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ABSTRACT

Although internal policy mismanagements can be cited in most recent emerging market crises, they seldom account fully for the severity of these crises. The reluctance of international investors to provide the resources that would limit the extent of the reversal almost invariably plays a key role in bringing a previously (over?)-heated economy to a costly halt. Domestic assets experience dramatic depreciation and otherwise solvent investment projects and production, especially in the nontradeables sector, find no financiers and are wastefully shutdown. Ultimately, the reason for this breakdown of a country's access to international capital markets must lie in the inadequacy (real or perceived) of its *international collateral*. We build a framework where this insufficiency and its consequences stem from microeconomic contractual problems. Fire sales of domestic assets naturally arise as a result of desperate competition for scarce international collateral. This begs the question of why the private sector does not take steps to ensure sufficient international collateral when crises are likely. The answer lies in the presence of a pecuniary externality. We show that contractual problems also lead to a problem of insufficient *domestic collateral*, which restricts the transfer of surplus arising from the use of international collateral between the users and providers of this international collateral. The interaction between domestic and international collateral also sheds light on when pre-crisis capital flows ought to be regulated and on whether there is scope for currency support measures during the crisis or not.

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1 Motivation and Summary

Asset markets view. In contrast with the disagreements on the causes and appropriate responses to the ongoing Asian crisis, there is substantial consensus on the mostly negative role played by international capital markets during the crisis itself. The reluctance of international investors to provide the resources needed to smooth the impact of a combination of internal and external deficiencies, dramatically worsened the situation. As internal and external demand fell, external credit —and capital flows in general— vanished, bringing the real sector, especially nontradeables, to a virtual halt.[1] Asset deflation and currency depreciations —as symptoms and consequences— took unexpected proportions, "well beyond what was justified by any reasonable reassessment of economic fundamentals, even in the light of the crisis."[2]

Although a very dramatic one for its relative surprise and extent of "contagion," the Asian crisis is just the most recent chapter of an increasing trend toward shifting the "blame" from current to capital account issues. Many think that this trend is an almost unavoidable side effect of increasing globalization of capital markets. Such change of emphasis is gradually tilting policy advice as well. While large real devaluations were central ingredients in traditional policy advice on the face of external imbalances, there seems to be increasing concern with the possibility that "too much of the medicine may kill the patient." Currency boards and interest rates hikes to shore up the currency in the midst of severe crises are common advice these days, often even coming from the staunchest former advocates of devaluations. Markets also have spoken loudly at times; on Black Thursday (September 10, 1998) the Brazilian stock market plummeted by nearly 15 percent. In a desperate measure to stop the hemorrhage of capital flows, the authorities *raised* interest rates from 30 to 50 percent... and the stock market responded with a 13 percent *rebound*.[3] Largely due to the central role played by capital flows, economics of emerging markets is sometimes radically different from that of developed economies.

Gradually, the traditional "goods markets" view of external crises and their solution is being replaced by an "assets markets" view. The central issue in resolving an external imbalance is no longer to simply devalue the real exchange rate and allow the private sector to reallocate consumption and production to restore real activity and external accounts. Although certainly an important factor in the long run readjustment of an economy, this

[1] For the crisis-countries —Indonesia, Korea, Malaysia, the Philippines and Thailand— net capital flows declined from 73 billion dollars in 1996 to minus 11 billions in 1997. The actual decline in net inflows was probably higher since "errors and omissions" went from -8.5 billions in 1996 to -19.5 billions in 1997.

[2] World Economic Outlook, May 1998, p.4.

[3] The leading international article in the Wall Street Journal on September 11 was entitled: "Brazil Bets Big in Winning Back Foreigners."

relative price ingredient is subordinate to the short run movements in asset prices and their feedback into real activity – a link which, in our view, is at the core of understanding the magnitude of crises and our ability to control them.[4]

Goals. In this paper we develop a framework where asset markets take center stage to answer many of the questions surrounding crises in emerging economies. In particular, why is it that foreigners are unwilling to finance these crises? Why do assets' fire sales occur? How do these affect real activity? If foreigners are reluctant in providing the financing during crises, why doesn't the domestic private sector take steps to ensure profitability during these times by provisioning against them? Is the productive structure appropriate from the point of view of crisis-prevention? Is there a role for regulating capital flows? Should currency and assets be supported during crises?

The inessential and the essential. Our framework reflects our view that a core component of the answer to these central questions does not depend on the intertemporal substitution ingredients we normally emphasize in macroeconomics. The very fact that *emerging* economies —i.e. economies whose future looks brighter than their present— normally run very small current account deficits —in the order of 0 to 10 percent of GDP, rather than 150 percent or more, as they should in a neoclassical setup— indicates that they are normally severely financially constrained. Deep crises are just times when such constraints are overwhelming. Instead, our answers to the questions we posed above build around the simple and sufficient premise that, ultimately, the reason for the breakdown of a country's access to international capital markets, must lie in the inadequacy (real or perceived) of its *international collateral.*

Collateral. But what is international collateral? At a basic level, it is anything that can be valued and seized by foreign investors in lieu of promised repayments. The Neoclassical as well as the Sovereign Debt literatures make some proportion of the present value of net exports (or exports alone) the central answer.[5] Although it highlights a fundamen-

[4]The literatures on debt crises, currency speculation, and bank-runs, offer important insights on different aspects of assets markets during crises. Most of the effects in these literatures are either amplified or made more likely by the issues we emphasize in this paper. For papers on currency speculation see, e.g., Obstfeld (1994, 1996); on debt crises see, e.g., Calvo (1988), Giavazzi and Pagano (1990), Cole and Kehoe (1996); on bank runs see the canonical Diamond and Dybvig (1983) and the applications to open economies by Goldfajn and Valdes (1998) and Chang and Velasco (1998a). Also see Calvo (1998) for an overview and interesting discussion on implications and sources of capital market crises in small open economies. It is worth pointing out that, while insightful and probably very relevant, a central issue in these papers is the possibility of multiple equilibria, and in so doing this literature admits from the outset that a large part of the crisis must be left unexplained (i.e. to "sunspots").

[5]See Bulow and Rogoff (1989) for a canonical model of international debt capacity based on the amount of "punishable" future trade flows and exports.

tal constraint, this answer is incomplete among very central dimensions of modern crises scenarios. On one hand, it does not capture the idea that an excessive devaluation may be harmful for international collateral.[6] On the other, in today's emerging economies the private sector carries the lion's share of international borrowing, thus microeconomic rather than representative-agent frictions ought to be at the roots of the problem. Our model gives central roles to credit market constraints arising from microeconomic contractual problems in the process of creation and aggregation of international collateral.[7]

Domestically, collateral is created by the corporate sector itself, and is made of financial claims on firms in the nontradeable and tradeable sectors. Contractual problems —broadly understood— limit the number of claims that firms can issue, affecting both their ability to obtain external financing when in need, and to supply collateral to other firms when not in distress. The situation is worse with respect to foreigners, which only accept a subset of these claims as backed by *international* collateral.[8]

International collateral and shares on the tradeable sector. In most of our analysis we make a simple broadbrush assumption that international collateral is restricted to claims on the tradeable sector, while claims on both sectors count as domestic collateral. Although stylized, this assumption captures realistic biases. Very directly, it is justified by the fact that cash revenues from exports can be seized before they make it back into the country, a feature used by Mexico when their oil revenues were made part of the collateral backing the liquidity package it received during the 94-95 crisis, and by mandate on foreign institutional investors (e.g. limits on real estate investments).[9] More indirectly, this assumption is a

[6] Quite the contrary, an excessive (real) depreciation should build more international collateral and further entice foreign investors to finance the crisis.

Of course, if concerned with this specific issue alone, one could enrich the story by adding a financial sector which is over-exposed to the nontradeable sector, and plays the role of an input into production of tradeables. Still, one needs to address the question of why banks are over-exposed to begin with, and how an excessive depreciation is an equilibrium outcome.

[7] According to the IMF (1998, pp. 63-64), a distinguishing characteristic of the current crisis is that purely macroeconomic considerations has played a lesser role than in previous crises. Also, see Johnson, et al. (1998) for stark evidence on the correlation between weak corporate governance and institutional environment (i.e. a weak contractual environment) in an economy and the incidence of the current crisis. As the corporate finance literature has demonstrated, weak corporate governance and, more generally, weak contractual enforcement go hand in hand with credit market constraints.

[8] There is an extensive literature documenting "home bias" in asset holdings (see, e.g., French and Poterba 1991), matched by asymmetric information explanations (see e.g. Zhou 1998). There are also institutional reasons behind home bias, as most countries limit foreign ownership of domestic companies. These limits range from constraints on a few "strategic" sectors (e.g. oil and telecommunications), as in the U.S., to across-the-board constraints, as in pre-crisis Korea.

[9] Of course there are important exceptions (e.g. "too big to fail" utilities), but see, e.g., Kang and Stulz (1997) for systematic Japanese evidence showing that, for small firms, those that are export oriented are

very efficient mechanism to capture the central implications of an expanded model where foreigners' collateral-bias is only against small firms and current production of perishable nontradeable goods (see the appendix).

Financial Transactions. Financial claims in our economy consist of equity shares issued by tradeable and nontradeable firms. Stock markets function perfectly, so these shares can be traded freely.[10] Thus, a firm in the nontradeable sector in need of funds, for example, may issue its own shares in exchange for shares in the tradeable sector and use these, together with any tradeable shares it may have already owned, as well as the proceeds from selling other nontradeables firms' shares in its possession, as international collateral. This reshuffling of collateral through stock market transactions is assumed to be costless.[11]

Shocks. Domestic entrepreneurs (firms) are subject to aggregate and idiosyncratic shocks, which accumulate to determine a country's net import needs. International funds must finance —in full or part— such needs, for which foreign investors demand international collateral. Although the mechanisms we emphasize magnify the impact of aggregate surprises —be it a decline in terms of trade, in foreigners' "risk appetite," in external competitiveness, or in banking capital, etc.— the hedging and insurance issues brought about by these surprises are distinct from our main insights. In order to highlight these differences, we assume no aggregate surprises until the last section of the paper.

Bottlenecks. In our framework, there are two stages at which the "credit chain" may break down. First, a country may fail to aggregate international collateral properly; if firms hit by shocks have severe agency problems and/or scarce collateral provisions, they may be constrained by domestic collateral well before the country has used up all its available

favored by foreign investors. See, e.g. Blommestein (1997), for a discussion of how real estate and other assets considered highly illiquid or exposed to exchange risk are generally avoided (sometimes by mandate) by foreign institutional investors. Interestingly, the very few exceptions to the sovereignty principle, by which the rating on debt issued by a country's corporate sector is bounded from above by that country's government debt rating, are for companies which belong to the export sector.

[10] In this sense, individual foreigners may hold shares on firms in the nontradeables sector, but the total value of foreigners' holding of shares in tradeables and nontradeables must not exceed the total value of the pledgeable shares in the tradeable sector.

[11] Some words of interpretation are in order. Our focus purely on frictionless equity markets is certainly a far cry from the reality of emerging markets. First, debt contracts rather than equity are the more usual form of financing in most economies. Qualitatively, and with a few caveats that are not central to our story, whether external financing takes the form of equity purchase or debt is not an interesting distinction. Quantitatively, debt rather than equity contracts would aggravate many of the effects we describe by introducing debt overhang problems and the like. Second, the reshuffling of collateral in an emerging economy is more often done by the banking system than directly by firms' trades in a stock market. Again, adding richness by modeling the role of intermediaries in these transactions is not central to our insights. All these transactions are costless in our model, which means that it is irrelevant whether a creditor or borrower implements them.

international collateral.[12] Second, even if aggregation can be done fully, the international collateral creating sector may not be able to generate enough pledgeable shares to finance the crisis; this scenario is more likely as contractual problems in this sector rise. We refer to these as *domestic* and *international* collateral problems, respectively. Given institutions and contractual problems, which constraints the economy encounters depends on the severity of aggregate shocks. For mild shocks —perhaps "normal" times for an emerging economy— the domestic constraint is likely to bind, while during deeper recessions the international one is likely to become active as well.

It is the latter scenario, with the simultaneously binding constraints, that accounts for the most dramatic differences between crises in developing and developed economies, and in the appropriate policy response to these crises.

Equilibrium Prices and Fire Sales Once in a costly crisis scenario, whether the economy falls into one region or the other depends on the relative price of domestic and international collateral. Other things equal, as the relative price of domestic collateral rises, the likelihood of wasting international collateral falls. On the other hand, the behavior of this equilibrium price depends to a large extent on whether the economy is in one region or the other. As the international collateral constraint becomes more binding, the relative price of domestic collateral declines rapidly as competition for scarce international collateral rises. Indeed, we show that a *fire sale* of these shares, by which we mean a decline of their price below their fundamental value, is a natural consequence of a binding international collateral constraint.[13] In our model, this sharp decline in the domestic share prices can be thought of as the combination an "excessive" depreciation of the real exchange rate and a substantial widening in the domestic-international interest rates spread.

Collateral underprovision. On the face of these potential fire sales, the question arises as to whether they are not sufficient incentive for the private sector to reallocate factors of production to collateral creating sectors to benefit from the additional international collateral value of their shares. We find that indeed the private sector will value collateral provision and increase its supply, but generally it will not do as much of it as is socially optimal. The source of the externality behind the undervaluation of collateral provision is interesting in itself, for it is the result of the interaction between the domestic and international credit constraints. Despite fire sales, the domestic credit constraint limits the transfer that

[12]This is equivalent to the "wasted liquidity" in Holmstrom and Tirole (1998), although our "wasted collateral" has implications for pre-crises policies not present in theirs, which stem from the two-goods nature of our economy.

[13]This definition of a fire sale is similar to that of Shleifer and Vishny (1993). When the domestic economy is collateral constrained, prices must fall. However, unlike Shleifer-Vishny there is no outside bidder for the assets as we assume that foreigners will never hold claims on the nontradeable firms.

firms in distress can make to suppliers of international collateral. The anticipation of this constrained demand for international collateral reduces the incentive to create it. Contractual problems in collateral providers generate the fire sale, while contractual problems in distressed firms act as a disincentive on collateral provision.

Overinvestment in nontradeables. Even if additional international collateral is not needed, as is the case in the milder wasted collateral region, we argue that the economy would benefit from reallocating resources from the nontradeable to the tradeable sector. Such reallocation would appreciate the long run real exchange rate, boosting the collateral value of nontradeables shares during the crisis period. Individual investors in the nontradeables sector do not internalize the negative effect of their investment on others' collateral value.

Capital flows. These externalities may harbor some of the answers on why emerging economies predictably run into systemic crises. The natural question to follow is whether pre-crisis capital inflows can exacerbate these externalities. We show that the answer to this question depends on whether the economy is more likely to fall in the wasted collateral or in the more severe fire sale region. In the former, equilibrium capital flows are insufficient since individuals do not take into consideration the collateral aggregation value of a real exchange rate appreciation. In the fire sale region, on the other hand, the problem is one of insufficient international collateral, and this is aggravated by pre-crisis capital inflows. Although the equilibrium domestic collateral provision premium is a natural obstacle to capital inflows in situations where domestic and foreign return differential is low, it is not so when this differential is large. The standard neoclassical arbitrage of relative productivity differential overwhelms the collateral provision enterprise, making severe crises and fire sales all the more likely.

Policy. Since the outcomes of our simple structure are certainly reminiscent of the events and dilemmas faced by emerging economies, it is difficult to resist the naive temptation of discussing policy implications. Many of the natural policies in this setup take the form of insurance contracts; we relegate these to a secondary role because they often have high informational and enforcement requirements which are not likely to hold well in emerging economies. Rather, we focus our attention on direct intervention in asset and exchange markets, without attempting to differentiate among asset holders within each type of asset.

Perhaps the clearest implication of our model in terms of policy is during the pre-crisis period where subsidizing domestic investment in sectors that create international collateral should be contemplated whenever the likelihood of falling into the wasted collateral or fire sale region is significant. Advice regarding capital flows is more ambiguous; fostering or taxing pre-crisis capital flows depends on whether the aggregation or the amount of international collateral is more likely to be the main problem in the event of a crisis.

What can be done during crises exacerbated by collateral constraints? Boosting the price of domestic shares, or lowering domestic interest rates, is in principle useful when the problem is primarily one of insufficient domestic collateral. But the costs of these measures may be high, since arbitrage conditions require persistent interventions and implicit transfers if the exchange rate is to be maintained.

In the fire-sales region the story is quite different. Since the fundamental problem is one of insufficient international collateral, boosting the price of domestic shares without supplying additional international collateral or resources does not have any positive impact by itself. Supplemented and financed with an *increase* in domestic real interest rates —if this is what is required for the government to attract foreign funds at the margin— may instead have favorable effects.[14]

Collateral in macroeconomics. The international economics literature has long recognized the importance of international collateral and its relation with a country's tradeable sector.[15] The Latin American debt crisis of the 1980s led to the development of formal models of sovereign debt renegotiation, and to the closely related question of what is it that international lenders can threaten sovereign countries with in the event of a default (see Eaton and Gersovitz (1981), Bulow and Rogoff (1989)). Since in this literature default and its costs is mostly modeled as a country-wide phenomenon, the question immediately arises on whether the domestic private sector internalizes the effect of their actions on the likelihood of these events. Bardhan (1967), Harberger (1985) and Aizenman (1989) advocated taxing capital flows on the grounds that individual agents do not pay for the increase in a country's average cost of capital brought about by their international indebtedness. Our results on capital flows and collateral underprovision can be seen as a formal description of the circumstances under which this problem is likely to arise. Similarly, our policy recommendation in favor of subsidizing the tradable sector to increase collateral availability is akin to Borensztein and Ghosh's (1989) advocacy for subsidizing investment in the export sector.

Although we touch on many of the insights of the debt-crisis literature, both our modeling and conceptual differences with it are large. On these aspects, our approach is more closely related to the new literature on the role of collateral in macroeconomics. Kiyotaki and Moore (1997) place the collateral role of a fixed input —land— and its distribution across agents at the center of their amplification mechanism. Krishnamurthy (1998) shows

[14] Generally, these policies have perverse effects on the incentives for collateral provision during normal times. These should be offset with some form of collateral creation incentive. See Krugman (1998) for an account of the recent Asian crisis in terms of a model that highlights the absence of such palliatives, together with uncertainty about the government's willingness to provide "insurance."

[15] See, e.g., Simonsen (1985).

how a richer set of contracts than that allowed by Kiyotaki and Moore shifts the relevant constraint from that which applies to individual agents to the total availability of collateral in the economy. Holmstrom and Tirole (1998) argue that the stock market alone may provide insufficient collective collateral if not aggregated properly. They also show that even when wasted corporate collateral (liquidity) is not an issue, public supply of it may be required in the presence of large shocks. Although our differences in terms of goals and modeling aspects with each of these articles are plenty, our central theoretical departure with them as a group is our focus on the presence of two collateral constraints —a domestic and an international one— and their rich static as well as dynamic interactions.

Certain aspects of our model are similar in structure to models of liquidity in the banking literature (Diamond and Dybvig (1983)). In this light, underprovision of collateral is analogous to the free rider problems and underprovision of liquidity emphasized in that literature (see Jacklin (1987), Bhattacharya and Gale (1987)). However, the source of the externality behind this inefficiency in our model is the endogenous result of imperfect contract laws and institutions, while theirs is the exogenous divergent ex-post valuation of liquidity by consumers. A second departure from these models is in our focus on markets rather than on banking arrangements and their key sequential servicing constraint. While we do believe that bank failures and runs can aggravate crises, our model points out that the basic features of crises and their prelude arise even when there are only stock markets. Moreover, the fire sale mechanism we emphasize boosts the likelihood of banking crises themselves (see the appendix).

Outline. Section 2 follows this introduction with a description of the model, starting from the crisis period. It analyzes and characterizes the critical wasted collateral and fire sale regions. It continues with a discussion of the dangers of a weak domestic banking system, as well as with an illustration of the fragility brought about by excessive leverage. Section 3 takes a step back and analyses the history preceding crises. In particular, it illustrates the basic externalities leading to private undervaluation of collateral provision investment and to overinvestment in nontradeables. It then shows how these externalities are affected by pre-crises capital flows. Section 4 discusses insurance markets and the shock structure. Section 5 discusses policy implications more generally and concludes. An appendix follows.

2 The Crisis Phase

2.1 Basic Setup

Overview. We model the core of our economy as comprised by ex-ante identical entrepreneurs who use their resources to begin companies in a tradeable and a nontradeable sector,

and to buy shares of other companies. Contractual problems limit the extent of entrepreneurs' leverage, so that they must retain a fraction of their own shares. Entrepreneurs do not value diversification per-se, as they are risk neutral with respect to idiosyncratic shocks; however they have a strong incentive to hold others' shares as collateral in the event of facing an idiosyncratic crisis. In equilibrium, residents are indifferent on whether to hold this collateral in the form of shares on firms on the tradeable or nontradeable sectors (T- and N-shares, respectively). To start, we assume foreign investors are not; although they accept N-shares as individual collateral, they promptly swap these for T-shares in the market.[16]

In emerging economies, marginal investment (and consumption) is financed externally. We capture this feature in a simple environment. Firms are hit by shocks which raise their net demand for tradeable goods. At the aggregate level, these shocks require external financing, for which foreigners require T-shares as collateral. If governance problems are not too severe, a substantial fraction of the required financing may be obtained by diluting existing shareholders. If the firm in need is in the nontradeables sector, its new shares have to be exchanged for T-shares to serve the role of international collateral.[17] The rest has to be financed with the collateral at its avail, some of which may be in the form of N-shares which also need to be swapped for T-shares. The problem of a firm in the tradeable sector is very similar, although its own issuance can be used directly as international collateral.

Basic setup. The world lasts three periods. Time is indexed as $t = 0, 1, 2$. Date 0 is the fully flexible period when economic agents design the productive structure, ownership structure, and portfolio allocations. Date 1 is the crisis period. Date 2 represents the future and "accounting" period; it summarizes the cost of the crisis and realizes budget constraints. Although interrelated, the date 0 issues are distinct from the crisis issues. We reverse the chronology, and discuss crisis issues here taking history and its "mistakes" as given. In the next section we discuss history formation. Thus, for the purpose of this section, our economy starts at date 1.

The domestic economy is populated by a continuum of unit measure of agents with Cobb-Douglas preferences over date 2 consumption,

$$u^d = (c_t c_n)^{1/2}$$

Where, c_t is consumption of tradeable (T) goods at date 2 and c_n is consumption of nontradeables (N) at date 2. We denote the date 2 exchange rate of T-goods in units of N-goods as e. By specifying preferences over date 2 consumption only, we remove from our analysis

[16] One of the roles the domestic financial sector plays, in our view, is in evening this asymmetry. We will return to this issue below.

[17] Whether the borrower or lender implements this transaction is irrelevant.

standard intertemporal substitution and smoothing arguments which are not central to our approach.

On the production side, output at date 2 is the result of investments made at date 0 and how much care is given to the existing productive structure at date 1. Let k_n and k_t denote the total amount of capital devoted to sectors N and T at the beginning of date 1, inherited from date 0. At date 1, production in a fraction ρ of the firms is interrupted by a shock.[18] In the N-sector, firms are required to contribute $I_n \leq k_n$ additional units of the tradable good in order to realize output of $R_n I_n$ at date 2.[19] The domestic economy will have no tradable goods at date 1 to contribute and the shock can only be accommodated by an increase in imports.[20] Besides heterogeneity, the two essential ingredients of our modeling of the shock are an import need coupled with a margin on which to adjust production. Because having a second reinvestment opportunity does not add substantial additional insights, we model the shocks to the T-sector more simply as just resulting in lost output; firms that are hit with a shock lose all output at date 2. Production per unit of capital in T-firms not affected by the shock is R_t.

Firms' investments in the two technologies are held as N- and T-shares. These shares can be bought and sold at all dates subject to one important constraint. Because of an agency problem (contractual problem) between an entrepreneur/firm and its outside claimants, each firm must hold at least a fraction θ_n and θ_t respectively of its *own* shares.[21] Thus, only the complements, $1 - \theta$, can be transferred within the agents in the economy. This fraction constitutes domestic collateral. It has equal worth to all agents in the economy. Let $\theta_{0,n}$ and $\theta_{0,t}$ be the fractions that each firm holds in its own technologies at date 1. These fractions are the result of date 0 decisions and constraints.

As we said, foreign investors are willing to receive N-shares in exchange for funds but transform them immediately into T-shares. Thus international collateral constitutes only the T-shares. These investors are risk neutral and have preferences only over the consump-

[18] We assume that the identity of firms receiving this idiosyncratic shock is not verifiable. This rules out insurance markets against the shock. See section 4 for details.

[19] Production has a time-to-build aspect. Investments are made at date 0; date 1 leaves firms with the possibility of scrapping the project or investing more resources in order to realize some of the output at date 2.

[20] In the appendix we introduce production and consumption at date 1. Our conclusions remain unchanged with this extension and we can drop the assumption that foreigners do not accept N-shares as collateral to obtain our fire sale results (see below). The formulae is obviously more cumbersome, thus we leave it for the appendix.

[21] We appeal to agency conflicts in making this "high-level" assumption. See the appendix for a deeper justification of the assumption. Also, see La Porta et al. (1998) for worldwide evidence on the high positive correlation between corporate governance problems and ownership concentration (in their interpretation, higher concentration is needed to prevent managers from stealing).

tion of T-goods. Unlike domestics, foreign investors have preferences over consumption at all dates because they may be called on to supply tradeable goods at date 1. They have large endowments of T-goods at all dates. Additionally, we assume that they do not discount the future so that the preference structure pins down the international interest rate at zero. For now, we assume foreign investors have no positions in terms of domestic shares at the beginning of the crisis period.

Initial conditions. At the beginning of date 1 firms hold $\theta_{0,n}$ shares in their own N-technologies, while the remaining $1-\theta_{0,n}$ is held by other firms (the market). A fraction ρ of the N-firms are hit with a shock at date 1 that leaves them with the opportunity to replenish production up to $I_n \leq k_n$ with an input of I_n tradable goods. The shareholders of each firm that is hit with a shock are left with no value in terms of goods but value in terms of the option to replenish production. We assume that this option value rests purely in the hands of the manager of the firm. Outside shareholders are fully diluted upon a shock and their shares are worthless.[22]

Given the shock, the shares on the market of the N-sector will payoff in aggregate $(1-\theta_n)(1-\rho)R_n$, or each share repays $(1-\rho)R_n$.

Firms hold $\theta_{0,t}$ shares in their own T-technologies. Firms that receive the shock lose all of this at date 1. The remaining $1-\theta_{0,t}$ is held in the market and repays per share of $(1-\rho)R_t$.

Thus the total resources available to a firm at date 1 depend on whether or not it is hit by a shock. A distressed firm (D) is left with $(1-\rho)(1-\theta_{0,n})k_n$ shares of the N-sector and $(1-\rho)(1-\theta_{0,t})k_t$ shares of the T-sector. Let P be the price of an N-share in units of the T-shares at date 1. Then the date 1 collateral (in T-shares) of such a firm, w^d, is

$$w^d \equiv k_n P \omega_n^d + k_t \omega_t^d \tag{1}$$

where, $\omega_n^d \equiv (1-\rho)(1-\theta_{0,n})$ and $\omega_t^d \equiv (1-\rho)(1-\theta_{0,t})$.

Decisions and constraints. A firm in distress needs to raise funds to finance continuation. Suppose the firm chooses to finance $I_n \leq k_n$. Then it can issue against this a fraction $1-\theta$ of shares to raise $(1-\theta)I_n P$ shares of T-sector. However this share issue is subject to the constraint that the firm retains at least $\theta \geq \theta_n$ fraction of the firm because of the agency problem. In addition to the proceeds from the share issue, the available resources of the firm also include its shareholdings in other N- and T-firms. Suppose that it chooses to convert a fraction α of the N-shares of this holdings into T-shares so that these also

[22] Some degree of dilution of external claims' is obviously realistic. We have adopted an extreme form of it to exclude "debt overhang" problems from our discussion. In any event, expected dilution will be built into prices at date 0.

constitute resources for reinvestment. Then, the total resources of the firm at date 1 is,

$$(1-\theta)I_nP + \alpha k_n P\omega_n^d + k_t\omega_t^d$$

The firm chooses to sink I_n from these resources back into production. The profit on this reinvestment is,

$$\pi = \theta I_n R_n + e(((1-\theta)I_nP + \alpha k_n P\omega_n^d + k_t\omega_t^d)R_t - I_n)$$

The first term represents the fraction, θ, of date 2 output that the firm retains. The second term is the amount of resources that the firm is left with after contributing I_n towards saving production. The firm maximizes this profit subject to budget and collateral constraints,

$$\begin{aligned}
\max_{I_n,\theta,\alpha} \quad & \theta I_n R_n + e(((1-\theta)I_nP + \alpha k_n P\omega_n^d + k_t\omega_t^d)R_t - I_n) \\
s.t. \quad (1) \quad & ((1-\theta)I_nP + \alpha k_n P\omega_n^d + k_t\omega_t^d)R_t - I_n \geq 0 \\
(2) \quad & \theta \geq \theta_n \\
(3) \quad & \theta \leq 1 \\
(4) \quad & I_n \leq k_n \\
(5) \quad & \alpha \leq 1
\end{aligned}$$

Forming the Lagrangian,

$$\begin{aligned}
\mathcal{L} \;=\; & \theta I_n R_n + (e+\lambda_1)(((1-\theta)I_nP + w^d)R_t - I_n) + \lambda_2(\theta - \theta_n) - \\
& \lambda_3(\theta - 1) - \lambda_4(I_n - k_n) - \lambda_5(\alpha - 1)
\end{aligned}$$

where the λ's are multipliers on each of the five constraints and are all greater than zero.

Let I_n, θ and α be solutions to this problem. Then the total number of N-shares sold by these firms is $\rho((I_n(1-\theta) + \alpha\omega_n^d k_n)$.

A firm that does not receive a shock is sound (S) at date 1 and may choose to purchase these N-shares. This is paid for with its available shares of the T-sector, which because of the agency problem is the fraction $(1-\theta_t)$ of its T-share holdings. It chooses X, the number of N-shares to buy to solve,

$$\begin{aligned}
\max_X \quad & e(R_t k_t - XPR_t) + XR_n \\
s.t. \quad & XP \leq k_t(\theta_{0,t} - \theta_t + (1-\theta_{0,t})(1-\rho)) \\
& X \geq 0
\end{aligned}$$

Let $X(P)$ be the solution to this program.

Equilibrium. In equilibrium, the number of N-shares sold by the distressed firms must be purchased by the sound firms. Thus, market clearing is

$$(1-\rho)X(P) = \rho((1-\theta)I_n + \alpha\omega_n^d k_n)$$

This condition gives the date 1 equilibrium price, P, of an N-share in units of the T-shares.

Date 2 exchange rate and collateral premium. Consider now the spot exchange rate at date 2. Given the Cobb-Douglas preference structure, the exchange rate will only depend on aggregate consumption. The first order condition for a representative consumer yields,

$$e = \frac{C_n}{C_t}$$

Given I_n, k_n, k_t,

$$\begin{aligned} C_n &= (1-\rho)R_n k_n + \rho R_n I_n \\ C_t &= (1-\rho)R_t k_t - \rho I_n \end{aligned}$$

As we know, P is the price to exchange claims on R_n units of N for claims on R_t units of T at date 2. Consider however the simple exchange at date 2 of R_n goods of N for R_t goods of T. Let the price of this exchange be $\hat{P}$, which we refer to as the *fundamental price.* Then,

$$\hat{P} = \frac{R_n}{eR_t}$$

When $P \neq \hat{P}$, there is a collateral premium governing exchange at date 1. Let L be this premium,

$$L \equiv \frac{\hat{P}}{P}$$

we show in the next section that equilibrium will require that $L \geq 1$.

The strict inequality $P < \hat{P}$ holds if there is scarcity of international collateral relative to the amount of domestic collateral. Equilibrium requires that the return on holding domestic collateral rises above that of holding international collateral. This need not be interpreted exclusively as a decline in the relative price of N-shares. To see this, let us define a [fictional] date 1 exchange rate, e_1, as the price to exchange 1 unit of the T-good for e_1 units of the N-goods at date 1. Now consider the investment decision of an agent at date 1 holding one unit of T-good and choosing between investing this in the domestic or the international economy. Investing abroad just means buying international collateral. Since the international interest rate is pinned down to be one, the return on this investment is one

as well. Investing domestically means purchasing domestic collateral, which yields a return of L. The domestic transaction can also be implemented via an exchange rate transaction and an investment at the domestic interest rate. The agent can convert the T-good into e_1 units of N-goods at date 1, which can then be invested domestically at an interest rate of R_d, yielding $R_d e_1$ N-goods at date 2. The return on this investment must be equal to L, or,

$$R_d \frac{e_1}{e} = L$$

Thus, when $L > 1$, the domestic economy is in great need of foreign resources. To attract these resources, domestic investment must yield a high return, which can come either in the form of a high domestic interest rate, $R_d > 1$, or in the form of an expected real exchange rate appreciation, $e_1/e > 1$.[23]

In the next section we characterize decisions and equilibrium in more detail.

2.2 Wasted Collateral and Fire Sales

Preliminaries. Return now to the optimization problem of the distressed firms. Analysis of this problem will depend on which constraints bind. We focus our discussion on the case in which (1) binds ($\lambda_1 > 0$) and (4) does not ($\lambda_4 = 0$). Constraint (1) will not bind only if w^d is very large, so domestic firms are sufficiently well capitalized that they are financially unconstrained. While perhaps useful in classifying countries with well developed capital markets like the US, this constraint is likely to bind in the emerging economies which are the focus of this paper. Constraint (4) is similar, in that it represents the amount of positive net-present-value (henceforth, NPV) projects that the economy is able to undertake. This constraint only binds if the economy has sufficient resources to save all production in the N-sector and is thereby able to finance all of its positive NPV projects.

Differentiating the Lagrangian with respect to I_n, we obtain that constraint (1) binds as long as,

$$\theta(R_n - e) + e(1-\theta)(R_t P - 1) > 0$$

Saving a unit in distress in the N-sector is a project that creates R_n units of nontradeables at a cost e, the value of one unit of tradeable. The social return on this project is therefore R_n/e which we assume is greater than 1.[24] We will shortly show that $R_t P \geq 1$, implying that $R_n/e > 1$ is sufficient for (1) to always bind.

If (1) binds, then $\lambda_1 > 0$. Consider next the derivative with respect to θ,

$$\frac{\partial \mathcal{L}}{\partial \theta} = P R_t (e(L-1) - \lambda_1)$$

[23] The model does not pin down R_d and e_1/e because in our formulation there is no goods market at date 1 through which an exchange rate can be established. In the appendix we introduce this market.

[24] See appendix for assumptions on primitives that yield this result.

Our concern is mostly with regions where this expression is negative, for otherwise constraint (1) binds "voluntarily;" if the equilibrium price of N-shares is too low, entrepreneurs will not be willing to use up all their N-shares to finance reinvestment. We will return to this region at the end of this section; for now, let $\theta = \theta_n$ and $\alpha = 1$. Thus,

$$I_n = \gamma R_t w^d$$

where,

$$\gamma \equiv \frac{1}{1-(1-\theta_n)PR_t} > 0$$

and γR_t is the return on internal collateral of a firm that is hit with a shock.

Wasted collateral. Region 1 is the case in which the domestic collateral constraint binds while the international collateral constraint does not, which happens as long the following inequality holds:

$$\hat{P}\rho((1-\theta_n)\gamma R_t w^d + k_n \omega_n^d) < (1-\rho)k_t(\theta_{0,t} - \theta_t + (1-\theta_{0,t})(1-\rho)). \tag{2}$$

The left hand side (henceforth, LHS) of this inequality is the demand for T shares from firms that receive a shock. It reflects the amount of domestic collateral in the hands of distressed firms. The right hand side (henceforth, RHS) is the supply of T-shares from the rest of the domestic economy. As long as there is an excess supply of T-shares, the price governing exchange of N-shares for T-shares must simply reflect the exchange rate at date 2 (i.e. $\hat{P}$). There is *wasted international collateral* in this region because, while the economy as a whole would be better off selling more of this collateral in order to finance this shock, *domestic financial constraints* on the firms that receive the shock prevent this collateral aggregation. Two factors govern poor collateral aggregation. First, if θ_n is high, the domestic financial market is poor so that firms are reliant on their own resources. Scarcity of these resources (low w^d) compounds this problem.

As aggregate conditions deteriorate, the LHS of (2) rises relative to the RHS; this can be easily seen for an increase in ρ but it can also be shown for a decline in R_t or an increase in foreign cost of capital.[25] Eventually, such decline in aggregate conditions brings the economy into the more severe *fire sale* region.

Fire sales. In Region 2, the inequality (2) is violated at the (fundamental) price $\hat{P}$. Excess demand for T-shares requires that the price of these shares in terms of N-shares rises (i.e., that P falls), resulting in a depressed value of N-shares. We refer to this as the *fire sale* region because the shock results in firms selling N-shares at prices depressed beyond

[25] A decline in foreigners "risk appetite" can be easily built into our framework and has consequences very similar to an increase in θ_t; see below.

fundamentals. Investment (I_n) is primarily curtailed by *scarce international collateral.* The economy as a whole has T-shares of,

$$(1-\rho)(1-\theta_t)k_t$$

If the international collateral constraint binds, it must be that all of these shares are sold to foreigners to finance the shock so that reinvestment by each firm is,

$$I_n = k_t R_t \frac{1-\rho}{\rho}(1-\theta_t)$$

However, this equality derives from general equilibrium considerations. Each firm chooses I_n taking P as given. Thus, the equilibrium value of P must fall until $\gamma R_t w^d$ falls to satisfy (2) with P instead of $\hat{P}$. We can write this equilibrium condition in the fire sale region as

$$\frac{1}{1-(1-\theta_n)PR_t}\left(\frac{k_n}{k_t}P\omega_n^d + \omega_t^d\right) = \frac{1-\rho}{\rho}(1-\theta_t), \tag{3}$$

where we have made one simplifying assumption and let $\theta_{0,t} = \theta_t$ (we later show that date 0 optimality will ensure this relation.)

Equilibrium price and collateral premium. A number of comparative statics can be conducted from condition (3). First, a rise in the ratio of N-production to T-production (k_n/k_t) will shift the LHS downward so that P falls. Second, a fall in θ_n also shifts the LHS down, leading to a decrease in prices. Finally, a rise in θ_t will cause the supply of T-shares to shift inward resulting also in a decrease in P.[26] Figure 1 illustrates shifts on LHS (upward sloping curves) and RHS (vertical lines), together with their consequences for investment and prices in the fire sale region.

The main consequences of negative aggregate shocks, in terms of moving the economy into or along the fire sale region, are well captured by the cross sectional comparison of economies as their θ_t increases. This is what we do in figure 2. Raising θ_t traces out a decreasing curve of P in the fire sale region. Additionally, a large θ_t will mean that the economy has less international collateral and is less able to fund its shock in the N-sector. This will lead to less production of N-goods at date 2 and an appreciating currency (lower e). Thus, in the fire sale region eP is uniformly downward sloping.

In the wasted collateral region, domestic firms that do not receive a shock hold both N-shares and T-shares. The return on N-shares is R_n/P while the return on T-shares is eR_t. Since firms are holding both N and T shares, arbitrage will dictate that,

$$R_n/P = eR_t$$

[26]Note that an increase in R_t lowers P but by less than the increase in the former. That is, once correced by the productivity growth in tradeables, the relative price of N-shares rises.

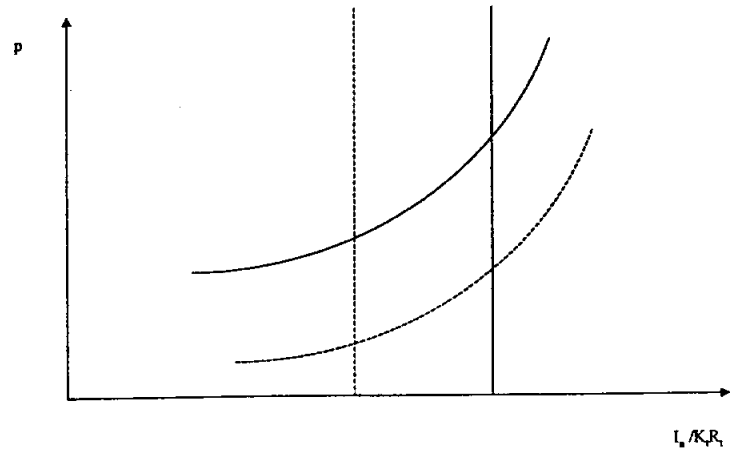

Figure 1: Equilibrium in the Fire Sale Region

or,

$$eP = e\hat{P} = R_n/R_t$$

The first region of this graph is the case in which $\theta_t < \theta^{FS}$. In this case θ is small enough that the only constraint that limits investment is the domestic collateral constraint and there is wasted international collateral. Prices in this region are simply $\hat{P}$ since there is sufficient T-shares. The second region is where, $\theta_t \geq \theta^{FS}$. In this case eP falls because the insufficiency of international collateral leads both to a fire sale and an appreciated currency. Then, the collateral premium,

$$L = \frac{e\hat{P}}{eP}$$

which is clearly increasing in θ_t. As the collateral premium rises, the cost of financing production in the N-sector becomes higher as issuance and sales of N-shares occurs at fire sale prices. The collateral premium is financed with the surplus from reinvestment, which is gradually transferred to T-shareholders. There is a point where this transfer is complete, and from then on firms hit by shocks withdraw voluntarily as they prefer to cut reinvestment rather than "give away" all their N-shares at extreme fire-sale prices; this is the right-most region of the diagram, where $\theta_t > \theta^{IC}$, and can be shown that $P = 1/R_t$.

Returns and transfers. In Region 1 only the domestic constraint is binding, while in region 2 both domestic and international constraints bind. In region 3 only the latter constraint

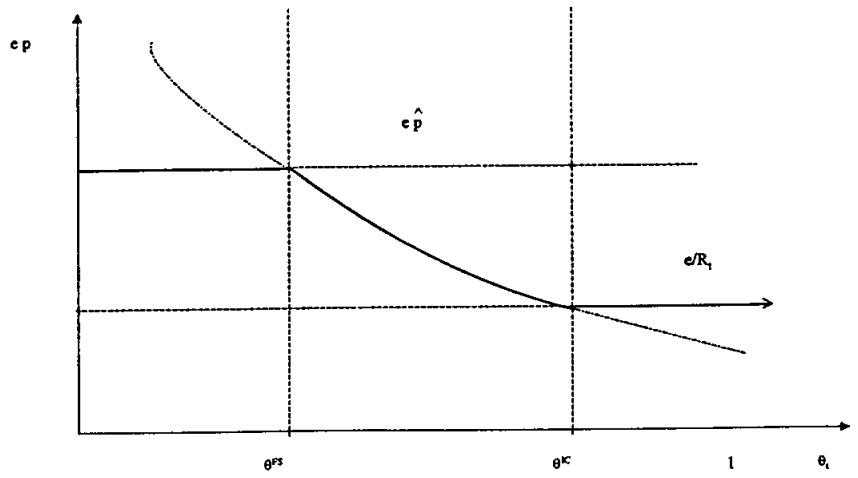

Figure 2: Regions

binds. This observation is important for understanding which arbitrage relations apply and which ones do not, and will play a key role later on when we analyze the social inefficiencies associated to each region.

The return to purchasing N-shares to an outside investor depends on P. The investor sells one share on the T-sector which is a claim on T-goods at date 2 totalling R_t. This is used to purchase $1/P$ units of N-shares which each return R_n units of date 2 N-goods. Thus, the *external* return on investment at date 1 is,

$$r^{ext} = \frac{R_n}{PeR_t} = L,$$

while the social or *total* return is

$$r^{tot} = \frac{R_n}{e} \geq L \geq 1.$$

Figure 3 depicts these returns as a function of θ_t . In the wasted collateral region, $L = 1$, the external return of T-shareholders is equal to one, the international cost of capital. Collateral providers, which are in excess supply in equilibrium, bid up P in their attempt to capture part of the surplus of reinvesting in a constrained firm. In equilibrium, all the surplus goes to the constrained firms. The problem is one of demand rather than supply shortage of international collateral.

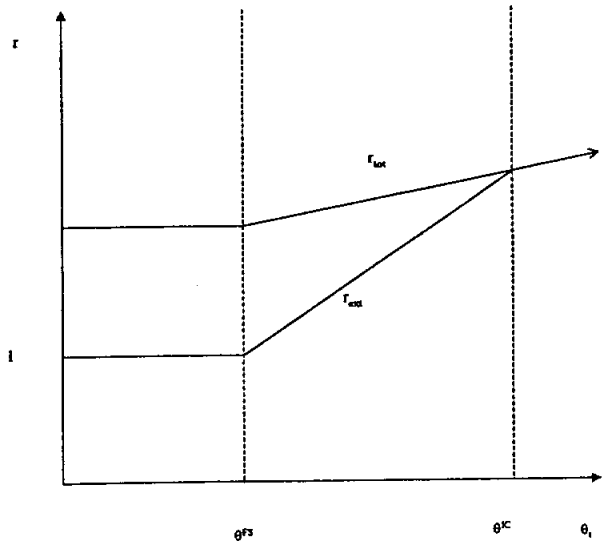

Figure 3: Returns

In the fire sale region, on the other hand, the supply of collateral becomes binding since all the pledgeable shares are used. Constrained firms compete for the few units of international collateral, and in so doing bid down the relative price of N-shares, and raise the collateral premium, L, above 1. As this happens, the domestic collateral constraint becomes binding, limiting the amount of surplus that constrained firms can transfer to collateral providers.

Eventually, as the increase in θ_t keeps reducing the amount of pledgeable T-shares, we reach a point where the entire surplus is transferred to external investors (region 3); from then on the price of N-shares stabilizes at $P = 1/R_t$, which sets $r^{ext} = r^{tot}$.

2.3 Fire Sales and the Banking System

Domestic financial systems play many useful roles in the allocation and aggregation of collateral. Most of these roles we have already circumvented in our assumption of perfectly functioning stock markets. One we have not, however, is the capacity of banks to smooth the distinction between domestic and international collateral in the eyes of foreign investors. In emerging economies, banks are largely in the business of intermediating foreign funds into nontradeable sectors. In our setup, since the tradeable sector has direct access to international financiers, banks have an "arbitrage" opportunity in the nontradeable sector

and naturally borrow abroad to lend to this sector. This intermediation is highly beneficial, especially in the event of a crisis, when domestic collateral can be used to access that part of future T-shares which is not part of international collateral due to governance problems in that sector. However, the cost of this activity is that it leaves the banking system with a fragile capital structure – assets and liabilities that are de-facto mismatched (N-assets and T-liabilities). A fire sale in this context will deteriorate banks' balance sheets rapidly by lowering the value of assets (N shares) while leaving the liabilities unchanged. This can create a host of problems by itself, either due to rigid institutional factors (BIS constraints) or simply through the possibility of a bank run by foreign investors which realize that a substantial withdrawal at fire sale prices would dry up the banks resources.[27,28] Indeed if the reason for the failure of the banking system is rigid capital adequacy ratios, a very straightforward but important recommendation is that closing banks using fire sales prices as a reference is not a good idea. It amounts to a self inflicted bank run, which can in turn reduce international collateral at the wrong time.[29]

2.4 Foreign Leverage

Opening the capital account at date 0 will allow domestic firms to increase their scale of production by selling some of their T-collateral to foreigners and using these proceeds to finance more production. At the aggregate level, the consequence of this is that firms will have less T-collateral to sell to foreigners at date 1. We show in this section that this will aggravate the price decline in the fire sale region.

We shall analyze how equilibrium relation,(3), in the fire sale region,

$$\frac{1}{1-(1-\theta_n)PR_t}(k_n P\omega_n^d + k_t\omega_t^d) = \frac{1-\rho}{\rho}k_t(1-\theta_t)$$

changes with the introduction of foreign leverage.

Changes in foreign leverage have effects on both the RHS and LHS of this expression. First, if firms sell a fraction θ_f of their T-shares to foreigners at date 0, the RHS of this

[27] See, for example, Diamond and Dybvig (1983)

[28] Indeed, the bulk of the capital flows reversal in the crisis economies of Asia came in the form of a sharp reversal in cross-board interbank lending, which went from 41 billion dollars in 1996 to minus 32 billions in 1997. Most of the pre-crisis loans were transformed into unhedged domestic currency loans or foreign-denominated loans to the N-sector (primarily real estate), in which case exchange-rate risk came in the form of credit risk. Banks' realization of the risky nature of their unhedged positions after Thailand's devaluation was a big factor behind the regional currency crises that followed; see IMF (1998).

[29] As for real or self inflicted bank runs, they can be avoided by boosting the price of N-shares. In a multiple equilibria scenario, this can be done by just credibly announcing a transfer to "patient" foreign investors in the event of a run. As always, if credible this policy will cost nothing.

expression will become,

$$\frac{1-\rho}{\rho}k_t(1-\theta_t-\theta_f)$$

Selling shares at date 0 also reduces holdings of T-shares as internal collateral from date 0 to date 1. The per capital return on the distressed entrepreneur's holdings of T-shares, ω_t^d, falls since a fraction of this is sold to foreigner. Thus,

$$\omega_t^d = (1-\rho)(1-\theta_{0,t}-\theta_f)$$

Substituting these into the equilibrium relation yields,

$$\frac{1}{1-(1-\theta_n)PR_t}(k_nP\omega_n^d + k_t(1-\theta_t-\theta_f)) = \frac{1-\rho}{\rho}k_t(1-\theta_t-\theta_f).$$

The key expression to be analyzed is $k_t(1-\theta_t-\theta_f)$. On the one hand, raising funds from foreigners allows financing more production, so that k_t rises. On the other hand, this increased production is held mostly as illiquid shares by domestic firms so that they hold less of the fraction of aggregate collateral at date 1. Suppose that all of the proceeds of shares issuance are used towards an increase in k_t, so that collateral creation is maximized. If the firm had originally invested $\hat{k}_t$ in the T-sector, opening the capital account will allow it to scale this investment up to,

$$\frac{\hat{k}_t}{1-R_t(1-\rho)\theta_f}$$

Then,

$$\frac{\partial}{\partial\theta_f}\frac{1-\theta_t-\theta_f}{1-R_t(1-\rho)\theta_f} = -\frac{1-(1-\theta_t)R_t(1-\rho)}{1-R_t(1-\rho)\theta_f} < 0$$

The numerator must be less than zero or production in the T-sector would be a money machine (which we must rule out by assumption). Since $k_t(1-\theta_t-\theta_f)$ falls with a rising θ_f, the curves in figure 1 are affected in two ways. First, the vertical curve shifts to the left reflecting a contraction in the aggregate supply of collateral at date 1. Second, the demand curve for T-shares shifts down reflecting the fall in domestic collateral. The net of these is that P must fall. Thus, aggregate collateral in the economy declines with foreign leverage resulting in a steeper price decline in the fire sale region.

A puzzling feature of crises is that both flows and stocks, rather than only stocks, seem to contribute to their unraveling and likelihood. Our model offers one possible explanation. Flows matter primarily through distressed firms which in principle can renegotiate the stock of debt but need the new flows to survive. Stocks, on the other hand, primarily matter though sound firms, by curtailing their role as suppliers of international collateral.

3 The Pre-Crisis Phase

3.1 The Model

Introduction. Of course, many of the conditions that lead to a crisis are created well in advance of the crisis itself. The analysis thus far has taken these initial conditions as given and illustrated the types of problems that they might lead to. As a shortage of international collateral is largely what is responsible for triggering a fire sale, a natural question that arises is why the private sector does not anticipate this and take steps to invest in highly profitable international collateral. In order to address these issues in our model, we add a history to our economy; a date 0 in which agents have full flexibility. In particular this section addresses two sets of choices: production and financing. On the production side, we study the difference between private and social incentives to allocate factors of production to tradeables and nontradeables. On the financing side, we study the benefits and costs of foreign leverage that results from opening the capital account at date 0.

The basic problem. Firms at date 0 must first decide how much to produce in each of the N- and T-sectors. Production requires resources at date 0 and firms must decide on how to finance this production — how many T- and N-shares to issue against production. Finally, the complement of this financing decision is an investment decision — how many T- and N-shares of other firms in the economy should be purchased.

We focus first on the case in which there is no date 0 borrowing from abroad. Since the total resources of the economy are fixed, we must have that,

$$k_n + k_t = w.$$

While the incidence of crises must surely by tied to aggregate shocks, our model allows us to highlight the main issues leading to a crisis in an environment with only idiosyncratic shocks. Given wealth at date 2 (in units of N-good) of w_2, a firm solves

$$\frac{w_2}{2}e^{-1/2} = \max\{u^d \ \ s.t. \ \ c_t e + c_n = w_2.\}$$

Since uncertainty is idiosyncratic, e is deterministic and firms are risk neutral. Each firm, taking e as given, simply maximizes the expected value of wealth at date 2.

Let V_n be the marginal value of a unit invested in the N-sector and V_t be the marginal value of a unit invested in the T-sector. Then the firm solves,

$$\begin{aligned} \max_{k_n,k_t} \quad & V_n k_n + eV_t k_t \\ s.t. \quad & k_n + k_t = w \end{aligned}$$

Investing in tradeables. Consider each of V_t and V_n in turn. A unit of date 0 resources physically invested in the T-sector generates returns in two components. First, the firm keeps a stake in its own enterprise of $\theta_{0,t} \geq \theta_t$. This illiquid component is worth (in date 2 T-goods),

$$\theta_{0,t} R_t (1 - \rho).$$

The complement $(1 - \theta_{0,t})$ is sold to the market. The market discounts these flows at a price of q. The firm raises from this issue T-goods at date 0 totaling,

$$(1 - \rho)(1 - \theta_{0,t}) R_t q.$$

Since these T-goods at date 0 can always be reinvested in the T-sector, the date 2 value of this is,

$$(1 - \rho)(1 - \theta_{0,t}) R_t V_t q.$$

Thus,

$$V_t = \theta_{0,t} R_t (1 - \rho) + (1 - \rho)(1 - \theta_{0,t}) R_t q V_t.$$

Rather than making a physical investment, a firm can also choose to simply purchase the T-collateral of another firm. Doing this produces two benefits. If the firm receives a shock, it can use this collateral to finance the shock with foreigners. The value of a unit of collateral in this case is $\theta_n \gamma R_n / e$. If the firm does not receive a shock, the collateral can be sold to another firm which does. In this case the collateral generates a value of L. Thus we define the *value of collateral provision* as,

$$\phi \equiv \rho \theta_n \gamma \frac{R_n}{e} + (1 - \rho) L > 1;$$

since the cost of a unit of collateral is q, the return to this investment is simply,

$$\phi / q.$$

Holding provisions of collateral from date 0 to date 1 is insurance against entering distress (precautionary savings on the part of firms). Firms can hold either N- or T-shares as insurance, however the shares must be saleable in the market at date 1. Thus, only collateral or the $(1 - \theta)$ share of production can satisfy this insurance need.

In equilibrium, the return on holding a unit of collateral, ϕ/q, must be equal to the return on undertaking physical investment, V_t. This is because if $V_t < \phi/q$, no firm will undertake physical investment and hence there will be no collateral for any other firm to purchase. On the other hand, if $V_t > \phi/q$, each firm will only undertake physical investment. Since neither of these is consistent with equilibrium, we have the above condition.

Then,

$$V_t = (1 - \rho)(\theta_{0,t} R_t + (1 - \theta_{0,t}) R_t \phi). \tag{4}$$

Consider now the choice of $\theta_{0,t}$. The firm chooses this to maximize V_t

$$\begin{aligned} \max_{\theta_{0,t}} \quad & \theta_{0,t} R_t(1-\rho) + (1-\rho)(1-\theta_{0,t}) R_t \phi \\ s.t. \quad & \theta_{0,t} \geq \theta_t. \end{aligned}$$

Since $\phi > 1$, it is easy to see that $\theta_{0,t} = \theta_t$. In other words, each firm will only hold the minimum possible of its own shares. Holding its own shares leaves the firm subject to shocks which reduce the resources of the firm precisely when they are most needed. Holding shares in the market is partial insurance against these shocks.

Investing in nontradeables. Turning now to the N sector, we continue working in the region where $\bar{I}_n < k_n$. Then, adding a unit of capital to N does not affect the option to reinvest by expanding the capacity constraint at date 1. A similar analysis to the above yields that,

$$V_n = (1-\rho)(\theta_n R_n + e(1-\theta_n) P R_t \phi).$$

Equilibrium. In equilibrium firms must be indifferent between investing in N and T. Equating V_n and eV_t yields:

$$\hat{P}(\theta_n + (1-\theta_n)\phi/L) = \theta_t + (1-\theta_t)\phi. \tag{5}$$

While this is an equilibrium relation, shifting fundamentals and the collateral premium sheds light on private incentives for production. A rise in $\hat{P}$, either through an increase in R_n/R_t or a fall in e, increases the return to production in the N-sector. On the other hand, a rise in the collateral premium, L, increases the incentive to shift resources to the T-sector.

3.2 Externalities in Collateral Creation and Nontradeables Investment

Issue and setup. While the collateral premium provides a clear private incentive for reallocating production from nontradeables to tradeables, we show in this section that this is insufficient to align private and social incentives.

To simplify the analysis, let $\theta_n = \theta_t = \underline{\theta}$. The problem of a firm at date 0 can be written as,[30]

$$\max_{k_n, k_t} \quad u^d = (c_n c_t)^{\frac{1}{2}}$$

[30] We have written the optimization problem as that of a representative agent over aggregate consumption. There are some issues of aggregation that have been suppressed in writing this optimization. It is valid in this case because of the Cobb-Douglas preference structure. A firm at date 1 is either distressed or sound. Thus, the objective function is,

$$\max \rho(c_n^d c_t^d)^{\frac{1}{2}} + (1-\rho)(c_n^s c_t^s)^{\frac{1}{2}}$$

However, aggregate resource constraints mean that,

$$\rho c_n^d + (1-\rho) c_n^s = c_n$$

$$
\begin{aligned}
s.t. \quad & c_n = R_n k_n (1-\rho) + \rho R_n I_n \\
& c_t = R_t k_t (1-\rho) - \rho I_n \\
& I_n = \gamma R_t (1-\underline{\theta})(1-\rho)(k_n P + k_t) \\
& k_n + k_t = w.
\end{aligned}
$$

Consider the derivative of the objective with respect to a perturbation of a Δ increase in k_t and Δ decrease in k_n.

$$
\frac{\partial u^d}{\partial \Delta}|_{\Delta=0} = \frac{1}{2u^d}\left(c_t \frac{\partial c_n}{\partial \Delta} + c_n \frac{\partial c_t}{\partial \Delta}\right)
$$

where,

$$
\frac{\partial c_n}{\partial \Delta} = -R_n(1-\rho) + \rho R_n \frac{\partial I_n}{\partial \Delta}
$$

and

$$
\frac{\partial c_t}{\partial \Delta} = R_t(1-\rho) - \rho \frac{\partial I_n}{\partial \Delta}.
$$

Substituting these into the above we arrive at the first order condition for a firm at date 0,[31]

$$
\frac{\partial u^d}{\partial \Delta}|_{\Delta=0} = \frac{c_t}{2u^d}\left((eR_t - R_n)(1-\rho) + \rho(R_n - e)\frac{\partial I_n}{\partial \Delta}\right) = 0. \tag{6}
$$

Social versus private problems. Consider next the first order condition for a central planner at date 0. This differs from (6) in only one way. Changes in Δ affect investment at date 1 through their effect on asset prices, that private decisions do not take into account. This difference is reflected in the term $\frac{\partial I_n}{\partial \Delta}$. At the private level,

$$
\frac{\partial I_n}{\partial \Delta}^{private} = \gamma R_t(1-\underline{\theta})(1-\rho)(1-P)
$$

whereas at the social level this is,

$$
\frac{\partial I_n}{\partial \Delta}^{social} = \frac{\partial \gamma}{\partial \Delta} R_t(1-\underline{\theta})(1-\rho)(k_n P + k_t) + \gamma R_t(1-\underline{\theta})(1-\rho)k_n \frac{\partial P}{\partial \Delta} + \frac{\partial I_n}{\partial \Delta}^{private}.
$$

Private incentives do not take into account the effect of a change in Δ on the value of collateral at date 1. Since firms at date 1 are financial constrained in both regions 1 and 2, increases in collateral values allow for more positive NPV investments ($R_n > e$) to be undertaken.

$$
\rho c_t^d + (1-\rho)c_t^s = c_t
$$

where, individual consumption satisfies, $\frac{c_n^d}{c_t^d} = \frac{c_n^s}{c_t^s}$. These relations and the fact that preferences are Cobb-Douglas imply that the objective can be written to maximize preferences over aggregate consumption.

[31] A little algebra verifies that this condition is equivalent to (5).

Wasted collateral region. In the wasted collateral region, increasing k_t causes the production of T-goods at date 2 to rise relative to that of N-goods resulting in an appreciated currency. At date 1, this raises P, the domestic value of N-collateral. Both $\frac{\partial \gamma}{\partial \Delta}$ and $\frac{\partial P}{\partial \Delta}$ are positive, meaning that the social value of increasing Δ is higher than the private value.

Fire sale region. In the fire sale region, this effect is reinforced because the change in k_t relaxes the international collateral constraint and raises P.[32] The intuition behind this is easily understood. Suppose that a central planner allocated one unit of resources away from N and into T. This generates aggregate collateral at date 1 of $(1-\rho)(1-\underline{\theta})R_t$. Since the economy is in the fire sale region, this collateral will always be used to fund reinvestment in the N-sector. The return to this reinvestment gives,

$$(1-\rho)(1-\underline{\theta})R_t(R_n/e-1)$$

which is always greater than zero since $R_n/e > 1$.

The mechanisms. If investment was not financially constrained (i.e. $\theta_n = 0$ or w^d high), prices would not affect the investment decision, I_n, at date 1, and private and social incentives would be aligned. Thus, the externality is closely related to the financial constraint at date 1. However, the mechanism underlying the externality differs across region 1 and region 2. In the wasted collateral region, shifting production to the T-sector results in a permanent appreciation of the currency. This is reflected at date 1 as an increase in the value of collateral, which loosens the financial constraint. The private economy does not take this into account because there is no extra price which internalizes the effect of production decisions on firms in distress. In the fire sale region, there is such a price, namely the collateral premium (L) at date 1. The source of the externality is that this premium is not high enough. Socially, the premium to collateral creation is R_n/e, however privately it is only L. In region 2, $R_n/e < L$, while in region 3, $R_n/e = L$. Thus, the externality diminishes as we move through region 2. An immediate implication of this is that any date 1 policy of supporting prices in the fire sale region has the ex-ante consequence of diminishing private incentives to create collateral.

3.3 Foreign Leverage

The issue. The question of whether capital flows should be regulated or not finds one answer in this asset markets view: it depends on whether they affect positively or negatively collateral constraints during the crisis phase; ultimately, on whether they raise or lower P during the crisis. As in our discussion of externalities in production decisions, private agents do not fully internalize the consequences of their decisions on others' collateral value at date

[32] I.e. P and γ rise by more with Δ.

1. In the wasted collateral region, the chief factor behind P is the long run real exchange rate; as capital inflows appreciate the latter, they help aggregating collateral during crises. In the fires sales region, on the other hand, the main factor for P is the collateral premium L; capital inflows increase this premium and lower P, as they reduce the country's availability of international collateral at the time of crisis.

Private tradeoffs. Borrowing resources from foreign investors allow firms to expand production at date 0. However, in return firms must sell some of their collateral which would otherwise yield a collateral premium at date 1. Foreigners always buy T-shares using a discount rate of one (the international interest rate), which means firms borrow if,

$$V_t - \phi \geq 0$$

or,

$$q \geq 1. \tag{7}$$

While, foreigners use a discount factor of one to buy T-shares, domestics discount flows at q. If $q < 1$, firms will always prefer to sell shares to foreigners and invest these proceeds in their domestic production. Expanding the expression for q, yields

$$q = \frac{1}{(1-\rho)R_t(\frac{\theta_t}{\phi} + (1-\theta_t))}$$

which shows that as $R_t(1-\rho)$ rises, the neoclassical advantage of borrowing from abroad to invest in high return projects rises. If this is high relative to the value of collateral provision (ϕ), q falls below one and firms find it profitable to borrow from foreigners and take on leverage.

Wasted collateral region. In the wasted collateral region, boosting the domestic exchange rate raises the value of N-collateral and loosens the domestic financial constraint at date 1. Foreign inflows are one way to accomplish this since they appreciate the currency. If firms at date 0 are able to leverage their production in the T-sector with respect to foreigners, the effective productivity of the T-sector rises. In turn, the increased production of T-goods appreciates the currency. This is the benefit of opening the capital account at date 0.

Fire sale region. The social benefits of opening the capital account are reversed in the fire sale region. Foreign leverage lowers the amount of international collateral available to the domestic economy and therefore lowers P (see section 2.4). This fall in collateral values reduces the amount of investment at date 1. On the one hand, selling a T-share at date 0 generates T-goods of $R_t(1-\rho)$, which are each worth V_t at date 0. On the other hand, this

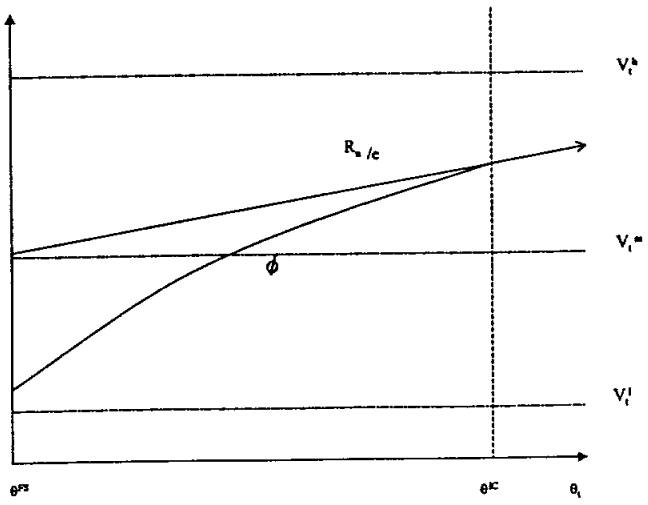

Figure 4: Social and Private Values in the Fire Sale Region

reduces the amount of collateral at date 1 by $R_t(1-\rho)$, which could otherwise be used to generate date 2 flows of R_n/e per unit. Thus, leverage is socially beneficial if,

$$R_n/e < V_t.$$

Figure 4 illustrates the divergence between private and social values of opening the capital account in the fire sale region. R_n/e is the social cost of selling a unit of collateral abroad, while ϕ is the private cost of this transaction. It is easy to show that $\phi < R_n/e$ in region 2 while it is equal to R_n/e in region 3. Thus the private cost is always less than the social cost.

This does not mean, of course, that capital flows should be stopped altogether. The benefit from borrowing from abroad is:

$$V_t = R_t(\theta_t + (1-\theta_t)\phi)$$

which shows that when R_t is high, the business of borrowing is very good and both private and social values dictate taking on foreign leverage. This case corresponds to the uppermost horizontal line in the graph.[33] On the other hand, when R_t is low, private costs of leverage

[33] While V_t^h is a function of θ_t, it has been drawn as a horizontal line. For the purpose of our figure, we are less interested in its shape than its dependence on R_t. This is the parameter that is shifted to give high, medium, and low values of V_t.

overwhelm the benefits of borrowing and firms do not access international capital markets at date 0. It is in the intermediate range, V_t^m in between R_n/e and ϕ, that firms will choose to take on foreign leverage when social incentives dictate otherwise. As aggregate leverage rises, both private and social costs of leverage rise, eventually turning V_t^h into the equivalent of V_t^m in the figure, and leverage will be socially inefficient.

4 Insurance Markets and Aggregate Shocks

If distressed firms could arrange in advance to receive financing from sound firms at favorable levels the inefficiency that we have identified would disappear. However, doing so would require introducing insurance contracts contingent on the date 1 idiosyncratic realization of firm type – contracts which our analysis has implicitly ruled out. To see why the introduction of such contracts would eliminate the inefficiency, consider the following. Note that the externality arises in the fire sale because at date 1 distressed firms are unable to transfer the full value of their surplus to sound firms because of a binding domestic collateral constraint. If these firms could arrange in advance that in the event of becoming distressed they would receive a payment to exactly leave the domestic collateral constraint slack, then they would always have sufficient resources to transfer the surplus to the sound firms. Ex-ante, since all firms are identical, the purchase of this insurance contract involves no transfers and is therefore clearly feasible as long as the firm type is verifiable.

While insurance markets against idiosyncratic shocks can be defensibly suppressed, those against aggregate shocks need be considered. First, a simplifying feature of our analysis is that we are able to describe crises and identify the collateral undervaluation externality without introducing aggregate shocks. However, the incidence of a crisis is surely tied to aggregate shocks, and as such we now extend the model to include aggregate shocks and insurance markets against these shocks.

At date 1, given date 0 decisions of $(k_n, k_t, \theta_{0,n}, \theta_{0,t})$, the extent of a crisis will depend on $(\rho, \theta_n, \theta_t, R_n, R_t)$. Let $s \in \{s_0, ..., s_j\} \equiv \mathcal{S}$ represent the state of the world at date 1, with corresponding probabilities $\pi(s)$. Then, in each state s there are realizations of $(\rho(s), \theta_n(s), \theta_t(s), R_n(s), R_t(s))$ that represent the aggregate shock. To simplify let us focus on the case where $s \in \{s_0, s_1\}$ and all aggregate uncertainty is captured by variation in $\rho \in \{0, \rho_1\}$, where $\rho(s_0) = 0$ is a state where no constraints bind and $\rho(s_1) = \rho_1$ is a state where the economy is in a fire sale.

Let us close the capital account at date 0, so that $k_n + k_t = w$, but allow foreigners to provide insurance against shocks. This is captured by letting $\theta_{0,t}$ depend on s, but subject to the restriction that,

$$1 - \theta_t = \pi_0(1 - \theta_{0,t}(s_0)) + \pi_1(1 - \theta_{0,t}(s_1))$$

At date 0, $1-\theta_t$ is the fraction of T-shares that can be sold to foreigners. The restriction is arrived at by imagining that firms sell all of this to foreigners and then purchase back a state contingent number of shares. The quantity of insurance is then denominated in units of T-shares.

Now, if in state s_0 the economy firms encounter no shock, there is no reason to purchase insurance against this state, so that $1-\theta_{0,t}(s_0)=0$. This implies that,[34]

$$1-\theta_{0,t}(s_1)=\frac{1-\theta_t}{\pi_1} \tag{8}$$

Return to the question of the choice of k_n and k_t. (8) reflects all of the insurance decisions that firms will take in response to aggregate shocks. Then, at date 0, the problem of k_n and k_t is similar in character to that of the case in which there are no aggregate shocks – k_t is just a scale factor on the amount of T-shares available in s_1. While in state s_0 the T-shares have no collateral value, in state s_1, T-shares are very valuable and hence command a premium. However, for the same logic as in the previous section the premium will be insufficient to incentivize efficient collateral production and the decentralized economy will underprovision for the fire sale.

5 Final Remarks, Caveats and Policy Considerations

In terms of our model, the first phase of the current crisis (mid 1997) —Thailand in particular— can be seen as an accumulation of aggregate shocks, leverage and weakening financial institutions that eventually ran the economy into the fire sale region. Together with the devaluation of the baht, came investors' learning of a series of less than fully transparent practices and institutions, which they extrapolated to neighbor countries. Effectively, these countries —Indonesia, Malaysia and the Philippines, in particular— experienced a sharp increase in perceived θ's and perhaps a decline in the fraction of the available shares which were thought to be appropriate international collateral. This perception of declining international collateral was exacerbated by a widespread weakening of financial institutions.

As the crisis has spread, beginning with the regional consequences of Hong Kong's stiff defense of their currency board after the Taiwanese devaluation, continuing with the severe distress of Korean and Japanese banks, and reaching a climax in Russia's collapse, the problem has shifted in nature from domestic to one of shortages in the international supply of funds. Even relatively solid countries within Latin America have been severed from international capital markets. Although the world as a whole seems to have plenty of liquidity, those that have the know-how to invest in these countries have seen their funds,

[34] One can think of this as a line of credit that the central bank takes out from foreign banks.

capital and mandate dry up. Marginal investors in the region are either uninformed or very constrained ones. Both considerations have led to an increase in the required return on these countries. Equivalently, the "flight to quality" and avoidance of exchange rate risk of these investors has led to a reduction in the fraction of domestic shares that are acceptable by foreigners — a negative aggregate shock from the point of view of collateral. As before, widespread fire sales are the natural consequence of these shocks.[35]

Before discussing policy aspects of our problem, it seems particularly appropriate to remind the reader of the narrow goal we have pursued in this paper; which is to highlight the core features of a world where asset market and financing considerations take center stage. In so doing, we have removed many aspects of the problem which obviously need to be considered when designing an actual policy package; traditional nominal and real wage rigidities, intertemporal smoothing and aggregate demand factors, to name a few.

Even within the domain of an asset markets perspective, we have limited ourselves to what we view as the essence and novel, leaving aside important issues which have been already discussed in the literature and for the most part, would only reinforce our conclusions. We have assumed, for example, that full dilution of claim holders on distressed firms is smooth and uneventful. The prolonged and costly nature of the Latin American debt overhang problem during the 1980's attests to the fact that the process of dilution is a sluggish and imperfect one.[36] Adding such considerations would reduce even further the collateral available to distressed firms, and it would also reduce international collateral since commitments to foreigners are often made —directly or through domestic banks— in terms of T-shares. Similarly, except for our brief discussion of the banking system, we have shutdown the most powerful dynamic multiplier mechanisms discussed in the credit constraints literature. Adding a few periods to our model would give us dynamic amplification mechanisms a la Kiyotaki and Moore (1997), where the anticipation of a fire sale, which may be the result of today's distress, further feeds back into today's decline in stock prices, exacerbating the extent of the crisis and the effects we have discussed.[37]

Throughout our analysis we have taken contractual problems as given, and have explored the implications of these for crises scenarios and their likelihood. Whether a country is likely to exhibit a crisis —and the particular form it takes— depends to a large extent on whether

[35] See the section on financial panic as well as the appendix for a discussion of situations where the strict allocation of international collateral to a fixed number of T-shares is relaxed. Financial panic does much of its damage, we argue, precisely by reducing the number of shares that are acceptable collateral to foreigners.

[36] See, e.g., Krugman (1985a,b) and Sachs (1984) on disorderly workouts.

[37] The main reason we do not have this effect in our two periods (dates 1 and 2) model, is that in the last period there can be no fire sale and the date 2 real exchange rate always dampens rather than amplifies underinvestment problems. By adding more periods, the equilibrium real exchange rate constraint can be postponed and replaced, along the transition, by a dominant collateral premium effect.

individual entrepreneurs can commit effort and output at relatively low cost. Rather than the direct consequence of misguided policies, we have given a more active role to the private sector in generating the conditions for crises in emerging economies. The government's fault is more indirect, and it lies in not providing economic agents with appropriate enforcement and commitment mechanisms. Johnson et al (1998) find strong support for this view in the recent crisis. They document that corporate governance factors seem to do substantially better in explaining the cross sectional variation in aggregate distress —as measured by stock market decline, exchange rate depreciation and interest rates hike— in emerging economies, than do traditional macroeconomic variables.

Unfortunately, while removing misguided policies should be "relatively" easy, creating appropriate institutions to protect investors and financiers from dishonest behavior is certainly a more complex task, as it often involves changing deeply ingrained customs and rent-seeking cultures.[38] We are not nearly as ambitious in our discussion; instead we focus on the policy implications of our analysis, given imperfect institutions. Consistent with this approach is our omission of insurance, complicated microeconomic contracts, and narrowly targeted transfers, from our discussion of potential remedies.

The most immediate implication of our model in terms of policy is during the pre-crisis period, where subsidizing domestic investment in the tradeable sector (perhaps financed with a tax on nontradeable investment) should be contemplated whenever the likelihood of falling into wasted collateral or fire sale region is significant. Although the bottom line is not, the rationale for such reallocation policy is different in each region. In the wasted collateral region the goal is one of long run appreciation of the real exchange rate, which raises the relative price of N-shares. In the event of a crisis, this higher price facilitates collateral aggregation and thus reduces the extent of the waste. Policy incentives are needed because the private sector does not take into account the negative consequences that overinvesting in nontradeables has on others' collateral.

In the fire sale region, on the other hand, the most acute problem is one of international collateral shortage, which is obviously alleviated by an expansion of domestically owned tradeable sector. Incentives to create collateral are inefficiently low in the private sector, because collateral providers anticipate a relatively depressed demand for this collateral due to limited domestic collateral. It is the dynamic interaction between domestic and international collateral constraints, which underlies the externality that justifies government intervention.

On pre-crisis capital flows, our recommendation varies depending on whether a fire sale is likely or not. If wasted collateral is the primary concern, then capital flows should

[38] Which, in turn, are sometimes the consequence of misguided policies.

be fostered. The long term real exchange rate appreciation which results from such active policy would revalue assets in the nontradeable sector, boosting domestic collateral values.[39] However, if fire sales are the primary concern, then the opposite is true. Since individual entrepreneurs consider the effect of foreign leverage on their own fragility, but disregard the negative impact of their leverage on aggregate fragility, taxing capital flows is the suggested course of action.[40,41]

As the recent events so vividly highlight, countries do not always take the appropriate amount of preventive measures, and in those circumstance that they do, aggregate shocks —real or speculative— may be large enough to make crises unavoidable. The question arises, then, on what actions to take during crises. In particular, and motivated by policies advocated and implemented during the current Asian crisis, how should one think about direct stock market intervention and interest rate hikes within an asset markets view?

Again, it is important to distinguish between different types of crises. In the —in principle milder— wasted collateral scenario, boosting the price of N-shares is useful because it relaxes the financial constraint of distressed firms. But unless this is accompanied by an appreciation of future exchange rates, such policy will depress the expected return on holding N-shares and create arbitrage opportunities across N-shares and T-shares. In other words, devised only as a temporary measure, and not supplemented by structural changes supporting a more appreciated currency in the future, this policy can be prohibitively expensive in terms of the resources needed to make it succeed.

In the fire sale region the story is quite different and more relevant for current events in emerging economies. Boosting the price of N-shares without adding available international collateral or resources has no effect by itself. It is at this juncture that raising domestic interest rates —not in the sense of pure monetary policy but by offering a high return instrument to foreigners— may have a favorable effect.[42] For this to happen, the government must be able to partially circumvent foreign investors concerns with holding N-shares by promising a high return on the bonds issued.[43] The international collateral so generated

[39] Alternatively, with a well capitalized domestic banking system, this incentive may not be needed since the N-sector also becomes the recipient of capital flows in that case.

[40] The same argument rationalizes, within our model, the practice of government's reserve hoarding which can be used as international collateral in the event of a crisis. It is straightforward to show that, because of the externality, the private sector will not undo one for one the government's reserve accumulation.

[41] In agreement with our policy proposition and the factors behind it, IMF (1998, p.7) conjectures that in the absence of good financial supervisory and corporate gove.nance, taxing short term capital inflows may be appropriate.

[42] Of course, the initial shock could be the withdrawal of existing foreign resources, in which case raising interest rates is a mechanism to reduce the outflow.

[43] A possibility not available to individual entrepreneurs. Cavallo (1996) describes Central Bank policy in a currency board system as the "normal ones" of a Central Bank but where funds must be obtained from

must be channeled back into N-share holders in distress, possibly by boosting the price of their shares, which otherwise would be hurt by the high interest rates.[44]

A brief formal model highlights the limits of such interest rate policy. Suppose the government can issue bonds to foreigners at date 1 against an imperfect promise that it will make payments of T-goods at date 2. The government issues B bonds and faces a downward sloping demand curve for these bonds. $R(B)$ is the required return by international investors, with $R(0) = 1$, and $R'(B) > 0$. The proceeds from the sale of B bonds in the fire sale region reduces the extent of the fire sale and allows for more investment. $L(B)$ is the collateral premium given B. Domestics will not buy bonds as long as $L(B) > R(B)$. This is because they prefer to hold the domestic stock market at these prices. It follows that the optimal bond issue sets $L(B) = R(B)$. Raising interest rates as long as these returns are less than the return on domestic holding of N-shares assures that the economy is better off. If R is raised beyond this point, the domestic stock market starts to fall to equalize the return, and actually the economy raises less funds from abroad.[45]

In closing, we highlight a few extensions which we have left for future work. First, we have not paid much attention to a central vulnerability issue, which is the maturity structure of foreign debt. The same mechanism leading to underprovision of collateral in our model should encourage excessive short term borrowing as well. Second, in actual crises domestic investors also run. We view this as a dynamic issue, which reflects the informational advantage these investors have, and therefore their ability to anticipate the fire sale scenario. After the capital loss occurs, they are likely to return before foreign investors do to reap the benefits of fire sales. Lastly, we have discussed wasted collateral and fire sale regions almost in parallel. In reality, they are likely to correspond to different phases of development and medium frequency events. For example, an early wasted collateral region can gradually turn into a fire sale region as capital inflows accumulate without the parallel development of an adequate enforcement and regulatory environment.

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willing lenders rather than from printing money.

Argentina's issuance of collateralized (by domestic mortgages) repos, is a very direct example of N-shares turned into international collateral through government intermediation.

[44] Unlike the wasted collateral region, there is no need to promise a higher price of N-shares during the post-crisis scenario, since the increase in P just reduces the extent of the fire sale, so there is no need to worry about arbitrage across N- and T-shares.

[45] To shorten our discussion, we have disregarded the monopoly aspects of the government bonds issuance problem. Taking into account the monopoly problem, we get that the optimal B is such that $R(B) = \min\{L(B), R_n/e(1+\mu)\}$, where μ is a monopoly markup.

6 Appendix

6.1 Regions

We have discussed fire sales and wasted collateral regions in the text without demonstrating that both of these regions necessarily arise in the model. The purpose of this subsection is to find conditions on parameters such that these regions exist.

Take the case where $\theta_n = \theta_t = \underline{\theta}$. Then date 0 optimization means that,

$$\hat{P}(\underline{\theta} + (1-\underline{\theta})\phi/L) = \underline{\theta} + (1-\underline{\theta})\phi$$

Consider first the wasted collateral region. In this case, $L = 1$, so that

$$\frac{R_n}{eR_t} = \hat{P} = 1.$$

From the aggregate constraints at date 2,

$$e = \frac{R_n k_n(1-\rho) + \rho R_n I_n}{R_t k_t(1-\rho) - \rho I_n} = \frac{R_n}{R_t}$$

solving,

$$I_n(R_t+1) = R_t \frac{1-\rho}{\rho}(k_t - k_n).$$

Now,

$$I_n = \gamma R_t(1-\underline{\theta})(1-\rho)(k_n\hat{P} + k_t) = \gamma R_t(1-\underline{\theta})(1-\rho)w$$

where the last equality follows from the fact that $k_n + k_t = w$.

Substituting this above and solving for k_t, yields

$$k_t = \frac{w}{2}\left(\frac{\rho(R_t+1)(1-\underline{\theta}) + 1 - (1-\underline{\theta})R_t}{1-(1-\underline{\theta})R_t}\right) > \frac{w}{2}.$$

We are in the wasted collateral region where $L = 1$ if two conditions are satisfied: (1) if,

$$I_n \leq \frac{1-\rho}{\rho}\underline{\theta} R_t k_t$$

and (2) if,

$$I_n < k_n$$

Substituting in for k_t and rewriting inequality (1),

$$\frac{\underline{\theta}}{1-(1-\underline{\theta})R_t} \leq \frac{1-\rho}{\rho}.$$

The RHS varies from 0 to ∞ as ρ falls from 1 to 0. The LHS is bounded and always greater than zero. Thus there exists ρ^* such that $\rho < \rho^*$ implies that (1) holds. The complement, $\rho > \rho^*$, gives us the fire sale region.

Both region 2 and region 3 are possible when $\rho > \rho^*$. We show next that it is not possible to jump from region 1 to region 3, so that the fire sale of region 2 can occur. The optimality condition at date 0 is,

$$\hat{P}\underline{\theta} + (1-\underline{\theta})P) = \underline{\theta} + (1-\underline{\theta})\phi$$

rewriting,

$$\underline{\theta}(\hat{P}-1) = (1-\underline{\theta})\phi(1-P)$$

It easy to show the following: $\hat{P}$ and P are continuous, monotone decreasing functions of $\frac{k_n}{k_t}$; ϕ is a continuous, increasing function of $\frac{k_n}{k_t}$. This ensures that equilibrium is unique in the fire sale region.

The collateral premium is $L = \frac{\hat{P}}{P}$. In region 3, this becomes $L = R_n/e > 1$. In order to jump from region 1 to region 3, we must have that L jump from 1 to R_n/e. However, continuity of the optimality condition with respect to ρ means that this is not possible.

Finally, $\rho < \rho^*$ ensures that we are not in the fire sale region. However, for small enough shocks (e.g. $\rho = 0$), inequality (2) may be violated. A sufficient, but not necessary, condition for (2) to always hold is that,

$$R_t(1-\underline{\theta}) \leq \frac{1}{3}$$

6.2 Returns

Some basic assumptions on returns which we have not stressed in the paper are required. To ensure that investments be positive NPV at date 0, both $R_n(1-\rho)$ and $R_t(1-\rho)$ must be greater than one. We also require that, when firms are able to borrow, the multipliers on internal collateral be bounded. In other words,

$$1-(1-\theta_n)R_n > 0$$

and,

$$1-(1-\theta_t)R_t(1-\rho) > 0.$$

We have also assumed throughout the paper that $R_n/e > 1$ so that saving a distressed unit is always a positive NPV project.

In the wasted collateral region we have that,

$$\hat{P} = \frac{R_n}{eR_t} = 1$$

rewriting,

$$\frac{R_n}{e} = R_t > 1$$

which verifies the assumption.

In the fire sale region, we must have that,

$$\underline{\theta}(\hat{P}-1) = (1-\underline{\theta})\phi(1-P)$$

Since $\hat{P} > P$, it must be that $\hat{P} > 1$ and $P < 1$. Therefore,

$$\frac{R_n}{e} > R_t > 1$$

which again verifies the assumption.

6.3 Incentive Constraints

We have appealed to agency conflicts in order to justify the assumption that entrepreneurs be required to retain a fraction of their shares. One possible formulation to justify this illiquidity assumption is as follows.

Consider a contract between a firm and a lender at date 0. Suppose that a firm investing one unit at date 0 yields date 2 flows of $\tilde{R}_t$ where $E[\tilde{R}_t] = R_t$, and the support of $\tilde{R}_t$ is $[0, \infty)$. Now assume that the realization of $\tilde{R}_t$ is private information of the firm. A lender can observe this payment only by paying a cost of c (in units of T-good). Then, it is fairly standard to show that an optimal contract will be a debt contract (see Gale and Hellwig (1985)). The contract will specify a face of f; if $\tilde{R}_t > f$ the firm makes the repayment of f; otherwise, the firm defaults and lenders pay the audit cost and receive $\tilde{R}_t - c$.

Assume that each firm has a continuum of such projects each with i.i.d. return of $\tilde{R}_t$. Each project is individually financed via a debt contract. Then define,

$$\theta_t = \frac{E[\tilde{R}_t - f | \tilde{R}_t > f] Prob[\tilde{R}_t > f]}{R_t} < 1$$

This is the share of each firm that the entrepreneur necessarily holds. Lenders receive expected flows of,

$$E[\tilde{R}_t - c | \tilde{R}_t < f] Prob[\tilde{R}_t < f] + f Prob[\tilde{R}_t > f]$$

scaled by R_t this is,

$$\frac{E[\tilde{R}_t - f | \tilde{R}_t < f] Prob[\tilde{R}_t < f]}{R_t} - c\frac{Prob[\tilde{R}_t < f]}{R_t} + f Prob[\tilde{R}_t > f] = 1 - \theta_t - c\frac{Prob[\tilde{R}_t < f]}{R_t}$$

This is the component of firms that can be held by outsiders. In our formulation we have suppressed the cost c, so that this component is simply the complement of what the firm holds itself. However, this makes no qualitative difference to the problem.

6.4 Domestic and International Collateral

Throughout the paper, we have assumed that international collateral is restricted to shares on the T-sector. While justified in many instance, this assumption is often violated - the most prominent example being the ADRs on Telecoms and Utilities. Thus, a natural question to pose is how sensitive are our results to the assumption that all N-shares are purely domestic collateral. Two basic results have been stressed the paper. First, a shortage of international collateral generates a fire sale at date 1. In terms of asset prices, we have interpreted the fire sale in two ways: an excessive date 1 real exchange rate depreciation and a fall in the value of non-tradeable shares. Second, we have shown that there is an externality that leads to underinvestment in the tradeable sector - or too little international collateral creation.

The purpose of this section is two-fold. First, we introduce a small "dividend" on production at date 1 and a corresponding consumption decision at this date in order to pin down the extent of exchange rate depreciation and rise in domestic interest rates. Second, we break the strict connection between domestic collateral and N-shares by assuming that a fraction of the N sector is also international collateral. The remaining N-shares ("small domestic firms") remain purely domestic collateral.[46] We show that even under this assumption, the fire sale region naturally yields a large fall in the price of N-shares and a large real exchange rate depreciation. In addition, the basic externality in collateral creation is preserved. The important auxiliary assumption that is needed is an asymmetry in the goods market: foreigner never accept N-goods as payment, but always accept T-goods. In other words, at date 1 N-goods count only as domestic collateral while T-goods count as both domestic and international collateral.

Consumption at Date 1

Extend preferences to include consumption at date 1,

$$u^d = (c_{n,1}c_{t,1})^{\frac{1}{2}} + (c_{n,2}c_{t,2})^{\frac{1}{2}}$$

As before, given aggregate domestic consumption at dates $d = 1, 2$ of $C_{n,d}$ and $C_{t,d}$, we have that,

$$e_d = \frac{C_{n,d}}{C_{t,d}}$$

Suppose that given production choices of k_n, k_t, a dividend is generated at date 1 of $D_n k_n$ N-goods and $D_t k_t$ T-goods to each firm. We assume that these goods are perishable.

[46] A trivial extension is to add "small" T-firms, whose shares do not constitute international collateral. Indeed, by introducing enough of these, we can go back and rely only on the "home-bias" —as opposed to the N-bias— finding as our primitive assumption driving the wedge between domestic and international collateral.

However, while N-goods must be consumed by domestics, T-goods can be sold to foreigners to generate resources to finance the production shock.

Consider now the problem of a sound firm. It has resources of goods at date 1, and shares at date 2 in each sector. Let the fraction of N-shares that is international collateral be f. Then its liquid resources at date 1 in units of T-goods is,

$$\begin{aligned} w^s &= k_n(D_n/e_1 + (1-\rho)(1-\theta_n)fR_n/e_2 + \\ &\quad (1-\rho)(1-\theta_n)(1-f)PR_t/e_2) + k_t(D_t + (1-\rho)(1-\theta_t)R_t) \end{aligned}$$

and illiquid wealth at date 2 of N-goods of $\theta_n R_n k_n$ and T-goods of $\theta_t R_t k_t$. Given this, the firm chooses expenditures of E_1 and E_2 at each date to maximize,

$$\begin{aligned} \max \quad & E_1 e_1^{\frac{1}{2}} + E_2 e_2^{\frac{1}{2}} \\ s.t. \quad & E_1 + E_2/L = w^s + (\theta_n R_n k_n/e_2 + \theta_t R_t k_t)/L \\ & E_2 \geq \theta_n R_n k_n/e_2 + \theta_t R_t k_t \end{aligned}$$

The F.O.C. for this is,

$$\frac{1}{L} e_1^{\frac{1}{2}} = e_2^{\frac{1}{2}} + \lambda$$

where $\lambda \geq 0$ is the multiplier on the second constraint.

$$\left(\frac{e_1}{e_2}\right)^{\frac{1}{2}} \geq L$$

In the wasted collateral region, we know that $L = 1$ and that the second constraint will not bind. Thus it must be that $e_1 = e_2$. When $L > 1$ in the fire sale region, we have that $e_1 > e_2$, or the real exchange rate is excessively depreciated at date 1.

The problem for a distressed firm is similar to the case of only date 2 consumption, with suitable modifications of liquid and illiquid resources. Consider, however, the aggregate collateral constraint. The amount of international collateral must be modified to include date 1 T-goods as well as claims on date 2 N-shares which are international collateral. Thus,

$$I_n \leq k_t D_t + (1-\rho)(1-\theta_t)k_t R_t + (1-\rho)(1-\theta_n)fk_n R_n/e_2$$

The economy can finance a production shock by selling resources at date 1 and resources at date 2. Suppose it sells $I_{n,1}$ at date 1 and $I_{n,2}$ at date 2, then (1),[47]

$$I_{n,1} \leq k_t D_t$$

and (2),

$$I_{n,2} \leq (1-\rho)(1-\theta_t)k_t R_t + (1-\rho)(1-\theta_n)fk_n R_n/e_2$$

[47] We have suppressed the aggregate resource constraint at date 2, that $I_{n,2} \leq R_t k_t(1-\rho)$.

Note that while it can sell all of its resources at date 1, its sale of date 2 resources depends on θ. Given these choices,

$$\begin{aligned} C_{n,1} &= D_n k_n \\ C_{t,1} &= D_t k_t - I_{n,1} \\ C_{n,2} &= (1-\rho)k_n R_n + (I_{n,1} + I_{n,2})k_n R_n \\ C_{t,2} &= (1-\rho)k_t R_t - I_{n,2} \end{aligned}$$

In the model with consumption at both dates, the analogy to wasted collateral is that,

$$\frac{D_n k_n}{D_t k_t - I_{n,1}} = e_1 = e_2 = \frac{(1-\rho)k_n R_n + (I_{n,1} + I_{n,2})k_n R_n}{(1-\rho)k_t R_t - I_{n,2}}$$

while in a fire sale,

$$\frac{D_n k_n}{D_t k_t - I_{n,1}} > \frac{(1-\rho)k_n R_n + (I_{n,1} + I_{n,2})k_n R_n}{(1-\rho)k_t R_t - I_{n,2}}$$

Consumption smoothing dictates that $e_1 = e_2$, or that the economy balances its sale of T-goods at both dates 1 and date 2. However, if θ_t is very high (and f low), the economy is unable to sell sufficient claims on consumption at date 2 and (2) will bind. The result is that $e_1 > e_2$. It follows closely that in the fire sale region we will have $L > 1$, since claims on date 2 consumption that can be sold to foreigners carry a premium over purely domestic collateral. In addition, it must be that both the N shares that is international collateral as well as the T-shares that are international collateral carry this premium. The fire sale is restricted to domestic collateral, which in this case will be N-shares that are not international collateral and the date 1 N-goods (manifest as the exchange rate depreciation at date 1).

Consider next the price of a claim on the non-tradeable sector. In this formulation the N-shares that are international collateral and the domestic N-shares will have different prices. While, as in the main text, it is clear that domestic N-shares will fall in price (fire sale), with consumption at date 1, the international N-shares will also fall in price.[48] To see this, consider a bond that is issued by such a firm which pays a dividend at each of dates 1 and 2 of one unit of N-good. The cum-dividend price of such a bond will be,

$$P^n = \frac{1}{e_1} + \frac{1}{e_2}$$

If the economy is not in a fire sale, then $e_1 = e_2 = e$ and,

$$\overline{P}^n = \frac{2}{e}$$

[48]The decline in the latter's price is not a fire sale, in the sense that the price is still equal to the present value of dividends. Still, its decline is excessive in the Kiyotaki and Moore (1997) sense.

Now, consider the following experiment. Suppose we increase θ_t until the point that the fire sale constraint (2) on sale of date 2 consumption is exactly binding. A fire sale occurs if θ_t is increased further, as the economy is not able to smooth its consumption of T-goods across time. We can calculate the effect of such an increase on P^n be evaluating how a small reallocation in consumption between these dates will affect the exchange rates and thereby prices. As such, suppose consumption at date 1 is decreased by dC and that at date 2 is increased by dC. Then,

$$P^n = \overline{P}^n - \frac{dC}{e}\left(\frac{1}{C_{t,1}} - \frac{1}{C_{t,2}}\right)$$

If $C_{t,2} > C_{t,1}$, then the expression in parentheses is positive so that the price of N-shares falls in the fire sale region. Constraints in an emerging economy will usually mean that there are more resources available in the future than in the present (but liquidity issues prevents financing a consumption increase in the present), thus this inequality will naturally hold. The economy would rather finance a production shock by selling claims on future consumption than claims on present consumption. Inability to do this causes a severe exchange rate depreciation at date 1. Dividend on N shares are just N-goods, and the value of these falls due to this depreciation resulting in a fall in share prices. Note that this fire sale effect is over and above the fall caused by a depreciation in both e_1 and e_2 due to the sale of T-goods to finance a shock.[49]

Consider next the externality that leads to too little international collateral creation and underinvestment in the T-sector. The logic now is exactly as before. In the fire sale region, provisions of international collateral will receive a yield of L. However, the social return is still $\frac{R_n}{e}$. Divergence in these returns leads to the externality. Investment in N-sector that is international collateral is beneficial, however, this investment is packaged with a flow of date 1 N-goods that is only domestic collateral.

6.5 Banking

This subsection sketches more formally the role and potential collapse of a banking system. Let us introduce banks whose main role is that they can invest in the N-sector at either of date 0 and date 1 and raise foreign funds against these assets. Thus banks are a conduit through which foreigners can invest in the N-sector. However in order to raise funds from foreigners at date 0, we assume that banks must standby to provide liquidity in case of early (date 1) withdrawals by foreigner. This is accomplished by selling foreigners a claim with

[49] An extension of the above by adding consumption and dividends at dates $d \in [1,2]$ along the lines of Kiyotaki and Moore (1997) may amplify this price drop. The exchange rate at each date will be depreciated in a fire sale, this in turn will mean that dividends will be less valued at each date and their present value (the share price) will fall.

the option to redeem this claim at par at date 1.[50] One way of thinking about short versus long term debt, a central issue during crises, is to think of the former as foreign investments with an option to redeem.

The bank holds $k_n\theta_{B,n}$ shares of the N-sector at date 0. Against this, it issues claims whose face value is $R_n k_n \theta_{B,n}/e$ in units of date 2 T-goods. If any foreigner wishes to withdraw at date 1, the bank simply sells its N-shares to another firm in the domestic economy for T-shares and gives these T-shares to the foreigner.

The assets of the bank, in units of T-shares is therefore,

$$Pk_n\theta_{B,n}$$

while the liability of the bank at date 1 in units of date 1 T-shares is,

$$\frac{R_n}{eR_t}k_n\theta_{B,n} = \hat{P}k_n\theta_{B,n}$$

A fire sale occurs if P falls below $\hat{P}$. Each foreign investor then has a choice. If he does not withdraw funds, the bank remains solvent, as the fall in P is greeted by an appreciation between date 1 and date 2. However, if the investor conjectures that other investors withdraw funds, then he too will withdraw funds. This has two effects. First the bank fails at date 1 and is therefore unable to provide any additional funds to the N sector. Second, the foreign withdrawals imply that banks need to buy T-shares, which further contracts the supply of scarce international collateral and the fuels the fire sale process.

[50] These contractual features follow the model of Diamond-Dybvig (1983). See that model for a justification of the optimality of the banking contract.

References

[1] Aizenman, Joshua, "Country Risk, Incomplete Information and Taxes on International Borrowing," *Economic Journal 99*, March 1989, pp. 147-161.

[2] Bardhan, Pranab K., "Optimum Foreign Borrowing," in Karl Shell, ed., *Essays on the Theory of Optimal Economic Growth,* Cambridge, Mass., MIT Press, 1967, pp. 117-128.

[3] Bhattacharya, Sudipto, and Gale, Douglas M., "Preference Shocks, Liquidity, and Central Bank Policy", Barnett, William A., ed.; Singleton, Kenneth J., ed.. *New pproaches to monetary economics: Proceedings of the Second International Symposium in Economic Theory and Econometrics.* International Symposia in Economic Theory and Econometrics series Cambridge; New York and Melbourne: Cambridge University Press 1987, pp. 69- 88.

[4] Borensztein, Eduardo, and Atish R. Ghosh, "Foreign Borrowing and Export Promotion, *IMF Staff Papers, 36-4*, December 1989, p. 904-932.

[5] Bulow, Jeremy and Rogoff, Kenneth, "A Constant Recontracting Model of Sovereign Debt", *Journal of Political Economy 97-1*, February 1989, pp. 155-78.

[6] Calvo, Guillermo A., "Balance of Payment Crises in Emerging Markets," mimeo, Maryland, January 1998.

[7] Cavallo, Domingo, "A Comment," in *Volatile Capital Flows: Taming Their Impact on Latin America,* ed. by R. Hausmann and L. Rojas-Suarez, IDB, Washington DC, 1996, pp. 45-48.

[8] Chan-Lau, Jorge A., and Zhaohui Chen, "Financial Crisis and Credit Crunch as a Results of Inefficient Financial Intermediation-with Reference to the Asian Crisis," mimeo IMF, August 1998.

[9] Chang, Roberto and Andres Velasco, "Financial Crisis in Emerging Markets: A Canonical Model," mimeo Atlanta FED, July 1998a.

[10] Chang, Roberto and Andres Velasco, "The Asian Liquidity Crisis," mimeo Atlanta FED, July 1998b.

[11] Diamond, Douglas W. and Dybvig, Philip H., "Bank Runs, Deposit Insurance, and Liquidity," *Journal of Political Economy 91-3,* June 1983, pp. 401-19.

[12] Cole, Harold L., and Timothy J. Kehoe, "A Self-Fulfilling Model of Mexico's 1994-95 Debt Crisis," Minneapolis FED, Research Staff Report 210, April 1996.

[13] French, Ken and James Poterba, "Investor Diversification and International Equity Markets," *American Economic Review 81*, 1991, pp. 222-226.

[14] Gale, Douglas and Martin Hellwig, "Incentive Compatible Debt Contracts: The One-Period Problem" *Review of Economic Studies 52(4),* October 1985, pp. 647-63.

[15] Giavazzi, Francesco and Marco Pagano, "Confidence Crises and Public Debt Management," in *Public Debt Management: Theory and History,* ed Rudiger Dornbusch and Mario Draghi. Cambridge Univesity Press, p.94-118.

[16] Goldfajn, Ilan and Rodrigo O. Valdes, "The Twin Crises and the Role of Financial Intermediation," IMF mimeo, August 1998.

[17] Harberger, Arnold, "Lessons for Debtor-Country Managers and Policymakers," in J.Cuddington and G.Smith (eds.), *International Debt and the Developing Countries.* Washington: World Bank, 1985.

[18] Holmstrom, Bengt and Tirole, Jean, "Private and Public Supply of Liquidity," *Journal of Political Economy 106-1,* February 1998, pp. 1-40.

[19] Jacklin, Charles J., "Demand Deposits, Trading Restrictions, and Risk Sharing," Prescott, Edward C., ed.; Wallace, Neil, ed.. Contractual arrangements for intertemporal trade. Minnesota Studies in Macroeconomics series, vol. 1 Minneapolis: University of Minnesota Press 1987, pp. 26-47.

[20] International Monetary Fund, "International Capital Markets: Developments, Prospects, and Key Policy," in *World Economic and Financial Surveys,* directed by Charles Adams, Donald J. Mathieson, Garry Schinasi, and Bankim Chadha, 1998.

[21] Johnson, Simon, Peter Boone, Alasdair Breach, and Eric Friedman, "Corporate Governance in the Asian Financial Crisis, 1997-98," MIT mimeo, September 21, 1998.

[22] Kang, Jun-Koo and Rene M. Stulz, "Why Is There Home Bias? An Anlysis of Foreign Portfolio Equity Ownership in Japan," *Journal of Financial Economics 46-1*, October 1997, pp. 3-28.

[23] Kiyotaki, Nobuhiro and Moore, John, "Credit Cycles," *Journal of Political Economy, 105-2*, April 1997, pp. 211-48.