers have no incentive to withdraw early since they know the bank will always have adequate funds in the future. The bank will have adequate funds because it suspends convertibility if deposit withdrawals threaten its reserves.

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1. In autarky, each individual would self insure by investing less than his whole wealth in the productive asset, holding some wealth in liquid form. If a bond market opens, an agent who discovers that he needs liquidity can finance early consumption by issuing a bond rather than liquidating (at a cost) the long-term asset. This improves over autarky, but still fails to provide liquidity insurance efficiently.

Allowing for a suspension of convertibility does not affect the fundamental maturity transformation service which banks provide. It acts more as an equilibrium selection device, ensuring that the economy achieves the good equilibrium without runs. Prior to the founding of the Federal Reserve System, US banks normally suspended convertibility during banking crises.

The parallels with international crises are evident. The counterpart to a suspension of convertibility would be a 'standstill' enforced by the IMF or some other organisation. If capital outflows reach a certain limit, convertibility could be suspended. Properly designed, this would eliminate the need for fire sales of assets as banks attempt to liquidate their asset portfolios. However, such a policy can achieve efficient risk-sharing only if the appropriate cut-off at which suspension should occur is known. A suspension policy cannot achieve the optimal allocation when the true fraction of impatient consumers is stochastic (i.e. when there is aggregate uncertainty).

A third class of solutions is the most commonly observed – deposit insurance. Under a deposit insurance scheme, patient depositors have no incentive to withdraw their deposits.[2] Of course the presence of deposit insurance can lead to a moral hazard problem, as banks have an incentive to hold riskier assets. The role of government insurance in creating the conditions for a crisis is discussed below.

A fourth solution, due to Jacklin (1987), alters the nature of the deposit contract, essentially replacing it with an equity stake in the bank. Depositors who discover they are impatient can sell their shares at a market-determined price. Depositors who discover they are patient will wish to buy additional shares in the bank. While eliminating the possibility of a run, equity contracts may do worse than deposit contracts as a means of providing liquidity insurance.

The potential inefficiency with equity contracts may be of less concern when applied to international capital flows. There, the stability of the domestic financial sector, rather than the provision of liquidity to international investors, would be of primary concern.

While equity contracts do solve the problem of runs, in that banks cannot be forced to close, the attractiveness of equity contracts is diminished as soon as additional credit market imperfections are recognised. Imperfect information about investment projects, for example, can lead to agency costs that, in turn, give rise to a role for collateral. In such an environment, fluctuations in the share price of the bank may affect the bank's ability to raise funds.

Chang and Velasco (1998) have used the Diamond-Dybvig structure to analyse international capital flows. They focus on the problem of illiquidity, defined as a situation in which the domestic financial sector's short-term potential liabilities exceed the liquidation value of its assets. Access to foreign borrowing can reduce the chances of a bank run by providing the domestic bank with an additional source of short-term funds. However, failure of foreign lenders to extend lending when

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2. Leaving their deposits in the bank involves no risk since the government guarantees they will receive full value. This is enough to ensure that a bank run never emerges as an equilibrium.

domestic banks experience a run has the effect of making banks more vulnerable to runs. The belief on the part of domestic depositors that foreign lenders will refuse to extend short-term credit can trigger a bank run and force the closure of domestic banks. The presence of short-term foreign borrowing makes the domestic financial sector more vulnerable to a decision by foreign lenders not to roll over the existing stock of debt. In that sense, short-term foreign debt increases financial sector fragility.

Models of bank runs direct attention to two aspects of the financial environment. One aspect is the nature of financial contracts. The second is the possibility for multiple equilibria, with a crisis being a possible equilibrium phenomenon. In the next section, we review the literature on herd behaviour and informational cascades to better understand the nature of such self-fulfilling runs.

3.4 Sequential service constraints, herding and financial fragility

The first-come-first-serve nature of deposit contracts creates an incentive for even patient depositors to withdraw funds immediately if they fear others may withdraw their deposits. Investors' beliefs about what other investors will do become critically important, and multiple self-fulfilling expectational equilibria can exist. A set of financial institutions and regulations may support an efficient and welfare-enhancing equilibrium, but the same set of institutions may also be vulnerable to shifts in expectations that push it into a bad equilibrium.

The fragility of financial markets to runs and investor panics has always provided a primary rationale for regulation. Regulations typically are designed to reduce the incentive for runs by such means as deposit insurance and to limit the riskiness of the underlying asset portfolio held by the bank through prudential regulation. Capital controls can be viewed as one mechanism for changing the incentives to run, but to evaluate their possible role requires some consideration of the underlying reasons for investor panics.

One approach has emphasised the problems that may arise when investors have little information themselves, and so base their actions to a large extent on what they see others doing. Seeing others invest in emerging markets, for example, other investors draw the conclusion that such investments are promising, leading to a large flow of capital to emerging markets. Seeing others pull their funds out, others follow suit. This highlights the potentially important role of 'herd' behaviour and informational cascades. Investors may base their actions on what they see others doing, rather than on their own information about underlying fundamental conditions.[3]

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3. Banerjee (1992) and Bikhchandani, Hirshleifer and Welch (1992) provide models of herd behaviour. The common structure of these models involves a discrete choice (leave funds in the bank or withdraw them, for example) that must be made sequentially by agents on the basis of limited information. Agents are assumed to have two sources of information. First, they have a private but noisy signal about which choice is the correct one. Second, they can observe what others before them have done. A key assumption is that while agents can observe the choices made by those who have gone before them, they cannot observe the signals the earlier movers received.

The distinction between observing the information of others versus simply observing what others have done is critical, but it is also quite realistic. Particularly in the environment of a crisis, 'actions speak louder than words'.

If enough individuals are observed having made one choice (say withdrawing funds), subsequent agents will disregard their own private information and mimic the actions of others. The weight of the evidence of the choices others have made outweighs the individual's own information. Agents may behave in ways that are inconsistent with their own private information if others have made a different choice. At some point, herd behaviour results. Everyone ignores their own information and follows the behaviour of the earlier movers.

In this environment, the decisions by the early movers can be critical. For example, if a few investors liquidate holdings in a country, others may assume that they must have had good reason to do so (whether in fact they did or not). Drawing such an inference, they also liquidate positions, and a run occurs. This can happen even if the later movers all had private information that indicated they should not liquidate.

Three important points are worth emphasising. First, the quality of the individual agent's own information will be important. If an individual believes he has very good information, he may ignore the actions taken by others, deciding instead to act on his own private information. Second, beliefs about the quality of the information others possess is also important. If investors think that the first to liquidate are likely to be better informed on average, more herd behaviour will result. Third, herding behaviour can result in the wrong choice being made.

When multiple equilibria based on non-fundamental factors are possible, it may be possible for government policies to serve a co-ordinating role that focuses expectations, and therefore the actual outcomes, on the good equilibrium. When capital outflows result from herding behaviour, can capital controls help select the correct equilibrium? If capital flows are particularly sensitive to herd behaviour, does a role for controls emerge?

The heart of the problem is information, or rather the lack of accurate information. Public information might help, but two difficulties present themselves. First, it is not clear that anyone knows the true state. Second, a government might attempt to provide information on the state of the economy, but clearly a domestic government faced with a financial crisis has an incentive only to release information that would stem the panic. Credibility becomes a critical issue.

Pure information cascades may have implications for contagion effects as well. Key is what inferences investors make based on the actions of others that they observe. The information provided by observing actions is very coarse – in the case of a currency crisis, for example, the general conclusion drawn might simply be that expected returns have fallen, but it will matter greatly whether international investors assume this is due to country specific factors or more general factors. In the case of the latter, they will conclude that expected returns are now lower not just in the country under attack, but in all countries viewed as similar.

This type of contagion might be expected to be the norm. Herding behaviour is most likely to arise when individual agents have relatively poor private information. This is why they may ignore their own information and follow the herd. In such situations, it is unlikely that investors will be able to draw a clear inference about whether a crisis results from country specific factors or whether it results from factors affecting all countries in a similar risk class. Any signs of a crisis spreading may lead quickly to attacks on other countries.

Because information cascades can lead to runs that, *ex post*, are based on incorrect information, they generate inefficient outcomes. As noted earlier, the solution is to provide better information, but this may not be possible. Governments may have little credibility since they clearly have no incentive to provide accurate information unless it is 'good' news. International agencies might have greater credibility, but again the likelihood is that they too would be viewed as unlikely to provide truthful information unless it is good news.

Calvo and Mendoza (1999) argue that it is rational for speculators to remain poorly informed if they have small positions in a number of small emerging markets. For this reason it may be rational for international investors to react to information generated by trades of other investors.

Calvo (1995) develops a simple model of signal extraction that might account for herd behaviour in emerging markets. Informed traders sell either because fundamentals have changed or because they must meet a margin call generated by losses on some part of their portfolios. Poorly informed investors observe the sale but not the reason. If most sales are due to fundamentals it is rational for uninformed traders to misinterpret a margin call sale. Calvo emphasises quantity information rather than price; emerging markets prices are volatile and do not seem to be related to fundamentals.

3.5   Rational information-based runs

Both the Diamond-Dybvig model of runs and the herd behaviour that results from information cascades are essentially reflections of bubble phenomena – there is no fundamental reason for the runs. An alternative view of bank runs is that they are based on fundamentals and, in particular, that they can be information-based (Gorton 1985).

The basic idea is that bank portfolios are subject to risk, and depositors have only imperfect information about the value of these underlying portfolios. As in any model of the pricing of risky assets, current portfolio choices and asset prices will depend critically on the perceived co-movements among asset returns. Thus, any new information about returns on one class of assets will also affect prices of other assets with correlated returns.[4] In particular, bad news about returns in one country will lead investors to sell off holdings in other countries viewed as similar. Contagion arises as the rational response to new information.

A rational, information-based financial panic bears some resemblance to inefficient, information cascades. Imperfect information plays a key role in each case. A key

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4.   See Reinhart and Kaminsky (1999) and Kodres and Pritsker (1998).

distinction is that information cascades can lead to inefficient equilibria in which agents ignore valuable information. Information-based runs of the type Gorton analyses reflect rational re-assessments of risk on the basis of new information. Since agents cannot distinguish solvent from insolvent borrowers, any inefficiencies are *ex post*, not *ex ante*, in nature.

As in any information-based crisis, there may be a role for policy that either provides information or that limits the ability of investors to run. The first type of policy emphasises the role of prudential regulation. Countries with adequate systems of financial supervision and regulation are unlikely to suffer contagion effects. When runs are based on a re-assessment of risks, standard recommendations to limit short-term capital flows may also play a role in limiting a crisis. Again, however, this is only the case if the underlying system is actually solvent.

3.6   Collateral, asset prices and credit cycles

The Diamond-Dybvig model and the informational cascade model focus on the behaviour of depositors or lenders. The fundamental problem in the Diamond-Dybvig model is the uncertain demand for liquidity. The maturity transformation provided by banks renders their liabilities more liquid than their assets. The 'bad' equilibrium, though, is not due to any problem with the underlying assets the bank holds. Information-based panics are based on depositors' incomplete information about asset portfolios. However, the specific implications of such imperfect information for financial contracts are not fully spelled out.

Actual banking crises do seem to be associated with concerns over asset quality. Two issues are particularly relevant for international capital market fragility. What is the role of asset prices and collateral in propagating economic disturbances? Does international borrowing raise special issues with regard to collateral?

A number of models show how asymmetric information about borrowers' projects can generate a role for collateral, producing the potential for credit rationing, financial fragility, and credit cycles. These models are often classified as Costly State Verification (CSV) models since they emphasise the effects that arise when lenders can verify borrower actions and project outcomes only by bearing some cost.

Two characteristics of financial markets that may arise with costly state verification are (i) credit rationing; and (ii) financial accelerator effects. The former implies credit availability will be limited by the value of the borrower's collateral; the latter implies that asset price declines and the resulting deterioration of collateral values can amplify the impact of an initial negative shock.

Suppose all firms have access to an investment project yielding either a good return (success) or a bad return (failure). Firms differ in the amount of internal funds they can invest in a project. If lenders can observe project outcomes only by incurring a cost, the firm has a clear incentive to always announce that the bad outcome has occurred unless it is monitored. So lenders will have to occasionally audit firms. The optimal loan contract must satisfy an incentive compatibility constraint – it must ensure that the firm has no incentive to report the bad state when, in fact, the good state has occurred.

Bernanke and Gertler (1989) characterise the expected costs of project auditing as the agency costs due to asymmetric information. These costs generate a wedge between the cost to the firm of internal versus external funds. As they show, some borrowers will find the investment project is not worth undertaking if they have only low levels of internal funds to invest. The probability of auditing that lenders require can make agency costs too high to justify investment. With a higher level of internal funds the project would have been undertaken.

The number of projects undertaken in this situation can vary with changes in the value of internal funds even if neither the opportunity costs of funds nor the project returns have changed. Agency costs drive a wedge between the costs of internal and external funds so that investment decisions will depend on factors, such as cash flow, that would not play a role if information were perfect.

Financial accelerator effects arise when internal funds are sensitive to the state of the business cycle. Since a recession will worsen firms' balance sheets, reducing the availability of internal funds, the resulting rise in agency costs and reduction in investment may serve to amplify the initial cause of a recession. An initial negative shock can be magnified if it worsens the balance sheet and induces additional cuts in investment spending.

This type of financial accelerator effect can also generate endogenous credit cycles. The amount of credit firms use in production is determined by their ability to borrow funds, and this is limited by the value of their collateral. The value of collateral, though, depends on the market price of assets. Hence, an asset price decline can limit borrowers' access to funds by reducing the value of their collateral. In addition, borrowing is limited by the expected future value of the collateral since lenders are concerned with the market value of the collateral at the time they might have to liquidate it. Thus, future asset prices affect current collateral values and borrowing constraints.

An initial negative shock to asset prices reduces the ability of firms to borrow, lowering productive activity. Because firms have reduced their borrowing, however, their future debt is lower. Eventually, this allows them to increase their borrowing since less of their cash flow is absorbed by debt repayment. They are now able to increase borrowing, and productive activity increases. Endogenous cycles occur.

This type of financial accelerator is most clearly evident in the model developed by Kiyotaki and Moore (1997) and adapted to international capital flows by Miller and Stiglitz (1999). There are four key elements in their model. First, firms must borrow to finance productive activity. Second, borrowers are credit constrained by a lack of collateral. They motivate this by assuming borrowers (firms) can walk away from projects if they choose. Lenders will therefore never lend firms more than the value of the collateral they could capture if a borrower were to walk away. Third, the model assumes that a productive asset, land in their terminology, is required as an input into production. Land has an alternative use that will serve to determine its rental value. Finally, there is an exogenous riskless rate of return that the net return on land must equal.

Bernanke and Gertler (1990) focus on a slightly different form of asymmetric information. Suppose firms can screen investment projects but are unable to credibly

communicate their information to potential investors. Because firms are leveraged, a classic moral hazard problem arises. Firms will undertake low-quality, high-risk projects since they gain if the project pays off, while creditors bear part of the cost if the project fails. Too many projects are undertaken.

This has some interesting policy implications. Because too many projects are undertaken, a policy that limits the number of investment projects may be welfare-improving. For example, a tax on successful projects would be welfare-improving. Such a tax would induce firms with low-quality projects to forgo their investment opportunity.

It is important to note that costly state verification and moral hazard result in agency costs, but do not imply lenders are not providing the 'right' level of oversight or monitoring. Perfect monitoring is an inefficient use of resources whenever monitoring is costly. Policies that lower agency costs can potentially be socially beneficial. Adequate reporting and auditing requirements that lower the costs of monitoring faced by private investors (either domestic or foreign) would improve the efficiency of the match between borrowers and lenders.

3.7 Domestic and international collateral

Collateral matters when information is imperfect and monitoring is costly. These two characteristics are unavoidable when domestic firms borrow from international lending sources. If international lenders have less information about domestic borrowers than do domestic lenders, a distinction arises between international collateral – assets against which international lenders will advance funds – and domestic collateral – assets that can be pledged to domestic lenders.

Caballero and Krishnamurthy (1999) examine the implications of this distinction. Their model, like that of Holmström and Tirole (1998), assumes that borrowers invest funds in projects that are then subject to both aggregate and idiosyncratic shocks. Depending on the realisations of these shocks, borrowers may need to borrow additional funds or face abandoning their projects. Borrowing against the future project returns is limited due to moral hazard. Holmström and Tirole show how aggregate shocks can produce a crisis in a closed economy since even firms with projects with expected positive returns will be unable to finance their short-term liquidity needs.[5]

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5. Holmström and Tirole (1998) consider a general equilibrium environment to determine whether there will be a sufficient supply of liquidity. The only marketable assets (in the absence of government debt) are claims on firms, since individuals are assumed to be able to default with impunity. If there is no aggregate uncertainty, an individual firm can hold a diversified portfolio of claims on other firms. This outcome is much like the autarky equilibrium in the Diamond-Dybvig model.
   The efficient outcome can be obtained in the absence of aggregate uncertainty if financial intermediaries are introduced. An intermediary pools firm risks and offers liquidity insurance to individual firms. With aggregate uncertainty, however, the private market cannot always supply sufficient liquidity. If all firms experience a large liquidity shock, the aggregate demand for liquidity may exceed the ability of intermediaries to provide it. The problem is ultimately related to the moral hazard that limits the funds that can be raised by pledging the expected returns from the underlying investment projects. While private intermediaries may be unable to meet the liquidity needs of firms in the presence of aggregate uncertainty, the government can play a role as a supplier of liquidity. This role arises from a government's ability to commit the future resource of the economy through future tax payments.

Caballero and Krishnamurthy emphasise the role of collateral in debt contracts in the presence of moral hazard *and* the implications of asymmetric information between foreign and domestic lenders. This asymmetric plays out in two ways. First, a broader range of assets may qualify to serve as collateral for domestic lenders than would be accepted by international lenders.[6] Second, foreign lenders will advance less against acceptable collateral than will domestic lenders. With frictionless domestic credit markets, firms would be able to borrow the full value of their domestic collateral from domestic lenders. However, this assumption is unrealistic when dealing with emerging markets. Instead, the types of moral hazard problems that limit borrowing from international sources will also limit the amount that can be borrowed domestically.

In this environment, distressed firms, i.e. those firms with large negative idiosyncratic shocks, may exhaust their international collateral. In this case, a crisis occurs in which the excess demand for funds pushes up the domestic interest rate. But this rise in the interest rate serves to reduce the present value of the distressed firms' domestic collateral, further weakening their financial position. Fire sales and asset price declines exacerbate adverse effects of the initial shocks.

Critical in this approach is the notion that emerging economies need to rely on foreign resources for normal activities – when a crisis hits, access to these resources is limited, placing a binding constraint on economic activity. In developing economies, banks play a central role in the financial system. Often this involves borrowing internationally to lend domestically to those unable to access international capital markets directly. During a crisis, asset price declines and the resulting deterioration of the banking sectors' balance sheets reduce their ability to intermediate between foreign lenders and domestic borrowers.

The policy implications of this view of crises depend critically on what is meant by 'international collateral'. Caballero and Krishnamurthy assume that it is closely related to the size of the export sector, on the argument that foreign lenders can seize revenues from export sales. With this identification, policies that promote the export sector would serve to make the economy more stable.

There is a second type of policy that increases the economy's access to international lending. What can be thought of as effective collateral depends on the underlying assets that can be pledged *and* the fraction of the asset value that can be borrowed per dollar of collateral. This fraction is less than one because of the moral hazard problems inherent when there is imperfect information. Policies that reduce moral hazard problems would increase the amount that could be borrowed against a given value of collateral. This implication again serves to emphasise the importance of prudential supervision and regulation of both the financial and non-financial sectors.

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6.   In their model, Caballero and Krishnamurthy (1999) assume international lenders will accept shares of firms in the tradeables sector as collateral, but will not accept shares of firms in the non-tradeables sector as collateral. Domestic lenders will accept either.

4.   Insurance Attacks

In our view, the virtues of the approaches outlined in Section 3 include more realistic and potentially useful treatments of governments' and private sectors' behaviour. But complexity is also a vice since it will be difficult to discriminate among a host of models with a very limited data set. Dooley (1999) argues that we may have abandoned first-generation models prematurely. The policy conflict considered by these models does not seem to be consistent with the behaviour of governments preceding the Asian crisis. But rather than appealing to more complicated behavioural assumptions, it may be fruitful to consider an alternative policy conflict within the discipline provided by a first generation model. In particular, the insurance model assumes that the private sector is rational and has perfect foresight. Moreover, the government follows a simple set of policy rules.

The policy conflict is generated by the desire of a credit-constrained government to hold reserve assets as a form of self-insurance and the government's inability to credibly commit not to liquidate these assets in order to lend to domestic financial and non-financial firms. This policy regime generates incentives for investors to acquire insured claims on residents and to then acquire the government's assets when yield differentials make this optimal. Dooley (1999) provides an estimate that US$0.68 of every US$1.00 private capital inflow after 1989 to the six emerging market countries that have experienced crises was matched, at the time of crisis, by liquidation of governments' liquid assets and lines of credit.

A key feature of the model is that free insurance raises the market yield on a set of liabilities issued by residents *for a predictable time period*. This yield differential generates a private gross capital inflow (a sale of domestic liabilities to non-residents) that continues until the day of attack. The private inflow is necessarily associated with some combination of an increase in the government's international reserve assets, a current account deficit and a gross private capital outflow. When the government's reserves are exactly matched by its contingent insurance liabilities, the expected yield on domestic liabilities falls below market rates and investors sell the insured assets to the government, exhausting its reserves. The speculative attack is fully anticipated and at the time of the attack nothing special happens to the fundamentals or expectations about the fundamentals.

A plausible sequence of events that would trigger an inflow/crisis sequence is financial liberalisation. Liberalisation involves both opening of domestic financial markets and improved access to international financial markets. These programs relax three constraints. First, they make domestic liabilities available to foreign investors. Second, they make the existing regulatory framework less effective. Finally, and perhaps most importantly, liberalisation provides an insurance pool because creditor governments and international organisations have provided generous lines of credit to support reform programs.

5.   Conclusions

These are exciting times for students of international financial markets. We are faced with a number of interesting and quite different academic views on what motivates capital flows and what has made them turn out so badly in many countries. Important lessons have been suggested by the existing literature that seeks to understand the behaviour of financial markets in closed economies as well as the government's role in promoting stability and instability. To borrow a phrase that one of our favourite economists borrowed following the 1982 debt crisis, 'I don't think we are in Kansas' – again.

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