Endogenous Financial Fragility and Prudential Regulation

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Abstract

We study the fragility of the banking system and its implications for prudential regulation. In our framework, fragility stems from the interconnections banks establish to protect themselves from liquidity shocks. Like Allen and Gale (2000) we find mutual insurance of assets is privately advantageous. An assumption of Allen and Gale's analysis is that aggregate shocks are a zero probability event. This makes banks indifferent between arrangements leading to varying degrees of fragility should the zero probability event actually materialize.

We depart from Allen and Gale by assuming that the aggregate shock is no longer a zero probability event. As a result, banks find insurance by other banks valuable, but are no longer indifferent about the form the insurance takes. We build a framework examining the consequences for interbank insurance when individual bank fragility stems from a moral hazard problem, as in Calomiris Kahn (1991) or Diamond Rajan (1998).

We examine the implications of bank insurance choices for system fragility. In some conditions, banks prefer universal mutual insurance, and will opt for this arrangement. Depositors may also prefer universal mutual insurance as well, it may be socially suboptimal, since it places too high a correlation on individual bank failures. If banks also provide payments services, then the social costs may be much higher from having all fail than from having some failing, thus creating a justification for a regulatory intervention. We briefly examine possible modes of intervention.

1 Introduction

In a modern economy, financial institutions interact in a bewildering variety of ways. The assets and liabilities of financial institutions include claims to and from other financial institutions, creating a high degree of interdependency. For the most part, these choices are voluntary: no outside authority forces these cross institutional holdings. On the other hand, no outside authority guarantees that these institutions get the degree of interdependence "right."

Some degree of interdependence is inevitable given the role of intermediaries. Intermediaries have the job of using superior information to channel capital from owner to user through creation of financial assets and liabilities. In a world with a high degree of complexity and specialization some intermediaries will have the job of channeling the capital of other intermediaries. Moreover, in a world where the responsibility for effecting payments is largely taken over by private financial intermediaries, the regular course of commercial activity will impose interdependencies on the institutions which take this role.

Do banks have an incentive to set the optimal degree of mutual dependence in liabilities and payments arrangements? If not what should regulators do about it? A recent literature has argued for an inherent fragility in the financial system, and a variety of mechanisms by which fluctuations in the financial system will propagate through the economy. To what extent is this propagation endogenous, and what are its determinants?

With alliterative allure, the term "financial fragility" encapsulates a key strand—indeed the best surviving strand—of the mainstream theoretical economic argument in favor of macroeconomic stabilization policy in a world where prices are flexible. Outside the financial system, the main prescriptions given for increasing economic stability are neoclassical and laissez faire in their outlook: allow the participants in the market to adjust to the changes in the economy by eliminating structural rigidities in labor and product markets; increase transparency so that market participants can correctly and intelligently adjust to government's and firms' activities. In the case of financial markets, however, a respectable body of opinion has always argued, and still argues, for an inherent instability and a need for intervention to correct that instability.

Economists and historians have always looked to the financial system as a possible source of the fluctuations that have hit economies. This focus is natural: the apparent rapid response of financial institutions to news and innovations and the pervasiveness of financial activities in the economy as a whole also makes them a natural source and propagation mechanism for transmitting fluctuations to the economy. Still, even if we accept such claims, we do not know that the financial system delivers the "wrong" degree of fluctuation to the economy. Perhaps the financial system is not "fragile" but "responsive."

In this paper we argue that for the most part, financial institutions have the incentive to get it "right." The flexibility with which financial assets can be designed and priced causes the market participants correctly to take into account the economic effects of their own interdependence. We illustrate this by using a modification of the Diamond and Rajan (2001) model of banks, in which banks decide on the correct degree of mutual insurance. On the other hand, when it comes to the role of financial institutions in the payments system, such flexibility is not available. Financial institutions which provide payments services have an incentive to become too interdependent, since some of the beneficiaries of the payments arrangement are unable to compensate the banks for maintaining independence. We illustrate this point in a simple model as well.

The theoretical underpinnings of our model are the "usual suspects" in the information and contracting literature: moral hazard, imperfect information, and externalities. Indeed the first point is simply an illustration of the general principal of constrained optimality in a decentralized ex ante contracting environment.[1] The inefficiency in the second case arises because ex ante contracting is not possible. Nonetheless, we think that the application of this general principle is particularly relevant when financial intermediaries run payments systems. In general financial institutions are able to devise complex and flexible arrangements to cover numerous contingencies; thus in general, it is natural to model financial contracts in a complete contracting environment. However payments arrangements are intended to be universal. When

[1]See Prescott and Townsend (1984). Allen and Gale (2003a) provide a general presentation in a financial markets framework, and Allen and Gale (2003b) provide a survey of arguments for and against intervention.

such systems are decentralized, there is no way for all the potential recipients of payments to agree ahead of time to complex terms for the arrangement. The natural starting point is to assume no ex ante contracting over payments arrangements between pairs of potential transactors.

The rest of the paper is organized as follows. The next section reviews the related literature and compares it with our contribution. Section 3 presents an intuitive overview of our model, which is provided in greater detail in section 4. Section 5 discusses the implications of our model for regulation, and section 6 provides a brief conclusion.

2 Literature Review

Bryant (1980) and Diamond and Dybvig (1983) were critical to our understanding that a bank is an inherently unstable financial institution. These papers, however, only provide a limited contribution to our understanding of the potential fragility of a banking system. In their models, financial instability is associated with bank runs as a self-fulfilling prophecy ("sunspots"). Moreover, since they model the behavior of a single representative bank they are unable to consider the implications of bank interrelationships for industry stability.

Gorton (1985), Jacklin and Bhattacharya (1988) and Chari and Jagannathan (1988) added to our understanding of the stability of a banking system by showing that when there is asymmetry of information between depositors and their bank the release of new information on the bank's financial condition may trigger a run on the bank's deposits. However, in these models the only connections between banks are purely informational. A full-scale financial collapse may only occur if a run on an individual bank provides depositors of other banks information about aggregate conditions. De Bandt (1995) models a form of this propagation mechanism in a setting where banks are subject to an aggregate and an idiosyncratic shock. If depositors in one bank learn about their bank financial condition afterwards, other depositors may use this information to revise their expectations about the impact of the aggregate shock on their banks, creating a channel for the propagation of bank failures.

Rochet and Tirole (1996) further expanded our knowledge of the stability of the banking sector by showing that interconnections between banks, though advantageous, they may create the conditions for a system failure. Peer monitoring in their model is valuable to control bank moral hazard but it introduces a link between banks which may propagate a crisis from one bank to another. If one bank fails it is assumed that the other banks were not adequately monitored thus triggering their failure.

Acharya (2000) also presents a theory of systemic risk that builds on noncontractual linkages between banks. In his model, the advantage of failing together gives banks an incentive to choose assets which are highly correlated with other banks' assets creating, therefore, the conditions for a joint failure. (The argument is based on posited strategic advantages of failing together). The fundamental message of the paper is that if widespread failure is socially more disastrous than isolated failures, then, contrary to received wisdom, regulators may have to impose *greater* penalties on banks which fail when others fail.

Finally, Allen and Gale (2000) provide a theory of systemic risk which builds on the financial interconnections between banks. Allen and Gale build on a Diamond and Dybvig (1983) setting where banks have demand deposits because depositors need liquidity. Because assets are risky, a run will occur when the value of assets falls below a critical level. As a result, mutual insurance of assets is privately advantageous, as well as socially desirable. (This mutual insurance is achieved in the Allen and Gale model through cross-holdings of interbank deposits, but this is somewhat of a red herring). Their key observation is that while mutual insurance can protect banks against idiosyncratic bank risk, it cannot offer protection against aggregate bank asset risk and in this case the entire banking system may collapse. The reason is that if the banks' insurance arrangements make them mutually dependent then loss of value in one bank—driven by a liquidity shock for example—can cause sufficient loss of value in a second bank to precipitate a run there, and so on. Key to this result is Allen and Gale's assumption that the aggregate shock is a zero-probability event. In this case the banks are indifferent between a variety of insurance arrangements, that, nonetheless have different implications if the aggregate shock does occur. If insurance is carried out in a "daisy chain" each bank in the

sequence bears the full brunt of the shock, propagating it without dissipating it. Alternatively, if the insurance arrangement were universal then shocks would dissipate as losses spread out among the other participants.

3 Overview

Our objective in this paper is to study the fragility of the banking system and its implications for prudential regulation. Like Rochet and Tirole (1996), Acharya (2000), and Allen and Gale (2000), we too abstract from the problem of contagion runs and focus on the implications of the interconnections between banks. In contrast with Rochet and Tirole (1996) and Acharya (2000), however, we model banks as establishing financial linkages among themselves to protect from liquidity shocks. We agree that financial institutions do have wide discretion to invest in projects and therefore a temptation to alter the correlation of their projects; nonetheless, fragility through the asset side will likely involve a much slower process than the fragility resulting from interbank liabilities. In this regard, our paper is closest to Allen and Gale (2000). However, we diverge from them in several key respects and reach different conclusions.

Our first departure from the Allen and Gale model is to drop the assumption that an aggregate shock is a zero probability event. Thus banks are no longer indifferent about the degree of mutual insurance.

To see what happens in this case, suppose that there are a large number of banks. Each bank has assets whose value can be high or low. If the asset is low and if the bank were on its own a run would occur. As a result, banks find insurance by other banks valuable. Suppose with high probability, the high and low banks cancel each other out and there is no aggregate shock. However, with a small, but non zero, probability there are a few more low banks than high banks. For sufficiently small excess, the optimal arrangement is universal mutual insurance, and the banks will opt for this arrangement. This will have an important implication. All banks fail or stand together. The probability of failure for any one bank is lower than it would be without insurance, but the probability that all banks fail at the *same*

time is in fact *higher* than it would be without insurance.

The banks themselves, *ceteris paribus,* prefer this universal insurance arrangement. It is less clear that the bank's creditors do so as well. And if banks perform other useful tasks—such as running a payments system—it is possible that the social costs from having all banks fail is more than proportionately greater than the social cost of having some banks fail.

But that remains to be seen. In other words, we have outlined a scenario in which financial intermediaries by underwriting each others' liabilities induce financial fragility, in the sense that it becomes more likely that all institutions fail simultaneously. What the outline cannot make clear is whether this increased financial fragility, when it occurs, is inefficient. The burden of the more formal models which follow is to illustrate that when ex ante contracting is possible, as is likely to be the case for arrangements by which an intermediary raises capital, then competition and flexible pricing induce the efficient level of interdependence and of bank failure. When ex ante contracting is not possible, as is likely to be the case for potential recipients of payments, then banks will increase their interdependence beyond the efficient level, making simultaneous failure more likely than optimal.

We explore these issues in a framework in which bank failure, following the intuition of Calomiris and Kahn (1991) is expensive but constructive for ex ante incentives. In our environment it is not even necessary to introduce risk aversion as a motive for interbank liabilities: such liabilities can aid in increasing the bank's available capital or reducing the cost of raising capital. This is established in the following section, which begins by modeling banks's decisions independently, and then considers the consequences of banks' decisions to provide cross guarantees. The section concludes by introducing a rudimentary payments system into the framework.

4 The Model

4.1 Independent Banks

There are two periods: 1 and 2. All agents are risk neutral and care only about period 2 consumption. Banks are agents, each of whom possesses access to an exclusive pool of potential investment projects, but no capital. Investment projects require capital input in period 1 and mature in period 2. Other agents ("consumers") possess capital in period 1, but no projects. The economy wide required expected rate of return is 0. (Equivalently, capital is in unrestricted supply and there is a storage technology which converts one unit of period 1 capital into one unit of period 2 consumption)

A bank raises capital and uses it to fund a portfolio of assets chosen from its pool of projects. The portfolio of assets has a realized value of Y in period 2 as long as it is in the banker's hands; however it can be liquidated in period 2 for a realized value of X, where $X < Y$. These values are stochastic as of period 1 and observable, but not verifiable at period 2.

A bank raises capital by issuing two sorts of liabilities: "deposits" with a total face value of D and "debt" with a total face value of R. If $Y < D$ the bank is liquidated, depositors receive X and the bank and the debt holders receive zero. If $Y > D$ depositors receive D, the debt holders receive $\min\{(X-D)_+, R\}$ and the banker receives $Y - z$ where

$$\begin{aligned} z &= D \quad \text{if } D > X \\ &= X \quad \text{if } D + R > X > D \\ &= D + R \quad \text{if } X > D + R \end{aligned}$$

This structure for a bank captures the insight of Diamond and Rajan (2001), that demandable debt increases a bank's "liquidity"—that is, it enables the bank to borrow more than it could borrow under simple debt. It does so by making it more difficult to renegotiate arrangements after the fact, where simple debt will have limited ability to generate funds because of ex post hold up. On the other hand, the difficulty of renegotiation means that

the demandable debt arrangement is inflexible in some circumstances, leading to additional expenses in reorganization or liquidation.

The bank's portfolio of assets is drawn from a pool which is unique to the bank. For bank i, The distribution $F_i(Y, X; K_R + K_D)$ of value of the portfolio depends on the total of the amounts of capital raised from deposits K_D and the capital raised from debt K_R. (For convenience, we will assume the distribution is non atomic, and we will suppress the third argument and the subscript when focusing on a single bank). The amount of capital raised through deposits and debt depends on the terms (D, R) and the implicit return they generate. The return that the depositors will receive is

$$D \int_{Y>D} dF(Y, X) + \int_{Y<D} X \; dF(Y, X).$$

Note that this is independent of the choice of R. The return that the debt holders receive is

$$\int_{D<X<D+R} X - D \; dF(Y, X) + R \int_{X>D+R} dF(Y, X).$$

The banker's objective is to choose (D, R, K_D, K_R) so as to maximize

$$\int_{Y>D} Y - z \; dF(Y, X)$$

subject to the following two individual rationality constraints for the two classes of investors:[2]

$$D \int_{Y>D} dF(Y, X) + \int_{Y<D} X \; dF(Y, X) \geq K_D$$

$$\int_{D<X<D+R} X - D \; dF(Y, X) + R \int_{X>D+R} dF(Y, X) \geq K_R.$$

Simplifying, this means that the banker's objective is to maximize

$$\int_{Y>D} Y \; dF(Y, X) + \int_{Y<D} X \; dF(Y, X) - K_R - K_D$$

[2]Note that we are assuming that the choice of investments—that is the choice of the bank's distribution of asset values—is observable at the time of collecting the capital. If not considerations as in Kahn and Winton (2003) apply.

subject to those same two restrictions. Note that this simplified expression is also the social surplus associated with the bank's activities. Thus an economy of such banks, achieves a constrained efficient outcome.

4.2 Cross Guarantees

Banks could in principle engage in a variety of cross-guarantees for reach others' liabilities. The simplest version of this to consider is complete consolidation. Suppose that there are two banks 1 and 2, which are contemplating such a complete set of cross guarantees; effectively, the assets of both banks jointly back the liabilities of each. Clearly such a consolidated bank will have a common face value for debt and a common face value for deposits. Its objective will be to choose $(D, R, K_D^1, K_D^2, K_R^1, K_R^2)$ so as to maximize

$$\iint_{Y_1+Y_2>D} Y_1 + Y_2 - z \; dF_1(Y_1, X_1; K_D^1 + K_R^1) \; dF_2(Y_2, X_2; K_D^2 + K_R^2),$$

where

$$\begin{aligned} z &= D \quad \text{if } D > X_1 + X_2 \\ &= X \quad \text{if } D + R > X_1 + X_2 > D \\ &= D + R \quad \text{if } X_1 + X_2 > D + R \end{aligned}$$

and subject to

$$D \iint_{Y_1+Y_2>D} dF_1(Y_1, X_1; K_D^1 + K_R^1) \; dF_2(Y_2, X_2; K_D^2 + K_R^2) + \iint_{Y_1+Y_2<D} X_1 + X_2 \; dF_1(Y_1, X_1; K_D^1 + K_R^1) \; dF_2(Y_2, X_2; K_D^2 + K_R^2) \geq K_D^1 + K_D^2$$

and

$$\iint_{D<X_1+X_2<D+R} X_1 + X_2 - D \; dF_1(Y_1, X_1; K_D^1 + K_R^1) \; dF_2(Y_2, X_2; K_D^2 + K_R^2) + R \iint_{X_1+X_2>D+R} dF_1(Y_1, X_1; K_D^1 + K_R^1) \; dF_2(Y_2, X_2; K_D^2 + K_R^2) \geq K_R^1 + K_R^2.$$

As before, the consolidated bank's objective simplifies to the social surplus:

$$\iint_{Y_1+Y_2>D} Y_1 + Y_2 \; dF_1(Y_1, X_1; K_D^1 + K_R^1) \; dF_2(Y_2, X_2; K_D^2 + K_R^2) +$$
$$\iint_{Y_1+Y_2<D} X_1 + X_2 \; dF_1(Y_1, X_1; K_D^1 + K_R^1) \; dF_2(Y_2, X_2; K_D^2 + K_R^2) - K_R^1 - K_R^2 - K_D^1 - K_D^2$$

As a result we have:

Proposition 1 *Intermediaries will choose the optimal degree of interdependence.*

The proof is immediate: since each bank individually and the banks as a pair will maximize social surplus, it will be profitable for them to provide mutual insurance if and only if such an action increases social surplus. The key feature generating the result is the fact that capital is fairly priced. It is indeed possible that it is less likely that both banks when independent would fail than that the consolidated bank would fail. But the costs of such a failure to lenders are passed on to the bank through the price of debt.

Extensions. We have only discussed the possibility of the two extremes of bank interdependence: complete independence and full mutual insurance. We could imagine a variety of intermediate cases, and with them a variety of limited or contingent recourse between the holders of one institution's liabilities and the assets of the other institution. Kahn and Winton (2003) show in particular that, when the choice of investments is not observable by the debt holders, the introduction of more complex subsidiary structures, with limited recourse among them, can improve a bank's choice of investments. Nonetheless, it will still be the case that a financial institution with these instruments available to it will still pick the constrained socially optimal degree of interdependence between the various affiliated institutions.

The presentation above implicitly incorporates a variety of competitive assumptions: in particular, no bank possesses monopoly power over the capital market. A consolidated set of banks would very likely possess some such market power, and that would be a deterrent to allowing them to join together. In the presence of antitrust regulation on interest rate pricing, it is conceivable that mutual insurance arrangements could provide a back-door to such market power.

In Allen and Gale (2000) a second issue arises: aggregate shocks have the potential to change the shadow value of capital.[3] That paper's "aggregate shock" is in fact concentrated at a single bank. Thus taking the model literally, a solution would be to cut that single bank out of the insurance arrangement in the case of an "aggregate shock." Arrangements in which the degree of insurance provided by one bank to another varied depending on aggregate conditions are extremely plausible—indeed historically documented. Roberts (1995) cite a variety of examples where early clearing houses provided a limited form of mutual insurance which only arose in times of panic.

Nonetheless, it is also plausible that interbank arrangements are imperfect and that some of them would on occasion mistakenly treat aggregate (non-insurable) shocks as if they were insurable. However a systematic restriction of this sort requires quite stringent restrictions on clauses permitted in contracts: First it means treating aggregate shocks as nonbservable, at least within the relevant time frame. It means treating market prices generated—including pricing of intermediary liabilities themselves—as either unobservable, or as somehow not including aggregate information. And it means prohibiting the use of one firm's bankruptcy as a triggering clause in the contracts of other intermediaries.

4.3 Payments and Production

Now we modify the structure to include rudimentary production and a payments system. We add a third category of agent: "producers." Each producer produces an idiosyncratic good. If a producer pays a fixed cost C in period 1 he has available for sale, with certainty, one unit of the good in period 2. Each consumer desires at most one unit of production. Which consumer desires which production good (if any) is not known before period 2. At period 2 a consumer learns his valuation of each good; it is either v or 0.There are N producers, 2 banks, and a large number of consumers. Each producer is endowed with C units capital, and each consumer is endowed with v units of capital. As before, banks have no capital endowment.

[3]See also Diamond and Rajan (2000) and (2003).

We assume without motivation that bank debt is the sole means of payment in the economy.[4] Payments are made in period 2; at this point the value of the debt is known (the debt of failed banks cannot be used as payment). For concreteness, we make the following additional assumptions: Each bank's asset valuations is drawn from an independent distribution. In the pool for each bank are K units worth of capital projects with extremely high expected returns;[5] any additional capital will receive a negative return with certainty. (This assumption has the effect of fixing the size of each bank at K units of capital, regardless of whether the banks provide each other with cross guarantees).

As long as at least two agents with bank capital are matched with a particular producer, the market price of the producer's good in period 2 will be v. For simplicity in calculation, we assume that v will also be the price if exactly one agent is interested in the producer's good. Thus the consumers never receive surplus from the trade in goods.[6]

Clearly in economy, consumers will choose to put their capital into banks, while producers will, when the chance of a sale is sufficiently great, put their capital into production. From the point of view of the consumers (debt holders) and the intermediaries, the situation is exactly as described in the previous section, and decisions on debt contracts are unaffected by the production side. However social surplus now includes the expected profits of the producers. Suppose that T consumers have the bank debt enabling them to buy production goods. Then let $\Pi(S,T)$ be the probability that S producers find matches with consuming agents. If all producers produce then the profits to them are

$$\sum_S v\Pi(S,T) - NK$$

We do not need to know the details of the random process generating Π; all we require is that this process makes the above quantity to increase in T but at a decreasing rate. (Most

[4]See comments below.

[5]The specific formula is for the bound needed on the return to these projects is straightforward to calculate but cumbersome. Since it provides no additional intuition we omit it.

[6]Again, see comments below.

natural assumptions about random matching processes will satisfy that requirement). When both banks are solvent, there can be $2K/v$ consumers capable of buying production goods. When only one bank is solvent there can be only K/v consumers capable of buying production goods. Note that this means that the social cost of one bank's failure increases when there is a second bank failure. This marginal social cost of interdependence is not included in calculations that banks and debt holders make in determining the profit maximizing degree of interdependence. We conclude:

Proposition 2 *Intermediaries will never choose too little interdependence. For some parameter values intermediaries will choose excessive interdependence.*

In particular, for some parameter values, the choice of excessive interdependence by banks discourages production.

Comments. It is not essential that bank debt be the sole means of payment; it is only necessary that it is the most efficient means of payment.[7] For the point we make it is also not essential to restrict money to demandable debt and therefore we allowed *all* bank debt—demandable or ordinary—to be used for payment.[8] Incorporating such considerations will leave the result unaffected.

Note that we have assumed that all market power in the product market rests with the sellers. For this reason no additional contracts between the buyers and their intermediaries will solve the problem. If we were to assume, instead, that all market power rested with the buyers, it would be possible for the intermediaries to extract value from the buyers up front in return for a less fragile arrangement. However in this case, the product market would collapse entirely, since the ex post market price of the good (zero in our example) would not compensate for the up-front costs of its manufacture K. At the expense of notation and obfuscation, the

[7]For rationales for the existence and efficiency of inside money, see Cavalcanti, Erosa and Temzelides (1999) and Kahn and Roberts (2002).

[8]For theories as to why demandable debt is particularly suitable to payment see Gorton and Pennacchi (1990) and Calomiris and Kahn (1991).

model can be modified to allow for more complicated splits in the case of bilateral bargaining ex post (that is when exactly one buyer is interested in a producer's idiosyncratic good). The results will continue to hold as long as two key features are incorporated: the ex ante market for deposits is competitive, and the ex post price of the good leaves the sellers with *some* surplus. The inefficiency arises from the inability of the intermediary to capture or otherwise to take into account this seller surplus.

5 Implications for Regulation

With only two banks in our example, the inability of sellers to contract with them ex ante strains credulity. As the number of banks in the payment system increases, the idea becomes more plausible. The payments system has a natural scale economy: it is most effective when it is universal, encouraging production by extending the market for product. To the extent that payments systems are decentralized, with producers potentially receiving payment from any of a large number of purchasers delivered through any of a large number of intermediaries, it is unreasonable to assume that a potential recipient of payment can pre contract with all potential customers, or with their representative intermediaries. As a result, there is no incentive for those intermediaries to maintain the effectiveness and stability of that system.

Natural remedies include public maintenance or subsidy for the payments system. A related regulatory remedy is for the government to intervene to protect major payments-providing institutions in the case of widespread failure—a policy of "too strategically important to fail." In some cases this subsidy can take the form of ready provision of liquidity in response to aggregate shocks.[9]

In general, the policy implications of this model are similar to those of Acharya (2000): we want to provide banks with incentives not to fail when others are failing—that is, to be more forbearing of idiosyncratic failures than of collective failures. Like Acharya's analysis, ours thus leads to an immediate policy dilemma: the conclusion runs into the face of the

[9]Ready provision of liquidity by the government is also the remedy in Allen and Gale (2000).

standard recommendation that idiosyncratic failure is a signal of malfeasance, and thus needs to be punished more severely. However accounts relying on interdependence of bank liabilities differ from accounts relying on interdependence of bank assets in terms of the operative time scale. The combination of large interbank liabilities, high leverage, and ease of adjusting the financial portions of the balance sheet make the liability side of the balance sheet important for short-term economic stability. Given the relative illiquidity of bank assets the problems of excessive interdependence are therefore more likely to be of relevance for stabilization policy on the liability side.

Our framework emphasizes that it is the *decentralization* of the payments system that causes the potential instability of the financial sector. If the payment system is concentrated in the hands of a small number of institutions—and in particular if the payments system is arranged like the credit card industry, where payments recipients also establish extensive ex ante contractual relations with the payments mechanism (through, e.g., credit card merchant accounts)—then there is scope for the internalization of costs imposed by overdependence among financial institutions. Loosely speaking, then, the arguments we have provided would better justify intervention by financial authorities in America than in Europe.

6 Summary

Fragility stems from the interconnections banks establish to protect themselves from liquidity shocks. Mutual recourse for bank liabilities is often advantageous. The question we have addressed is whether banks have an incentive to increase fragility beyond the socially desirable level. When aggregate shocks are no longer a zero probability event banks find cross guarantees by other banks valuable, and are no longer indifferent about the form this insurance takes. We have build a framework examining the consequences for interbank insurance when individual bank fragility stems from a moral hazard problem.

As long as ex ante contracting between equally-uninformed parties is feasible, then banks and debt holders can reach constrained optimal arrangements for themselves. If cross

guarantees impose a risk, then the price of debt adjusts accordingly. Nonetheless, cross guarantees may be suboptimal, since it places too high a correlation on individual bank failures. If banks also provide payments services, then the social costs may be higher from having all fail than from having some fail, thus creating a justification for a regulatory intervention, when payments systems are decentralized.

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