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Internal Debt Crises and Sovereign Defaults*

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ABSTRACT

In this paper we provide a novel explanation of debt crises in emerging markets. In our model, crises arise because of the inability to punish private debtors when many of them default at the same time. We construct an optimal contracting model in which a successful entrepreneur repays the domestic lender yet an unsuccessful one defaults and liquidates his assets. However, the inability to liquidate extensive asset quantities generates the possibility of a second equilibrium with coordinated defaults, in which domestic borrowers find it optimal to default because all other borrowers are also defaulting. During coordinated default crises, the government's tax collections fall and thus it cannot pay the international lender in full. The model shows that, given tight aggregate constraints on liquidation, joint debt crises are an inevitable part of an optimal response to informational problems in private-sector lending.

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1. Introduction

Developing countries experience recurrent financial crises in which private debtors do not pay their private debts and sovereign governments do not pay their international debts. In this paper, we provide a novel explanation of these events. The main idea of the paper is that crises arise because of the inability to punish private debtors when many of them default at the same time. The crisis is generated by a simple self-fulfilling belief: If all debtors know that all other debtors are going to default, then they all know that they face a small sanction for doing so. During the crisis, government's net tax collections fall which can lead to sovereign default.

The model is motivated by evidence from developing countries that during financial crises, defaulters' assets are not seized by creditors due to weak bankruptcy institutions. For example, during the Mexican crisis of 1995, the country developed what many Mexicans called the "cultura de no pago" or a culture of non-payment in which few debtors paid their creditors. Creditors were unable to seize the assets of non-performing loans because the courts lacked the capabilities and guidance to manage the systemic bankruptcies effectively.[1] At the same time, debtors organized themselves into a powerful group, "Barzon," and exercised pressures halting any possibility of bankruptcy reform.[2]

Countries in East Asia during the 1997 crisis also exhibited fundamental weaknesses in their bankruptcy mechanisms and their judicial system. For example, initially in Indonesia only courts handled liquidations of failing firms. But as courts quickly became overloaded, the Jakarta Initiative Task Force (JITF) was created as a way to allow for less formal workouts. However, both the court system and the JITF had very limited success in expediting the process of non-performing loans. By October 1998, only 69 cases were settled of the 462 cases filed in courts and JITF. Thus, firms were allowed to run even when they were not

[1] "Many loans were written off because of issues directly related to the inefficient judicial procedures that involved the recovery of loans from bankrupted companies. The legal framework proved to favor debtors over creditors. Thus, it was not surprising to observe an excessive number of companies filing for bankruptcy, even when they were not in financial distress" (Sidaoui, 2005, Bank of International Settlements p. 278).

[2] Halac and Schmukler (2004) provide evidence of similar situations arising in the crises of Chile in 1981–83, Mexico in 1994–95, Ecuador in 1998–2000, Argentina in 2001–02, and Uruguay in 2002. During these crises large borrowers "quit paying their debts, expecting the government to bear the costs and anticipating no serious consequences for their actions" (Halac and Schmukler, 2004, p. 8). See also Krueger and Tornell (1999) for more details of the crisis in Mexico.

paying their debts.[3]

This evidence suggests that an important feature of systemic crises is the inability (or unwillingness) to punish a large number of defaulters. This paper develops a model where the inability to punish a large number of bankrupt debtors is the source of the crisis itself.

Our model has the following elements. There is a benevolent government in a small open economy which borrows from foreign risk-neutral lenders to buy public goods. At the same time, a small number of domestic risk-averse entrepreneurs borrow from domestic risk-averse lenders to buy capital goods for use in a productive investment opportunity. The domestic entrepreneurs' investment returns are a binary random variable that may equal zero with positive probability; returns are, ex-post, known only to the entrepreneur. The government imposes lump-sum taxes on domestic lenders in order to finance its repayments to the foreign lenders.

Liquidation plays a key role in the model. The entrepreneur's capital goods can be liquidated to become consumption goods, but liquidation involves a social loss.[4] We focus on equilibrium loan contracts which specify repayment/liquidation as a function of the entrepreneurs' declarations of success or failure. In an equilibrium contract, a successful entrepreneur will make a payment to the lender without any liquidation. In contrast, an unsuccessful entrepreneur will liquidate some of his capital, and use that to make a payment to the lender. Thus, equilibrium contracts look like standard debt contracts, with default provisions.

The key assumption of the model is that there is an upper bound on the *total* amount of capital that can be liquidated. Hence, if many entrepreneurs default, the lender can only liquidate a small amount of capital from each of them. We show that if the upper bound on aggregate liquidation is sufficiently tight, then a positive probability non-fundamental shock (a sunspot) can generate what we term a *coordinated default crisis*. In this crisis, domestic entrepreneurs use the non-fundamental shock to coordinate on a default decision,

[3]The general sentiment in countries in South East Asia during the 1997 crisis was that "the organizational capacity and human resources of the court appeared insufficient to meet the extraordinary demand for debt settlement posed by massive bankruptcies" (Insolvency Systems in Asia: An Efficiency Perspective, OECD Report, 2001, p. 57).

[4]This approach to designing an optimal loan repayment contract with default is similar to that taken by Diamond (1984) and Rampini (2005).

even if they have been successful. During coordinated default crises, successful entrepreneurs default because they know that sanctions will be small given that all other entrepreneurs will also default.

The massive default means that the domestic lenders cannot pay their taxes. Without these tax payments, the sovereign cannot repay the foreign lender in full. Indeed, in these crises, it may well be optimal (for risk-sharing reasons) for the foreign lender to make transfers to the sovereign. The government will then give those transfers to the domestic lenders.

The existence of coordinated default crises in our model is an example of what is called an *implementation problem* in the optimal contracting literature. In our model, an equilibrium contract generates a reporting game between entrepreneurs by specifying repayments and liquidations as a function of the joint reports of the entrepreneurs about their outcomes. In one equilibrium of this game, both entrepreneurs tell the truth, and induce a constrained Pareto optimal allocation of resources. The key property of our model is that, under some parameter settings, the equilibrium contract allows for a second equilibrium in the reporting game in which both lie. The resultant equilibrium outcome is not constrained Pareto optimal.

We show that in our model sovereign and domestic defaults occur simultaneously and that the rates of return of these two debt classes move together reflecting default risk. We document that these predictions are borne out in data from emerging markets. In particular, we find that ex-ante measures of domestic private sector default risk are positively correlated over time with sovereign default risk in emerging markets. We also demonstrate that in these countries, sovereign defaults are often associated with large numbers of domestic defaults, such as bank insolvencies and non-performing bank loans.

Related Literature

There is a large literature on implementation problems in contractual design. Our paper is most related to the recent contributions of Bassetto and Phelan (2008) and Bond and Hagerty (2007). As in our paper, their implementation problems emerge because society's ability to provide a negative incentive to a given player depends on the number of players who are also supposed to receive such incentives. More concretely, Bassetto and Phelan hypothesize that the probability of any given taxpayer's being audited falls if all taxpayers

claim to have low incomes. Under this hypothesis, there is an equilibrium in which all taxpayers choose to default on their tax obligations, regardless of their true incomes. Bond and Hagerty assume that resources for crime enforcement cannot be adjusted in response to the level of crime. Again, this technological restriction generates a second inferior equilibrium with large amounts of crime.

Our paper is also related to the literature that discusses how financial frictions can generate and exacerbate international financial crises. The papers in this literature have modeled a wide variety of financial frictions. Several papers emphasize that, especially in bad times, domestic banks/borrowers may run short on collateral that is acceptable to foreign lenders (Calvo (1998); Caballero and Krishnamurthy (2001); Chang and Velasco (2001)). Without this collateral, domestic agents face what is often termed a *sudden stop* to their borrowing from abroad.

Our paper differs from this prior literature on financial frictions in two important respects. First, in these earlier papers, the various crises emerge because some assets, such as non-tradable debt or long-term debt, are illiquid or non-marketable. In many cases, this illiquidity is assumed to exist and is the reason for the crisis. In our paper, crises arise because of limits to provide repayment incentives to borrowers when many are in default at the same time. The "insufficient incentives" mechanism of this paper stands as a stark alternative to the "insufficient liquidity" mechanism emphasized in the literature. This is especially relevant considering the evidence that during emerging markets crises, defaulting borrowers are the ones that gain the most due to weak bankruptcy institutions.

Second, the existing literature points to government's bad policies in the form of bailout guarantees as being a source of crises (Eaton (1987); Burnside, Eichenbaum and Rebelo (2004); Schneider and Tornell (2004)). We construct a contractual arrangement that is Pareto optimal, given the upper bound on liquidation. In this environment, government bailout guarantees can be part of an ex-ante optimal arrangement. Intuitively, private agents interact with foreign lenders/insurers only through their government. Because the foreign lenders are risk-neutral, they provide transfers of resources to the home country when the country is doing poorly. These transfers flow through the government to the private sector. They are, in fact, (partial) bailouts. Analyzing debt crises within an optimal contracting

structure allows us to pinpoint precisely the source of crises. Within our framework, improving legal institutions domestically to resolve large-scale defaults is the only way to reduce the probability of crises.

Finally, our paper is related to the literature on sovereign default. Although some sovereign default episodes can be rationalized using movements in output or other fundamentals (see Aguiar and Gopinath (2006) and Arellano (2008) for such an account of the recent sovereign default episode in Argentina), it is widely recognized that the connection between sovereign defaults and economic fundamentals is, at best, loose.[5] Without a convincing fundamental explanation available, other economists have turned, as we have, to a non-fundamental one where debt crises are attributed to *panics* or more general forms of coordination failures among foreign lenders. Cole and T. Kehoe (2000) for example emphasize that sovereign debtors might default when foreign lenders refuse to roll over its debt because they believe other lenders may also refuse to do so.

A major problem with this external debt crisis explanation of sovereign debt crises is its emphasis on the behavior of foreign lenders. But sovereign debt crises do not affect all borrowing countries - just developing ones. The external debt crisis theory does not tell us why this difference in the characteristics of the borrower should affect the prevalence of crises. Our theory does: developing countries cannot seize enough assets from borrowers when large numbers of them are in default.

The distinction between our new theory and the existing theories is not of purely academic interest. If debt crises arise due to limited liquidity of certain assets, the International Monetary Fund can provide support in terms of a lender of last resort, as argued in Corsetti, Guimaraes, and Roubini (2006). And if debt crises arise due to coordination failure of external lenders, the IMF can adopt policies that curtail these panics, as argued in a series of policy papers by Sachs (1997), Krugman (1998), Chari and P. Kehoe (1998), Fischer (1999), and Krueger (2002). However, when limited incentives for repayment are the key problem, the IMF and other international agencies really play no useful role. According to our theory, developing countries have debt crises because their process of domestic debt repayment is

[5]For example, Tomz and Wright (2006) document that 38 percent of default episodes since 1820 have occurred when countries had GDP levels above trend.

highly strained when faced with large numbers of domestic defaults. We model this limitation as purely technological. More realistically, developing countries can achieve better outcomes by improving the efficacy of their bankruptcy institutions to deal with potential large-scale defaults.

2. The Model: Environment and Equilibrium

We construct a simple model of domestic and foreign lending. We then characterize equilibrium contracts in this setting.

A. Environment

We consider a small open economy. Within this country, there is a domestic lender, who is endowed with two units of investment goods in period 1. The domestic lender has a technology that converts these goods into $2R$ units of consumption goods in period 2, where $R > 1$; this technology will serve as the lender's outside option. We think of this domestic lender as being any agent within the country who contributes resources to investment. In this sense, bank depositors are domestic lenders.

There are also two entrepreneurs. Entrepreneur n has a technology that converts 1 unit of investment goods in period 1 into R_n units of consumption goods in period 2. Here, R_n, $n = 1, 2$, are i.i.d. random variables, with realizations that are determined at the beginning of period 2. With probability $(1 - p)$, R_n equals $R^H > R > 0$ and with probability p, its realization is $R^0 = 0$. There is a key informational restriction in this setting: the realization of R_n is privately known to entrepreneur n, and the entrepreneur has the ability to consume the project return secretly.

Entrepreneurs also have a technology that liquidates invested capital in period 2. If L units of capital are liquidated, then it generates δL units of consumption goods, $0 \leq \delta \leq 1$. We assume throughout that $0 \leq L \leq 1$, so that liquidation is bounded by the entrepreneur's total capital investment. Entrepreneurs, but not lenders, derive consumption benefits from the $(1 - L)$ units of unliquidated capital. Those consumption benefits equal $B_E(1 - L)$ units of consumption.

The domestic lender has a utility function u_L over consumption goods. The utility functions u_L and u_E satisfy the properties $u'_L, u'_E, -u''_L, -u''_E > 0$, and $u_L(0) = u_E(0) = 0$.

Both functions exhibit non-increasing absolute risk aversion. The consumptions of the lender and entrepreneurs of every good are restricted to be non-negative.

In addition to the three agents, there is a government. The government is able to borrow and lend from foreign lenders at a gross rate of return $R^{FOR} > 1$. The government needs to create an amount G of public goods in period 1. It does so by borrowing G units of consumption goods in period 1 from an international debt market, and then transforming them, one for one, into the required public goods. It repays this loan in period 2, using taxes τ collected from the domestic lender.

The key to the model is that we impose a non-trivial upper bound on aggregate liquidation. We assume that total liquidation is bounded from above by ξ, where $1 \leq \xi < 2$. This constraint says that if both entrepreneurs default, it is not possible to take more than $\xi/2$ from either of them. As we shall see, this upper bound on liquidation lies at the heart of the model.[6]

Note that the model is designed to be as simple as is possible, given the issues that we want to analyze. We need a government and a foreign lender, because we want to include international sovereign borrowing in the model. We need a domestic lender, because we want to include private domestic borrowing/lending in the model. Finally, we need more than one entrepreneur in the model in order to get the possibility of a coordination problem of some kind.

B. Equilibrium

In period 2, the two entrepreneurs simultaneously announce their returns. There are four possible outcomes for these announcements. At the beginning of period 1, the government chooses a tax schedule $(\tau_s)_{s\in\{0,1,2\}}$, where τ_s is the domestic lender's tax payment when s entrepreneurs claim to have high returns. The government's goal is to maximize a weighted sum of the expected utilities of the entrepreneurs and the domestic lender.

After the government commits to a tax schedule, the domestic lender commits to a loan

[6] This technology assumes that it is impossible to liquidate more than ξ units of capital. We can generalize our main results to an alternative liquidation technology in which the domestic lender receives $\delta \min(\xi, L)$ units of consumption when L units of capital are liquidated. This allows more than ξ units of capital to be liquidated, but doing so is pure social waste.

contract (F, L) at the beginning of period 1. Under this contract, if in period 2 entrepreneur 1's announced return is R^i and entrepreneur 2's announced return is R^j, then entrepreneur 1's repayment is F_{ij} and entrepreneur 1's liquidation is L_{ij}. Symmetrically, entrepreneur 2's repayment is F_{ji} and entrepreneur 2's liquidation is L_{ji}. The upper bounds on liquidation and lower bounds on consumption of each good imply that for all (i, j) in $\{H, 0\}^2$:

$$
\begin{aligned}
& F_{ij} \leq R^i \\
(1) \qquad & 1 \geq L_{ij} \geq 0 \\
& L_{ij} + L_{ji} \leq \xi
\end{aligned}
$$

The Revelation Principle says that, without loss of generality in terms of equilibrium outcomes, we can focus on loan contracts that satisfy the incentive-compatibility condition:

$$
\begin{aligned}
(2) \qquad & (1-p)u_E(B_E\,(1-L_{HH}) + R^H - F_{HH}) + pu_E(B_E\,(1-L_{H0}) + R^H - F_{H0}) \\
\geq \; & (1-p)u_E(B_E\,(1-L_{0H}) + R^H - F_{0H}) + pu_E(B_E\,(1-L_{00}) + R^H - F_{00})
\end{aligned}
$$

Intuitively, entrepreneurs send simultaneous announcements of their returns to the lenders. These incentive-compatibility conditions guarantee that truth-telling is a Bayesian-Nash equilibrium of this reporting game. We ignore the incentive-compatibility conditions for entrepreneurs with zero returns; they turn out to be irrelevant in equilibrium.

While the model has only one active domestic lender, we suppose that there is potential competition that forces the domestic lender to deliver all surplus to the entrepreneurs. This potential competition implies that, regardless of the government's choice of tax schedule, the domestic lender gets only the reservation utility $u_L(2R)$. (More specifically, if the lender gets more than that, a potential competitor will offer a loan contract with a lower F_{HH}.) Hence, an *equilibrium contract* (τ, F, L) maximizes the utility of the entrepreneurs, and is any solution to the optimization problem:

$$
\begin{aligned}
\max_{(\tau,F,L)} \; & (1-p)^2 u_E(B_E\,(1-L_{HH}) + R^H - F_{HH}) + p(1-p)u_E(B_E\,(1-L_{H0}) + R^H - F_{H0}) \\
& + p(1-p)u_E(B_E\,(1-L_{0H}) - F_{0H}) + p^2 u_E(B_E\,(1-L_{00}) - F_{00})
\end{aligned}
$$

subject to (1), (2), an individual rationality constraint for the domestic lender:

$$(3) \qquad (1-p)^2 u_L(2(F_{HH}+\delta L_{HH})-\tau_2)+2p(1-p)u_L(F_{0H}+F_{H0}+\delta(L_{0H}+L_{H0})-\tau_1)$$
$$+p^2 u_L(2(F_{00}+\delta L_{00})-\tau_0)=u_L(2R)$$

and a zero-profit constraint for the foreign lenders:

$$(4) \quad (1-p)^2\tau_2+2p(1-p)\tau_1+p^2\tau_0 \geq R^{FOR}G$$

The last constraint says that the government's expected repayments are enough to compensate the foreign lenders for the initial loan of size G.

It is useful to understand when this constraint set is non-empty, so that there is an incentive-compatible contract that is superior to the outside options of the lenders. An entrepreneur who defaults alone can pay the lenders at most δ, while an entrepreneur who defaults with another can pay at most $\delta\xi/2$. Then, incentive-compatibility implies that the lenders can get at most $F_{\max}$ from a successful entrepreneur, where $F_{\max}$ satisfies:

$$u(R^H-F_{\max}+B_E)=pu(R^H)+(1-p)u(R^H+B_E(1-\xi/2))$$

It follows that the constraint set to the optimization problem is non-empty if and only if:

$$(1-p)^2 2F_{\max}+2p(1-p)(F_{\max}+\delta)+p^2\delta\xi \geq 2R+R^{FOR}G$$

Note that it is harder to satisfy this condition with a small value of B_E. The lenders extract resources from successful entrepreneurs only because they lose their capital if they claim to be unsuccessful. Hence, $F_{\max}$ is increasing in the entrepreneur's benefits B_E from unliquidated capital. In particular, the condition is only satisfied if $B_E > 1$.[7]

The following proposition provides a partial characterization of equilibrium contracts.

[7] We refer to the entrepreneurs' liquidating their capital. We can just as easily interpret the "capital" in our model as being "collateral goods", as in Kocherlakota (2001) and Kocherlakota and Shim (2007). Under this interpretation, we can think of B_E as being the entrepreneur's quantity of collateral, and $1/B_E$ as being the lender's marginal valuation of that collateral.

It shows that they look like debt contracts, with partial liquidations by the risk-averse entrepreneurs when they default.

PROPOSITION 1. *Suppose* (τ, F, L) *is an equilibrium contract. Then:*

1. $F_{HH} = F_{H0} > 0$
2. *If* $R^H > F_{HH}$, *then* $L_{HH} = L_{H0} = 0$
3. (τ, F, L) *satisfies the incentive constraint* (2) *with equality*
4. *The zero profit constraint (4) is satisfied with equality*
5. $F_{00} = F_{0H} = 0$
6. $2R = 2(F_{HH} + \delta L_{HH}) - \tau_2 = F_{0H} + F_{H0} + (\delta L_{0H} + \delta L_{H0}) - \tau_1$
   $= 2(F_{00} + \delta L_{00}) - \tau_0$

Proof. **Statement 1:** Suppose $F_{HH} \neq F_{H0}$. Define a new $\widehat{F}$ which is the same as F except $\widehat{F}_{HH} = \widehat{F}_{H0} = (1-p)F_{HH} + pF_{H0}$. Then, the entrepreneurs get higher utility with $(\tau, \widehat{F}, L)$, because of the strict concavity of the objective. As well, $(\tau, \widehat{F}, L)$ satisfies (1)-(4). Hence, in any equilibrium contract, $F_{HH} = F_{H0}$.

Statement 2: The existence of an equilibrium contract implies that $B_E > 1$. If L_{HH} or L_{H0} are positive, we can increase the objective, without violating the constraints, by lowering them by ε while increasing F_{HH} and F_{H0} by ε.

Statement 3: Suppose the third statement is false. Given that the incentive-compatibility constraint does not bind, the first order conditions for the equilibrium problem imply that:

$$\begin{aligned} & B_E(1 - L_{HH}) + R^H - F_{HH} = B_E(1 - L_{H0}) + R^H - F_{H0} \\ = \; & B_E(1 - L_{0H}) - F_{0H} = B_E(1 - L_{00}) - F_{00} \end{aligned}$$

But this violates the incentive constraint:

$$u_E(B_E(1 - L_{HH}) + R^H - F_{HH}) < (1-p)u_E(B_E(1 - L_{0H}) + R^H - F_{0H}) + pu_E(B_E(1 - L_{00}) + R^H - F_{00})$$

Statement 4: If the fourth statement is false, we can lower τ_2 by ε and lower F_{HH} by $\varepsilon/2$ without violating any of the constraints and increasing the objective; hence, in any

equilibrium the zero profit constraint holds with equality.

Statement 5: By (1), F_{00} and F_{0H} are non-positive. To satisfy (2), we need that $F_{0j} + L_{0j} > 0$ for at least one j. Suppose that $F_{0H} < 0$ and $L_{0H} > 0$. Define $(\widehat{\tau}, \widehat{F}, \widehat{L})$ to be a contract that is the same as (τ, F, L) except:

$$\begin{aligned}
\widehat{F}_{0H} &= 0 \\
\widehat{L}_{0H} &= L_{0H} + F_{0H}/B_E \\
\widehat{\tau}_1 &= \widehat{F}_{0H} - F_{0H} + \delta\widehat{L}_{0H} - \delta L_{0H} + \tau_1
\end{aligned}$$

The value of the objective under $(\widehat{\tau}, \widehat{F}, \widehat{L})$ is the same, and constraints (1), (2) and (3) are satisfied. The zero profit condition (4) is slack now:

$$\begin{aligned}
& (1-p)^2\tau_2 + 2p(1-p)\left(\widehat{F}_{0H} - F_{0H} + \delta(\widehat{L}_{0H} - L_{0H}) + \tau_1\right) + p^2\tau_0 \\
= \; & R^{FOR}G - F_{0H}2p(1-p)(1-\delta/B_E) > R^{FOR}G
\end{aligned}$$

From the proof of Statement 4 above, we know that we can now lower τ_2 by ε and lower F_{HH} by $\varepsilon/2$ to improve the entrepreneurs' objective. Hence, if $F_{0H} < 0$, (τ, F, L) cannot be an equilibrium, because $(\widehat{\tau}, \widehat{F}, \widehat{L})$ improves upon it. A similar argument can be used to show that $F_{00} < 0$ cannot be an equilibrium.

Statement 6: Suppose this statement is false. Then, we can define**:**

$$\begin{aligned}
\tau_2' &= 2(F_{HH} + \delta L_{HH}) - 2R \\
\tau_1' &= F_{H0} + F_{0H} + (\delta L_{0H} + \delta L_{H0}) - 2R \\
\tau_0' &= 2(F_{00} + \delta L_{00}) - 2R
\end{aligned}$$

The value of the objective has remained the same, and constraints (1), (2) and (3) are satisfied. Because u_L is strictly concave, we know that the expected value of the domestic

lender's consumption is lower under τ':

$$\begin{aligned} & (1-p)^2(2(F_{HH}+\delta L_{HH})-\tau_2')+2p(1-p)(F_{H0}+F_{0H}+\delta L_{0H}+\delta L_{H0}-\tau_1') \\ & +p^2(2(F_{00}+\delta L_{00})-\tau_0') \\ < \quad & (1-p)^2(2(F_{HH}+\delta L_{HH})-\tau_2)+2p(1-p)(F_{H0}+F_{0H}+\delta L_{0H}+\delta L_{H0}-\tau_1) \\ & +p^2(2(F_{00}+\delta L_{00})-\tau_0) \end{aligned}$$

This implies that:

$$\begin{aligned} & (1-p)^2\tau_2'+2p(1-p)\tau_1'+p^2\tau_0' \\ > \quad & (1-p)^2\tau_2+2p(1-p)\tau_1+p^2\tau_0 \end{aligned}$$

From the proof of Statement 4 above, we know that we can now lower τ_2' by ε and lower F_{HH} by $\varepsilon/2$ to improve the entrepreneurs' objective. QED

The contracts described in Proposition 1 are essentially defaultable debt contracts. An entrepreneur who announces a high return R^H makes a positive repayment to the domestic lender, and his capital is not liquidated. An entrepreneur who announces a low return makes no payment to the domestic lender, and his capital is definitely partially liquidated. Thus, announcing a low return is akin to deciding to default. Note that one entrepreneur's contract depends on the other's default decision only through the level of liquidation. Note too that, conditional on the entrepreneurs' announced returns, there is no way to restructure payments to make all participants better off. In this sense, the equilibrium contracts are renegotiation-proof.

3. The Possibility of Crises

Suppose (τ, F, L) is an equilibrium contract. Given this contract, the two entrepreneurs play a reporting game with one another in which they decide to report 0 or R^H. Given the nature of the equilibrium loan contract, we can interpret these choices as being to "default" or "not to default" respectively. We noted above that the incentive-compatibility conditions guarantee that if a successful entrepreneur chooses not to default, then it is optimal for the other entrepreneur to make the same choice if successful. However, the incentive-compatibility

conditions do not rule out the possibility of other (strict) equilibria in this reporting game between the entrepreneurs. Consider a putative equilibrium in which both entrepreneurs decide to default when in fact they have high returns. This strategy forms a strict equilibrium if:

$$u_E(B_E\,(1-L_{00})+R^H) > u_E(B_E+R^H-F_{H0})$$

(This condition exploits the result in Proposition 1 that $L_{H0}=0$ and $F_{00}=0$ in an equilibrium contract.) In words, this condition says that an entrepreneur, with a high return, finds it strictly optimal to default because he knows that the other entrepreneur is defaulting.[8] We shall call such an equilibrium a *coordinated default crisis,* and refer to contracts that allow for such an equilibrium in the reporting game as being *crisis contracts.*

As the above description suggests, the constraint that caps aggregate liquidations plays a fundamental role in generating crises. In particular, because $F_{00}=F_{0H}=0$, $L_{HH}=L_{H0}=0$, and $F_{H0}=F_{HH}$, we know that in any equilibrium:

$$\begin{aligned} & u_E(B_E+R^H-F_{H0}) \\ = \;& (1-p)[u_E(B_E\,(1-L_{0H})+R^H)]+p[u_E(B_E\,(1-L_{00})+R^H)] \end{aligned}$$

If $L_{0H}\leq L_{00}$, then the equilibrium contract is not a crisis contract, because:

$$u_E(B_E+R^H-F_{H0}) \geq u_E(B_E\,(1-L_{00})+R^H)$$

It follows that crisis contracts arise only because L_{0H} may be higher than L_{00}.

We provide a sharp characterization of the conditions under which equilibrium contracts are in fact crisis contracts. The key to this characterization is to understand when the constraint $L_{00}\leq \xi/2$ binds. We can gain insight into this issue by considering the *relaxed equilibrium contract problem,* which is the equilibrium contract problem without the four state-contingent constraints on aggregate liquidation.

[8] We assume that if entrepreneurs are indifferent between lying and telling the truth, they choose to tell the truth. This (conventional) assumption implies that any crisis must necessarily be a strict equilibrium.

PROPOSITION 2. *Suppose* (τ, F, L) *is a solution to the relaxed equilibrium contract problem. Then:*

$$L_{00} = L_{0H} = L_0 = F_H / B_E$$

Proof. Suppose (τ, F, L) is an equilibrium, but $L_{0H} \neq L_{00}$. Define the certainty equivalent $\widehat{L}_0$ so that:

$$u_E\left(B_E\left(1-\widehat{L}_0\right)+R^H\right) = (1-p)u_E(B_E\left(1-L_{0H}\right)+R^H) + pu_E(B_E\left(1-L_{00}\right)+R^H)$$

Define $(\widehat{\tau}, \widehat{F}, \widehat{L})$ to be a contract that is the same as (τ, F, L) except:

$$\begin{aligned}
\widehat{L}_{00} &= \widehat{L}_{0H} = \widehat{L}_0 \\
\widehat{\tau}_1 &= \delta\widehat{L}_{0H} - \delta L_{0H} + \tau_1 \\
\widehat{\tau}_0 &= 2\left(\delta\widehat{L}_{00} - \delta L_{00}\right) + \tau_0
\end{aligned}$$

Because u_E exhibits non-increasing absolute risk aversion, we know that:

$$u_E\left(B_E\left(1-\widehat{L}_0\right)\right) > (1-p)u_E(B_E\left(1-L_{0H}\right)) + pu_E(B_E\left(1-L_{00}\right))$$

and so the objective increases. Clearly, $(\widehat{\tau}, \widehat{F}, L)$ satisfies (1), (2), and (3). We also know that:

$$\begin{aligned}
& (1-p)^2\tau_2 + 2p(1-p)\widehat{\tau}_1 + p^2\widehat{\tau}_0 \\
= \; & (1-p)^2\tau_2 + 2p(1-p)[\delta\widehat{L}_{0H} - \delta L_{0H} + \tau_1] \\
& + p^2[2\delta\widehat{L}_{00} - 2\delta L_{00} + \tau_0] \\
= \; & R^{FOR}G + 2p\delta[\widehat{L}_0 - (1-p)L_{0H} - pL_{00}] > R^{FOR}G
\end{aligned}$$

where the last inequality is implied by the strict concavity of u_E. Hence, if $L_{0H} \neq L_{00}$, (τ, F, L) cannot be an equilibrium, because $(\widehat{\tau}, \widehat{F}, \widehat{L})$ improves upon it. The incentive constraint is then: $u_E(B_E + R^H - F_H) = u_E\left(B_E\left(1-\widehat{L}_0\right)+R^H\right)$, and so $\widehat{L}_0 = F_H/B_E$. QED

The aggregate resources the lender gets from entrepreneurs are lower when either of

them defaults, because liquidation is a costly form of repayment. The taxes collected by the government perfectly insure the domestic lender against this risk, which is then absorbed by the foreign lender. Hence, the payments received by the foreign lender from the sovereign borrower can be ordered as follows:

$$\tau_2 > \tau_1 > \tau_0.$$

We treat τ_2 as the face value of the sovereign debt. We say that a partial sovereign default occurs if the foreign lender receives τ_1 and a full sovereign default occurs if the foreign lender receives τ_0.

We can use the above proposition to readily solve for the solution to the relaxed equilibrium contract problem. In that case, $F_H/B_E = L_{0H} = L_{00} = L_0^*$. Hence, $\tau_2 = 2L_0^*B_E - 2R$, $\tau_1 = \delta L_0^* + B_E L_0^* - 2R$, and $\tau_0 = 2\delta L_0^* - 2R$. We can substitute these taxes into the zero profit constraint of the foreign lender to obtain:

$$(1-p)^2 B_E L_0^* + p(1-p)(B_E + \delta)L_0^* + p^2 \delta L_0^* = R + R^{FOR}G/2$$

which implies that equilibrium liquidation is given by:

$$L_0^*(R, p, G, R^{FOR}, B_E, \delta) = \frac{R + R^{FOR}G/2}{(1-p)B_E + p\delta}. \tag{5}$$

This expression is useful in proving the following proposition that characterizes when equilibrium contracts are in fact crisis contracts.

PROPOSITION 3. *If $L_0^*(R, p, G, R^{FOR}, B_E) \leq \xi/2$, then no equilibrium contracts are crisis contracts. If $L_0^*(R, p, G, R^{FOR}, B_E) > \xi/2$, then all equilibrium contracts are crisis contracts.*

Proof. Suppose that:

$$L_0^*(R, p, G, R^{FOR}, B_E, \delta) \leq \xi/2$$

We have seen that in any solution to the relaxed problem, $L_{0H} = L_{00} = L_0^*$. Since $L_0^* \leq \xi/2$,

any solution to the relaxed problem is also a solution to the original equilibrium contracting problem. Hence, in any equilibrium contract, $F_{HH} = F_{H0} = B_E L_0^*$, and $L_{0H} = L_{00} = L_0^*$. Given that $L_{0H} = L_{00}$, none of these contracts is a crisis contract.

Now suppose that ξ is small enough such that $L_0^*(R, p, G, R^{FOR}, B_E) > \xi/2$. In any equilibrium contract (τ, F, L), $F_{HH} = F_{H0} = F_H$, and (F_H, L_{0H}, L_{00}) satisfy:

$$\begin{aligned}(1-p)u_E(B_E(1-L_{0H}) + R^H) + pu_E(B_E(1-L_{00}) + R^H) &= u_E(B_E + R^H - F_H) \\ (1-p)F_H + p(1-p)\delta L_{0H} + p^2\delta L_{00} &= R + R^{FOR}G/2\end{aligned}$$

(The first equality is the incentive constraint. The second equality is a combination of the individual rationality and zero profit constraints.) We claim that this contract is a crisis contract; that is, we claim $L_{0H} > L_{00}$. Suppose not. Then, $\xi/2 \geq L_{00} \geq L_{0H}$. The incentive constraint then implies that $F_H \leq B_E\xi/2$. Then, we can substitute into the zero profit constraint to get:

$$(1-p)B_E\xi/2 + p(1-p)\delta\xi/2 + p^2\delta\xi/2 \geq R + R^{FOR}G/2$$

But this implies that:

$$\xi/2 \geq \frac{R + R^{FOR}G/2}{(1-p)B_E + \delta p}$$

which violates the hypothesized upper bound on $\xi/2$. It follows that all equilibrium contracts are crisis contracts. QED

The idea behind the proposition is simple. If ξ is high enough, then the upper bound on aggregate liquidation is basically irrelevant. It is possible to spread the equilibrium liquidation across the two states in such a way that L_{00} is equal to L_{0H}, which eliminates the possibility of a coordinated default crisis. On the other hand, if ξ is low enough that the constraint on aggregate liquidation binds, L_{00} must be less than L_{0H} in equilibrium.

It is simple to show that to satisfy the domestic lender's individual rationality constraint, it is necessary that $L_0^*(R, p, G, R^{FOR}, B_E, \delta) < 1$. Hence, Proposition 3 implies that no equilibrium contract is a crisis contract if $\xi = 2$. Crises occur only because there is a

substantial constraint on aggregate liquidation.

In our model, liquidation provides a way to compensate the lenders and it provides a way to discipline defaulting borrowers. Both roles matter in generating coordinated default crises. If ξ is too low, then it is not possible to deliver a sufficiently strong punishment if both borrowers default simultaneously. If δ is too low, then more liquidation is required to satisfy the zero-profit-constraint of the lender. If the required amount of liquidation grows to exceed $\xi/2$, then there is a possibility of coordinated default crises.

4. Crises and Correlations

Above we showed that for some parameter settings, under an equilibrium contract, there is the possibility of a second equilibrium being played in the reporting game between the entrepreneurs. However if this possibility is a real one, then the players, as Bayesians, should assign a positive ex-ante probability to this equilibrium being played. Doing so will affect the design of the original contract itself.

More specifically, suppose with probability ε, the entrepreneurs both privately observe 1 at the beginning of period 2, and with probability $(1-\varepsilon)$, they both observe 0. These private signals allow the entrepreneurs to coordinate their reports. In particular, assume that it is common knowledge that the entrepreneurs will default if they both observe 1 and if doing so is a mutual best response, given a contract.[9] We will call ε the *sunspot probability.*

As is typical in the coordination failure literature, we are silent about what the coordination device is. We think of the entrepreneurs as observing a number of independent payoff irrelevant signals. They choose which of these signals to use as a coordination device.

In this section, we examine the structure of equilibrium contracts, given that coordinated default crises are positive probability events. We show that domestic and sovereign defaults occur simultaneously and that the equilibrium rates of return on domestic and sovereign foreign debt are positively correlated.

[9] The lender could ask the entrepreneurs whether they have seen the sunspot or not. However, it is not possible to design a contract which does not have an equilibrium in which they jointly claim not to have seen the sunspot, but they actually have. For this reason, we do not bother to extend the contract to depend on the sunspot.

A. Domestic and Sovereign Default

The common private signal mentioned above does not affect the nature of the feasibility constraints (1) or incentive constraints (2). However, it does change the individual rationality constraint (3), the zero profit constraint (4), and the objective of the entrepreneurs. The individual rationality constraint becomes:

$$\begin{aligned}
&u_L(2R) = (1-\varepsilon)(1-p)^2 u_L(2(F_{HH}+\delta L_{HH})-\tau_2)\\
&+2(1-\varepsilon)p(1-p)u_L(F_{0H}+F_{H0}+\delta L_{0H}+\delta L_{H0}-\tau_1)\\
&+[(1-\varepsilon)p^2+\varepsilon]u_L(2(F_{00}+\delta L_{00})-\tau_0)
\end{aligned}$$

The zero profit constraint becomes:

$$(1-\varepsilon)(1-p)^2\tau_2 + 2(1-\varepsilon)p(1-p)\tau_1 + (p^2(1-\varepsilon)+\varepsilon)\tau_0 \geq R^{FOR}G$$

Finally, the entrepreneur's objective becomes:

$$\begin{aligned}
&(1-\varepsilon)(1-p)^2 u_E(B_E(1-L_{HH})+R^H-F_{HH})\\
&+(1-\varepsilon)p(1-p)u_E(B_E(1-L_{H0})+R^H-F_{H0})\\
&+(1-\varepsilon)p(1-p)u_E(B_E(1-L_{0H})-F_{0H})+[(1-\varepsilon)p^2+\varepsilon]u_E(B_E(1-L_{00})-F_{00})
\end{aligned}$$

An equilibrium contract, given sunspot probability ε, must maximize (the altered version of) the entrepreneur's objective subject to (1), (2) and the altered versions of (3) and (4).

Let $(\tau(\varepsilon), F(\varepsilon), L(\varepsilon))$ be an equilibrium contract given sunspot probability ε. It is straightforward to use the same logic as in Proposition 1 to establish the following characterization of $(\tau(\varepsilon), F(\varepsilon), L(\varepsilon))$, for any $\varepsilon \geq 0$.

PROPOSITION 4. *Suppose $(\tau(\varepsilon), F(\varepsilon), L(\varepsilon))$ is an equilibrium contract given sunspot probability ε. Then:*

1. $F_{HH}(\varepsilon) = F_{H0}(\varepsilon) > 0$

2. *If* $R^H > F_{HH}(\varepsilon)$, *then* $L_{HH}(\varepsilon) = L_{H0}(\varepsilon) = 0$

3. $(\tau(\varepsilon), F(\varepsilon), L(\varepsilon))$ *satisfies the incentive constraint* (2) *with equality*

4. $\tau(\varepsilon)$ *satisfies the zero profit constraint* $(4')$ *with equality*

5. $F_{0H}(\varepsilon) = F_{00}(\varepsilon) = 0$

6. $2R = 2(F_{HH}(\varepsilon) + \delta L_{HH}(\varepsilon)) - \tau_2(\varepsilon) = F_{0H}(\varepsilon) + F_{H0}(\varepsilon) + (\delta L_{0H}(\varepsilon) + \delta L_{H0}(\varepsilon)) - \tau_1(\varepsilon)$
$= 2(F_{00}(\varepsilon) + \delta L_{00}(\varepsilon)) - \tau_0(\varepsilon)$

Proof. The same as the proof of Proposition 1. QED

This proposition implies that in the equilibrium contract, given suspot probability ε, domestic and sovereign defaults occur simultaneously. When both entrepreneurs announce low returns, they default on their loan ($F_{00}(\varepsilon) = 0$), and their assets are liquidated ($L_{00}(\varepsilon) > 0$). These are times when the sovereign also defaults, as it cannot pay the foreign lender in full: $\tau_0(\varepsilon) = 2(\delta L_{00}(\varepsilon) - R) < 2(F_{HH}(\varepsilon) - R) = \tau_2(\varepsilon)$.

B. Positively Correlated Debt Returns

We know from Proposition 3 that crisis contracts exist only if $\xi/2$ is sufficiently small, so that:

$$\xi/2 < L_0^*(R, p, G, R^{FOR}, B_E, \delta)$$

In the following proposition, we use this condition to prove that when sunspots are more likely to occur, both domestic debt and sovereign foreign debt returns – that is, both $F_{HH}(\varepsilon)$ and $\tau_2(\varepsilon)$ – are higher.

PROPOSITION 5. *Define* L_0^* *as in (5) to be the equilibrium liquidation in a contract in which the upper bound on liquidation does not bind (assuming* $\varepsilon = 0$*). Suppose that:*

$$\xi/2 < L_0^*(R, p, G, R^{FOR}, B_E, \delta)$$

Then, for non-negative ε in a neighborhood of 0, $F_{HH}(\varepsilon)$ and $\tau_2(\varepsilon)$ are both strictly increasing in ε.

Proof. In Appendix A.

This proposition shows that if ε increases, a non-defaulting entrepreneur will make a bigger debt repayment to the domestic lender and the government will make a bigger debt repayment to the foreign lender. Intuitively, when ε rises, the foreign lender is less likely to receive the high repayment τ_2. The foreign lender must be compensated for this probability reduction with increased repayments by the government. This in turn calls for a larger repayment of the non-defaulting entrepreneurs to the domestic lender.

The above assumes that the lender simply allows for the possibility of coordinated default crises in offering a contract. The lender could instead restrict contracts to ones that eliminate coordinated default crises entirely. To do so, we augment the original contractual choice problem to include the constraint:

$$u(B_E + R^H - F_{H0}) \geq u(B_E\,(1 - L_{00}) + R^H)$$

or, equivalently, $F_{H0} \leq L_{00}$. Under the hypothesis of Proposition 3 about ξ, this constraint must be binding. In the resultant contracts, $F_{H0} < F_{HH}$. This extra randomness reduces the value of the entrepreneur's objective. However, the reduction is by an amount that is independent of ε. It follows that, as long as ε is sufficiently small, this kind of random contract is suboptimal relative to the one described in Proposition 5.

To sum up: sunspots affect the design of equilibrium contracts. In these contracts, domestic and sovereign defaults occur together and as the probability of a sunspot rises, the returns on domestic and foreign debt both rise.

5. Evidence

In the previous sections, we derived two key implications of our model. First, proposition 4 shows that private domestic and sovereign defaults happen simultaneously. When the aggregate bound of liquidation is tight, it is optimal for domestic borrowers to default if other borrowers are also defaulting. The government also defaults because it lacks sufficient funds

to pay the foreign lender due to low tax collections. Second, proposition 5 shows that private debt and sovereign debt interest rates move together. In the model, private and sovereign interest rates compensate for default risk; thus, as the probability of a coordinated default crisis increases, both rates rise.

In this section, we document that sovereign default risk and private default risk move together in emerging markets in both an ex-ante and ex-post sense. From an ex-ante perspective, we show that the dollar spreads on international sovereign bonds have a tight correlation to dollar domestic lending spreads charged to private borrowers. From an ex-post perspective, we show that episodes of international sovereign defaults largely coincide with episodes of large domestic private defaults.

We first look at the co-movement of the probability of default for sovereign governments and private borrowers in emerging markets. Our data set consists of monthly data for eighteen emerging markets: Argentina, Brazil, Chile, Colombia, Ecuador, Indonesia, Korea, Malaysia, Mexico, Nigeria, Panama, Peru, Philippines, Poland, Russia, Thailand, Ukraine, and Venezuela. Our choice of countries is guided by data availability – the countries we consider belong to the set included in J. P. Morgan's EMBI+, to the emerging markets considered in Kaminsky and Reinhart (1998), or both. Our measure for sovereign default probabilities[10] is the EMBI+ spread for each country, which is the difference between the yield of dollar denominated bonds relative to the yield of similar U.S. government bonds.[11]

For the private sector, we need a measure that captures the probability of default of domestic private borrowers on their loans. To this end, we use the *dollar* lending rates of domestic banks relative to the yield of United States Treasury bills. In countries for which domestic dollar rates are not available, we use the local currency spread between the average lending rate and the average deposit rate to proxy default probabilities. Table 1 shows that the correlations of sovereign and private default risk are strongly positive for 15 of the countries in

[10] Treating the EMBI+ spread in this way ignores other possible sources of changes in expected returns. These include variations in liquidity or variations in country-specific betas relative to the world market portfolio.

[11] Five of these countries (Chile, Indonesia, Korea, Malaysia and Thailand) do not have EMBI+ spreads. For these countries, we use spreads of an alternative government bond, instead of the EMBI+ spread. The details are in Appendix B.

the sample.[12] Figure 1 further illustrates the strong co-movement between sovereign default risk and private default risk and that spikes in sovereign default probabilities are generally accompanied by spikes in the domestic private default probabilities.[13]

Table 1: Correlations of Sovereign and Private Default Risk

Argentina	0.81	Nigeria	0.47
Brazil	0.38	Panama	0.44
Chile	0.45	Peru	0.69
Colombia	0.08	Philippines	-0.40
Ecuador	0.37	Poland	-0.48
Indonesia	0.29	Russia	0.47
Korea	0.54	Thailand	0.54
Malaysia	0.18	Ukraine	0.41
Mexico	0.85	Venezuela	0.33

Thus, from an ex-ante perspective, sovereign and private loan default probabilities fluctuate together over time. We now present evidence of ex-post covariation. We show that since 1980, episodes of sovereign defaults largely coincide with periods of internal debt crises. To date sovereign defaults, we use the Standard and Poor's classification and include defaults on both foreign currency bank debt and foreign currency bond debt. To proxy internal debt crises, we use the commonly used dates of banking crises from Caprio and Klingebiel (2003). As they document, these crises are characterized by widespread domestic defaults with large increases in non-performing loans and collapses of banks.[14]

[12] The correlations between EMBI+ spreads and nominal lending rates are strongly positive for all countries in the sample including Colombia, Phillipines and Poland. This finding is similar to that of Mendoza and Yue (2007). They show that the correlation between EMBI+ spreads and firm financing costs are strongly positive. Their measure of the latter is in terms of domestic currency, and so includes an own-country inflationary component.

[13] Appendix B contains the description and sources of all the data.

[14] Only two of the banking crises described by Caprio and Klingebiel (2003) feature bank runs. This suggests that banks' difficulties were primarily on the asset side of their balance sheets.

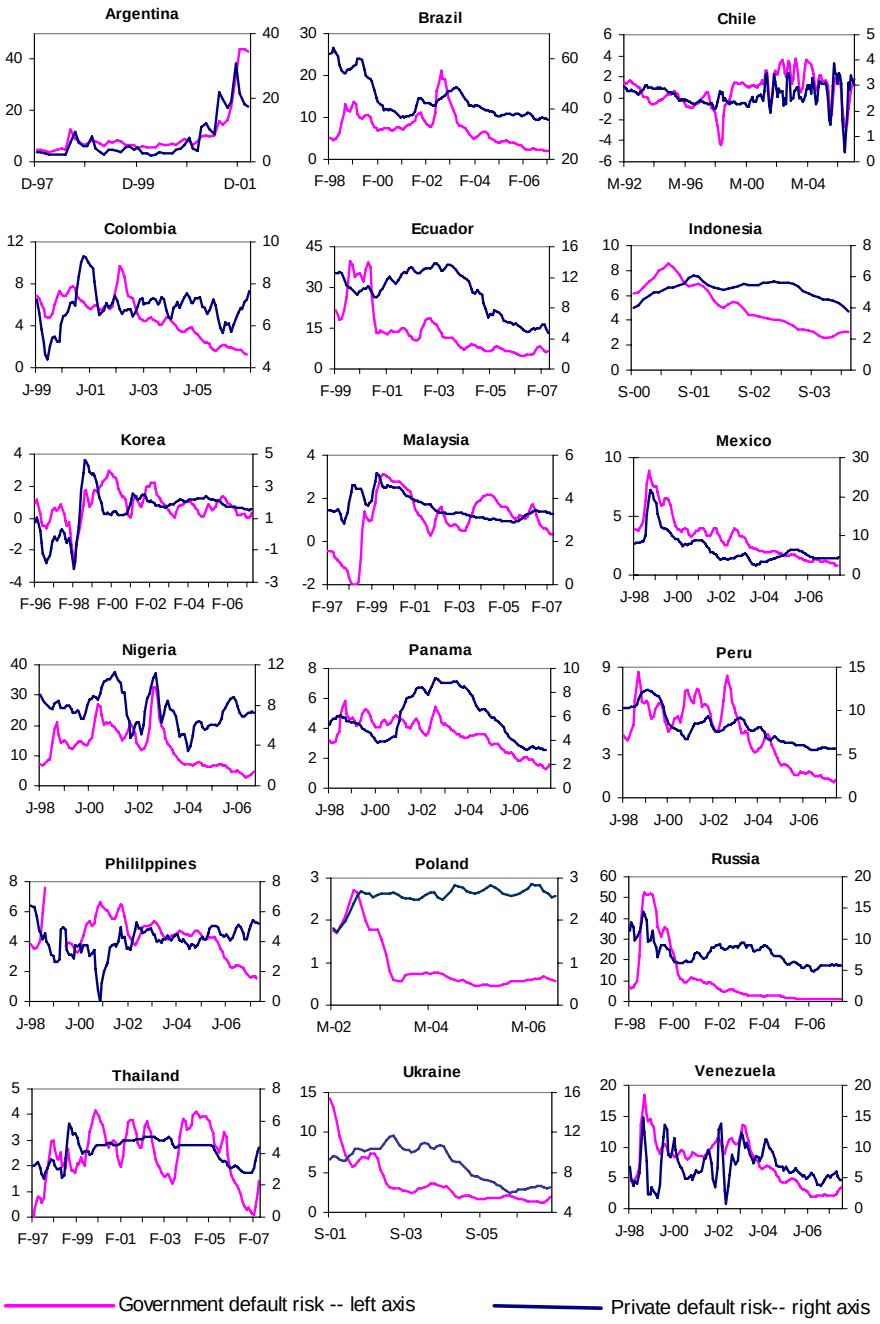

Figure 1: Sovereign and Private Sector Default Risk Over Time

Table 2: Sovereign Defaults and Internal Debt Crises from 1980-2003

	Only Sovereign	Only Private	Both
Emerging markets	3	14	19
Middle income countries	24	43	39

Table 2 shows that from 1980-2003 there have been 22 sovereign defaults in our sample of emerging markets and 19 of those have also involved an internal debt crisis.[15] These countries have also experienced 14 additional internal debt crises without a sovereign default. The unconditional default probability in any year is equal to 6.9% and the unconditional internal debt crisis probability is equal to 8.8% in our sample. Sovereign defaults also occur together with internal debt crises in a broader sample of all 93 middle income countries. We find that 39 out of the 63 sovereign defaults that occurred in these countries have been accompanied by internal debt crises. Appendix B contains the countries and dates for sovereign defaults and internal debt crises in our sample of emerging markets.

These data from emerging markets confirm the empirical implications of our model embedded in Propositions 4 and 5. In these countries, sovereign defaults largely coincide with periods of systemic domestic debt crises and so interest rates on both debt classes move together.

6. Discussion

In this section, we discuss how we can enrich our model of sovereign default, how our model can capture the link between real exchange rate depreciations and crises, and whether the global games approach is useful in eliminating the multiplicity of equilibria in the reporting game.

[15] The concurrence of internal debt crises and sovereign defaults appears greater than for the more studied twin crises of balance of payments and internal debt. Kaminsky and Reinhart (1998) report that from 1975 to 1995 in a sample of 20 countries, from the 57 balance of payment crises, only 19 of them were accompanied by an internal debt crisis.

A. Enriching Our Model of Sovereign Default

In our model, the government must repay all loans. In reality, governments have a choice over whether to do so or not, and indeed much of the literature on sovereign default focuses on this choice.[16] In this subsection, we consider two different ways to add such a choice into the model. We argue that enriching the model in this way does not affect our results greatly.

Ex-Post Participation Constraint

In our model, the sovereign has no ability to deviate from the recommendations of the contract. Suppose instead that in period 2, the sovereign has the option to pay the contractually mandated τ_s or choose to face a sanction with exogenously specified cost k. This option will impose an additional constraint on the equilibrium contracting problem that $\tau_s \leq k$ for all s. Intuitively, this additional constraint will increase the amount of risk each entrepreneur must bear in states when his announced return is R^H. To satisfy the incentive compatibility constraint of entrepreneurs, the contractually specified amount of liquidation must increase. Thus, the ability of the sovereign to default increases the range of the parameters consistent with equilibrium crisis contracts (just as increasing R or G does).

There is one empirical problem that emerges with this way of incorporating voluntariness on the part of the sovereign. If the participation constraint binds, so that $\tau_2 = k$, then τ_2 cannot vary with ε as in the prior section. Note that this empirically unattractive feature arises because in this model of default, the sovereign is tempted to endure the sanction in *good* times, not *bad* times.

Private Information About the Aggregate State

In the above simple model of sovereign default, the sanction k never occurs in equilibrium. Hence, in equilibrium, default is really still only a label that distinguishes repayment states from one another. Consider the following distinct model of default. Suppose that as above, it is possible to impose a sanction of cost k on the sovereign. In contrast to the above model, though, we assume that the sovereign has full commitment and that τ_s is privately

[16] See for example Eaton and Gersovitz (1981), Bulow and Rogoff (1989), and Atkeson (1991).

known to the sovereign.

The private information restriction will lead to an incentive-compatibility constraint on the sovereign. In this model, in an equilibrium contract, the sovereign will pay k (with some probability) for announcing values of s which lead to low repayments to the foreign lender. As is true of the private debt contract in our benchmark model, we can interpret the sovereign's announcing a low value of s as being akin to declaring default.

This extra incentive constraint on the problem introduces even more risk to the entrepreneurs, and so increases the amount of liquidation required. Again, this private-information model of default expands the set of parameters consistent with equilibrium crisis contracts, relative to our benchmark model. One attractive feature of this model is that, unlike the prior participation-constraint model, the face value τ_2 is an increasing function of ε (the probability of a coordinated default crisis).

B. Real Exchange Rate Depreciations and Crises

Debt crises are often associated with periods of real exchange rate depreciation. Our model captures this connection in the following sense. In our model, the domestic lender can lend to an entrepreneur or invest in an outside option. Suppose that the utility of the lender is over bundles of tradable and nontradable goods. Then the lender wants to maximize its wealth to subsequently buy a bundle of tradable and nontradable goods. Suppose too that entrepreneurs are engaged in the production of nontradable goods, where incentive problems are severe, while the lender's outside opportunity consists of the production of tradable goods. Under this interpretation, we can think of a depreciated real exchange rate as a rise in the value of the tradable good production – that is, as an increase in R.

An increase in R can generate crises, when none existed before because

$$\frac{\partial L_0^*(R, p, R^{FOR}, G, B_E, \delta)}{\partial R} > 0,$$

where L_0^* is defined to be the equilibrium contract when the aggregate liquidation constraint does not bind, as in (5). When the outside option R rises, $L_0^*(R, p, G, R^{FOR}, B_E, \delta)$ can increase above $\xi/2$. This change can lead all equilibrium contracts to be crisis contracts. Hence, in our model real exchange rate depreciations can generate sovereign and domestic

debt crises.

The relation between real exchange rate devaluations and crises is a common theme in the work on balance sheet effects (as in Calvo 1998). The idea is that an increase in the relative price of traded goods makes the value of the nontradable goods insufficient to pay the traded denominated debt through the debtor's budget constraint. In this paper a rise in the relative value of traded goods requires larger incentives for the entrepreneur to report truthfully and repay. However increasing repayment incentives requires larger liquidation which could exceed the aggregate bound. Thus, real exchange rate depreciations can generate coordinated default crises because repayment incentives are insufficient due to the inability of the economy to deal with large scales defaults.

C. Global Games: Getting Rid of the Multiplicity?

The problem in this economy is that there are two possible Bayesian-Nash equilibria in the reporting game. In one equilibrium, both entrepreneurs tell the truth. In the other, they coordinate on lying by claiming to be unsuccessful even when they are successful. In the past fifteen years, international economists have made effective use of global games refinements to eliminate multiplicities that emerge in models of currency crises (Morris and Shin (1998)). Can these methods be used to the same effect in our setting?

The essence of the global games approach is that we pick the equilibrium which best approximates equilibrium play in a perturbed game which has small private signals about the payoffs. In that way, we can understand which equilibrium is more robust to deviations from common knowledge about those payoffs. But in our contracting setup, the lender writes down a contract that specifies F_H, L_{0H}, and L_{00}. Why would these numbers then be anything less than common knowledge among the two entrepreneurs? To us, the lack of common knowledge of payoffs that underlies the global games approach seems strained in our setting.[17]

[17]It may still seem plausible to some readers that the two entrepreneurs' strategies are not common knowledge (as is assumed in a Bayesian-Nash equilibrium). What happens if we relax the common knowledge assumption in an ad hoc fashion? Note that of the two equilibria under consideration, the truth-telling equilibrium is actually less robust. We only consider the lying equilibrium if it is in fact a strict equilibrium. But the truth-telling equilibrium is necessarily not strict because the incentive constraint holds with equality. Clearly, without much loss in utility to the entrepreneurs, the lender could alter the contract slightly, so that truth-telling is a strict equilibrium. Nonetheless, under these slightly altered contracts, the lying equilibrium still risk-dominates the truth-telling equilibrium. As Carlsson and van Damme (1993) argue, the

7. Conclusion

In this paper, we provide a novel explanation of debt crises in emerging markets. Our theory is motivated by evidence from developing countries that during crises, defaulters' assets are not seized by creditors due to weak bankruptcy institutions. We develop an optimal contracting model in which entrepreneurs borrow from a lender to invest in projects that deliver random returns that are private information to entrepreneurs. The key component is that it is impossible to liquidate large amounts of entrepreneurial assets. In the optimal loan contract a successful entrepreneur repays the lender yet an unsuccessful one defaults and liquidates his assets. However, the inability to liquidate extensive asset quantities generates the possibility of a second equilibrium with coordinated defaults. During coordinated default crises, successful entrepreneurs find it optimal to default because the sanction of doing so is small when all other entrepreneurs are defaulting. During these crises, the government's tax collections fall and thus it cannot pay the international lender in full. The model shows that, given tight aggregate constraints on liquidation, joint debt crises are an inevitable part of an optimal response to informational problems in private-sector lending.

Recently, there have been a large number of defaults on home mortgages in the United States. From the point of view of our model, this event is revealing in two ways. First, it is clear that it has been difficult over the past several months for United States banks to handle such large number of foreclosures. Just like in our model, the marginal cost of liquidating so many houses is increasing in the aggregate amount of such liquidation.

Even in this rather extreme situation, though, liquidations and foreclosures continue apace. A defaulting homeowner still faces a large probability of losing her home in the United States. Hence, there is little possibility for the kind of domestic default crises that take place in our model. In this sense, the contrast with the situations in the Asian and Latin American crises is striking.

This comparison suggests the following important question: How do we change institutions in Asian and Latin American countries so that its liquidation cost function looks more like that in the United States? We hope to answer this question in future work. The

risk-dominant equilibrium survives a wider class of deviations from common knowledge and is the one picked out by a global games refinement.

theme of this paper is that answering this question will help stop sovereign debt crises, as well as domestic default crises.

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Appendix A

In this appendix, we provide a proof of Proposition 5.

We first prove that there is a neighborhood of 0 such that there is a unique equilibrium contract for all $\varepsilon \geq 0$. We start with $\varepsilon = 0$. Suppose that the equilibrium contract was such that the constraint on aggregate liquidation does not bind. Then, the equilibrium contract's payments would be given by:

$$\begin{aligned} F_{HH} &= F_{H0} = B_E L_0^*(R, p, G, R^{FOR}, B_E, \delta) \\ L_{0H} &= L_{00} = L_0^*(R, p, G, R^{FOR}, B_E, \delta) \end{aligned}$$

But this contract exceeds the upper bound on aggregate liquidation (because $2L_{00}$ exceeds ξ), and cannot be an equilibrium contract. It follows that there is a unique equilibrium contract (τ, F, L):

$$\begin{aligned} F_{HH} &= F_{H0} = \widehat{F}_H \\ F_{00} &= F_{0H} = L_{H0} = L_{HH} = 0 \\ L_{0H} &= \widehat{L}_{0H},\ L_{00} = \delta^{-1}\xi/2 \\ \tau_2 &= 2\widehat{F}_H - 2R \\ \tau_1 &= \widehat{F}_H + \delta\widehat{L}_{0H} - 2R \\ \tau_0 &= \xi - 2R \end{aligned}$$

where $(\widehat{F}_H, \widehat{L}_{0H})$ is the unique solution to:

$$\begin{aligned} & u_E(B_E + R^H - \widehat{F}_H) = (1-p)u_E\left(B_E\left(1 - \widehat{L}_{0H}\right) + R^H\right) + pu_E(B_E(1-\xi/2) + R^H) \\ & (1-p)\widehat{F}_H + \delta p(1-p)\widehat{L}_{0H} + p^2\xi/2 = R + R^{FOR}G/2 \end{aligned}$$

Now suppose $\varepsilon > 0$. By the Theorem of the Maximum, there is a unique equilibrium contract

for ε near 0, and that contract's (F, L) satisfies:

$$(6) \quad u_E(B_E + R^H - F_H) - (1-p)u_E(B_E(1 - L_{0H}) + R^H) - pu_E(B_E(1 - \xi/2) + R^H) = 0$$

$$(7) \quad [p^2(1-\varepsilon) + \varepsilon]\xi/2 + \delta p(1-p)(1-\varepsilon)L_{0H} + (1-p)(1-\varepsilon)F_H = R + R^{FOR}G/2$$

For notational convenience, we've set $F_H = F_{HH} = F_{H0}$ and suppressed the dependence of the payments on ε. Using the implicit function theorem, we can show that F_H is continuously differentiable in ε for ε near 0. Differentiating (6) and (7) with respect to ε, around $\varepsilon = 0$, we get:

$$\begin{aligned}(1-p)u'_E\left(B_E\left(1 - \widehat{L}_{0H}\right) + R^H\right)B_E L'_{0H}(0) &= u'_E(B_E + R^H - \widehat{F}_H)F'_H(0) \\ p(1-p)\delta L'_{0H}(0) + (1-p)F'_H(0) &= R + R^{FOR}G/2 - \xi/2\end{aligned}$$

Substituting the first equation into the second, we get:

$$p\frac{\delta u'_E(B_E + R^H - \widehat{F}_H)}{u'_E(B_E\left(1 - \widehat{L}_{0H}\right) + R^H)B_E}F'_H(0) + (1-p)F'_H(0) = R + R^{FOR}G/2 - \xi/2$$

which implies that $F'_H(0) > 0$. Since F_H is C^1 for ε near 0, we can conclude that $F'_H(\varepsilon) > 0$ for ε in a neighborhood of zero.

From Proposition 3, we know that:

$$\tau_2(\varepsilon) = 2F_H(\varepsilon) - 2R$$

and so $\tau'_2(\varepsilon) > 0$. QED

Appendix B

In this appendix we provide details on the data sources, series and default events dates used in the Section 5.

Default Risk Data

Private default risk is calculated as follows. For Argentina, Ecuador, Indonesia, Panama, Peru, Poland, Russia, and Ukraine, we use the spread between dollar average domestic lending rate and the yield U.S. Treasury of 1 year maturity. For Brazil, Chile, Colombia, Korea, Malaysia, Mexico, Nigeria, Philippines, Thailand, and Venezuela, we use the spread between the average local currency domestic lending rate and the average local currency domestic deposit rate.

Sovereign default risk is the EMBI+ spread for Argentina, Brazil, Colombia, Ecuador, Mexico, Nigeria, Panama, Peru, Philippines, Poland, Russia, Ukraine, and Venezuela. The additional five countries do not have EMBI+ spreads. These are the series used for them. Chile: Inflation Indexed 10-year Bond Yield relative to the Inflation Indexed deposit rate denominated in Chilean Peso, Indonesia: Spread of 7.75% Notes of 08-01-2006 denominated in U.S. Dollars relative to yield of a 1 year U.S. Treasury, Korea: 5-year Government Bond denominated in Korean South Won relative to the average deposit rate, Malaysia: 10-year Government Bond Yield denominated in Malaysia Dollar relative to the average deposit rate, Thailand: 10-year Government Bond Yield denominated in Thailand Baht relative to the average deposit rate.

All the data come from the Global Financial Statistics Database and the International Financial Statistics at the IMF except for the series on dollar lending rates for Poland and Russia that come from each country's Central Bank.

Dates of Sovereign Defaults and Internal Debt Crises

The following table reports the dates of sovereign defaults and internal debt crises.

Table 3: Crisis Dates

	Sovereign Defaults	Internal Debt Crises
Argentina	82-93, 89, 01-04	80-82, 89, 95, 01-04
Brazil	83-94	90, 94-99
Chile	83-90	81-83
Colombia		82-87
Ecuador	85-95, 99-00	80-83, 95-97, 98-02
Indonesia	98-00, 02	94, 97–02
Korea		97-02
Malaysia		85-88, 97-01
Mexico	82-90	81-91, 94-00
Nigeria	82-92, 86-88, 92, 02	92-97
Panama	83-96, 87-94	88-89
Peru	80, 84-97	83-90
Philippines	83-92	81-87, 98-02
Poland	81-94	90-95
Russia	91-97, 98-00	95, 98-99
Thailand		83-87, 97-02
Ukraine	98-00	97-98
Venezuela	83-88, 90, 95-97	81-86, 94-95