BANK FOR INTERNATIONAL SETTLEMENTS

BIS Working Papers

No 102

Allocating bank regulatory powers: lender of last resort, deposit insurance and supervision

by Charles M Kahn* and João A C Santos*

Monetary and Economic Department

August 2001

* Charles M Kahn, Department of Finance, University of Illinois and João A C Santos, Federal Reserve Bank of New York.

The authors thank Claudio Borio, Kostas Tsatsaronis, Xavier Freixas, Mark Carey and seminar participants at the Bank for International Settlements, the Federal Reserve Bank of New York, and the 2001 Federal Reserve Bank of Chicago Bank Structure Conference for useful comments. Much of the work for this project was done while Santos was at the Bank for International Settlements. Kahn thanks the Bank for International Settlements for financial support to carry it out. The views stated herein are those of the authors and are not necessarily those of the Bank for International Settlements, the Federal Reserve Bank of New York of the Federal Reserve System.

BIS Working Papers are written by members of the Monetary and Economic Department of the Bank for International Settlements, and from time to time by other economists, and are published by the Bank. The papers are on subjects of topical interest and are technical in character. The views expressed in them are those of their authors and not necessarily the views of the BIS.

Copies of publications are available from:

Bank for International Settlements
Information, Press & Library Services
CH-4002 Basel, Switzerland

E-mail: publications@bis.org

Fax: (+41 61) 280 9100 and (+41 61) 280 8100

This publication is available on the BIS website (www.bis.org).

ISSN 1020-0959

Table of Contents

Allocating Bank Regulatory Powers:

Lender of Last Resort, Deposit Insurance and Supervision

Abstract

Bank regulation in most countries encompasses a lender of last resort, deposit insurance and supervision. These functions are interrelated and therefore require coordination among the authorities responsible for them. These authorities, however, are often established with different mandates, some of which are likely to be in conflict. We consider these issues by studying the optimal institutional allocation of such functions.

We find that a single regulator will lead to insufficient bank monitoring and suboptimal bank investment in loans. It may also lead to too much forbearance. We consider alternative structures to deal with the problem of excess forbearance both in a full information setting and in settings with asymmetry of information between regulators. We show in the former setting that if it is feasible to prespecify the rates on lending of last resort, then it is useful to make this function the exclusive province of one regulator. By giving the deposit insurer authority to close banks and by having last resort lending insured, one gives the deposit insurer strong incentives against forbearance. If it is not possible to pre-specify such rates, then a useful arrangement is to have both the central bank and the deposit insurer acting as lenders of last resort. In this structure it is important for the last resort lending to be uninsured in order to reduce temptation to overlend, although this somewhat increases the deposit insurer's temptation to forbear.

The final section of the paper analyzes asymmetry of information between regulators. We show that regulators may have an incentive not to share gathered information. Since some regulators find it easier to collect particular information, this result suggests that it is important to consider informational advantages in the allocation of bank regulation.

1 Introduction

In complex modern economies separate authorities commonly police overlapping regulations. Conflicts between the objectives and requirements of these authorities pose problems for the designers of regulatory institutions. This paper examines some of these problems in the case of banking regulation.

Banks' simultaneous provision of liquidity insurance to depositors and monitoring services to investors leads to a mismatch between liquid liabilities and illiquid assets.[1] In the event of a liquidity shock, the same information asymmetries that lead banks to adopt this asset and liability structure make it difficult for them to borrow the necessary funds in the market. As a result, they may be forced into bankruptcy. The premature liquidation of bank assets is costly because it ends valuable relationships and it may develop into a bank panic that culminates in a system failure. This risk of a system failure underpins the classical argument for mechanisms to protect banks from liquidity shocks.

Bagehot (1873), for example, proposed that the central bank (CB) act as a lender of last resort (LLR) by stating in advance its readiness to lend any amount (at a penalty rate) to a bank that is illiquid but has good collateral and is solvent. Such a bank, however, would be able to borrow from the market. It is when there is some uncertainty about a bank's financial condition that market mechanisms will fail to insure banks against liquidity shocks.[2] This market failure provides a rationale for giving the LLR authority to supervise banks in order to have access to private information and consequently an opportunity to evaluate their financial condition more accurately than the market.

Diamond and Dybvig (1983) instead proposed deposit insurance to protect banks from runs on their deposits. This mechanism is effective but it can lead to moral hazard. By offering

[1] Diamond and Dybvig (1983) explain the role of demand deposits for the liquidity insurance provision and Diamond (1984) explains the role of loans for the monitoring services provision. Calomiris and Kahn (1991), Flannery (1994) and Diamond and Rajan (1998) explain the advantages of combining these two functions.

[2] Flannery (1996) and Freixas, Parigi and Rochet (2000) provide a rationale for a lender of last resort based on interbank market failures arising from asymmetry of information.

a full guarantee, the insurance provider diminishes depositors' incentive to demand an interest rate commensurate with the bank's risk.[3] Furthermore, because it charges the bank a flat premium, it does not make the bank internalize the cost of risk, thus giving it an incentive to increase risk.[4] These distortions render a rationale for giving the deposit insurer (DI) authority to supervise banks in order to insure their solvency and to control for risk-shifting policies.

Even if the LLR supervises banks, residual information asymmetry prevents it from perfectly distinguishing between insolvency and illiquidity. Thus, a LLR that lends only to banks it considers to be solvent will not fully insure them against liquidity shocks and thus cannot completely eliminate the risk of a system failure. On the other hand, deposit insurance can protect banks from runs driven by depositors but it does not insulate them from other liquidity shocks. For example, a bank may face liquidity problems if its interbank lenders refuse to roll over their loans or if it is unable to roll over maturing commercial paper. Hence, despite the presence of deposit insurance, the justification presented above for a LLR still applies. The coexistence of these forms of regulation, together with the monitoring they require, raises a number of issues concerning both their design and their assignment to authorities.

The lending of last resort function is almost always the responsibility of CBs while deposit insurance is usually managed by a public agency or the banking industry itself. Bank supervision is usually performed by the CB or an independent public agency.[5] The institutional allocation of bank regulation is important because even if the objectives of each authority could be specified so completely as to render them perfectly consonant, the incentive difficulties arising from the agency problem and imperfections in monitoring the behavior of the authorities

[3] Dewatripont and Tirole (1994) argue that even without deposit insurance depositors would not monitor banks because they lack the expertise and the incentive, as they hold small deposits and monitoring is costly.

[4] Asymmetry of information makes it impossible, or undesirable from a welfare viewpoint, to charge banks fairly priced premiums, Chan, Greenbaum and Thakor (1992) and Freixas and Rochet (1997), respectively.

[5] There are exceptions to these patterns. For example, in Germany, the LLR is managed by the Liko Bank, a private company owned by banks and the CB. In the Netherlands and Spain the CB manages the deposit insurance. Finally, in the United States, Canada and Italy, the DI has some supervisory responsibilities. See Santos (2001a) for a detailed discussion of the institutional allocation of bank regulation in several countries.

would still lead to conflicts between the authorities' objectives. For example, the assignment of the authority to close banks to an agency other than the DI may result in a looser closure policy because that agency does not bear the full costs of delaying closure. These costs will fall on the bank's residual claimants, often the deposit insurance fund. The allocation of the lending of last resort function to an institution other than the DI can lead to a "loose" policy of liquidity support to banks because by extending short-term collateralized loans, the LLR makes itself senior to depositors and avoids the costs its liquidity support may originate.

Some of the conflicts of interest between bank regulatory agencies have been addressed through regulations that protect one of them from another's policies. For example, the regulation which assigns the DI the right to withdraw insurance coverage to a bank and that which gives legal priority to insured depositors "protect" the insurance fund from the policies of the agency in charge of closing banks.[6] Other conflicts of interest have been addressed through regulations that target the agency whose policy may give rise to the conflict. For example, prompt corrective action schemes have the effect of reducing the discretion of the agency charged with the authority to close banks.[7] Another example is the regulations defining penalties on the LLR when its loans lead to losses to the insurance fund. These have the effect of increasing the LLR's incentives to lend to solvent banks.[8]

This paper examines the institutional allocation of the lending of last resort, deposit insurance and supervision (monitoring and authority to close banks) functions. We also inves-

[6]The authority to withdraw insurance coverage is a substitute for the authority to close a bank because banks that do not offer this coverage on their deposits will find it difficult to stay in business. An example of a country where the DI has this authority is the United States. In other countries, such as Canada and Italy, the DI has authority to intervene in a bank closure (Barth, Caprio and Levine 2001).

[7]The US prompt corrective action scheme, for example, defines several trigger points based on a bank's capitalization and a set of mandatory actions for supervisors to implement at each point.

[8]Following the US House of Representatives (1991) study claiming that Fed loans to troubled banks in the 1980s increased the losses to the FDIC, Congress introduced restrictions on Fed loans and defined a penalty for lending to banks that subsequently fail (loss of the interest income received from such banks). See Gilbert (1994) for the FDICIA restrictions on the Fed's loans and a dispute of the congressional report claim.

tigate the interplay between the allocation of these powers and the design of both the deposit insurance scheme and the lending contract used by the LLR. We focus on the relative seniority of the DI and LLR claims, and on the interest rate charged by the LLR.

We find several natural ways to ensure that regulators increase their willingness to close troubled banks. One is to give closure authority to the regulator which serves exclusively as DI. In this case, the loans of the LLR should be insured by the deposit insurer, provided that the interest rates on those loans can be committed to in advance. On the other hand, if this kind of commitment is infeasible, then competition between regulators in provision of lending of last resort services helps ensure that the illiquid bank will not be held up by the regulators and therefore will be more willing to take on profitable, but illiquid lending. When both regulators have the power to provide loans to illiquid banks, it is useful for the loans of the CB not to be insured by the DI, in order to prevent the temptation to overlend to distressed banks, despite the fact that this makes the DI somewhat more forbearing.

We then extend our analysis to consider asymmetry of information between regulators. When information gathering is expensive, it is natural to have the regulators that find it easiest to gather particular information specialize in the regulatory activities for which that information is most useful. When there are multiple regulators, we show, by means of examples, that regulators may have an incentive not to share gathered information. Therefore it becomes important to allocate responsibilities in accordance with the informational advantages. For example the CB may have a natural advantage in providing lending of last resort services because of the payments information it receives.

The rest of the paper is organized as follows. The next section reviews the related literature and presents our contribution to this literature. Section 3 presents our model. Section 4 discusses the case of a unified regulator and section 5 discusses the case of multiple regulatory agencies. The final section discusses possible extensions to our model.

2 Related literature

Our understanding of the interplay between bank regulations is still rudimentary because research on the design of bank regulation tends to study each of them separately. In the case of the lending of last resort, the focus has been on the issue of whether the CB should precommit to a policy (Goodfriend and Lacker (1999) and Freixas (1999)). In the case of deposit insurance, the focus has been on the moral hazard it causes (Kareken and Wallace (1978) and Merton (1977)), the feasibility of fair premia (Chan, Greenbaum and Thakor (1992) and Freixas and Rochet (1997)) and the effects of depositor-preference laws (Osterberg and Thomson (1999) and Birchler (2000)). Finally, in the case of supervision the focus has been on the moral hazard resulting from different closure rules (Davis and McManus (1991)).

The literature that has studied the interplay between the regulations under consideration here has focused on issues such as the relationship between closure policies and deposit insurance pricing (Pennacchi (1987), Acharya and Dreyfus (1989), Allen and Saunders (1993) and Fries, Barral and Perraudin (1997)) or between lending of last resort and deposit insurance policies (Kanatas (1986) and Sleet and Smith (2000)).[9] An aspect absent from this body of research is the interaction between regulators themselves.[10] This literature assumes that both regulations are managed by a single agency or different agencies acting in perfect synchrony. On the other hand, studies such as Campbell, Chan and Marino (1992), which analyzes supervisors' incentives to monitor banks, and Mailath and Mester (1994), which analyzes the DI's incentives to close banks, assume a single regulator.[11]

Repullo (2000) considers the interaction between regulators by studying the optimal

[9]Another strand of this literature has focused on the relationship between bank capital regulation and deposit insurance. See Santos (2001b) for a review of the capital regulation literature.

[10]See Haubrich (1996) and Goodhart and Shoenmaker (1998) for the debate on the allocation of supervision and Prati and Schinasi (1999) and Vives (1999) for the debate on the allocation of bank regulation in the European Union.

[11]See Kane (1990) and Goodhart et al (1998), Chapter 3, for a discussion of the principal-agent problems between regulators and the regulated.

allocation of the lending of last resort function in an incomplete contract framework. In his model, a bank is subject to liquidity shocks that require borrowing from a LLR. The CB and the DI can act as the LLR. The selected agency is given supervision authority to obtain information on the bank's financial condition. Each agency cares about its financial wealth net of the costs of a bank failure, but only the DI considers the obligations to depositors. Repullo finds that the CB should act as the LLR when banks' liquidity problems are small, but delegate to the DI when they are large. The explanation for this result is that a regulator that does not internalize the full cost of default tends to be too strict. On the other hand, a regulator that only internalizes the costs of liquidity provision will be less strict if these costs are small and more strict if they are large. Repullo then argues that if small liquidity problems are more frequent, to avoid duplication costs, supervision should be allocated to the CB with the understanding that it will transfer the supervisory information to the DI in case of a large liquidity problem.

Our paper builds on a framework derived from Repullo's. However, it diverges from it in several key respects and reaches quite different conclusions. Unlike Repullo, we allow for a distinction between insolvency and illiquidity. We allow for the rates on lending of last resort to be determined endogenously. Repullo's results depend on the assumption that regulators have a regulatory bias against forbearance; our model allows for the bias to go in either direction but we focus on the more natural case where regulators are biased towards forbearance. Because we consider the effects of interactions between regulators we can examine the problems of competitive (private) liquidity providers, the bargaining power of a monopolist LLR, and the competition among agencies entrusted with the lending of last resort function in both symmetric and asymmetric information settings. By taking these issues into account, we are able to study the optimal allocation of the lending of last resort function and also the optimal allocation of the authority to close banks and that to monitor banks. Furthermore, we are able to investigate the implications resulting from the relative priorities of the DI and LLR's claims.

3 The model

The bank in our model faces risks of illiquidity and insolvency. Both risks are relevant for bank regulation. The decision to extend credit to an illiquid bank can stave off the costs of liquidation, but because of the temptation to divert funds to socially wasteful investments it will be inefficient to extend credit beyond the amount needed to solve the liquidity problems.

For simplicity there is no time discounting in this world. There are three periods, labeled $0, 1$, and 2. At period 0 a bank raises funds in the form of demand deposits. The total amount raised is normalized to 1. A fraction λ of these deposits is invested in "loans" — an illiquid asset that yields a random payoff $\lambda\tilde{R}$ at $t = 2$. The remainder $1 - \lambda$ is invested in a liquid asset that yields the market interest rate (which is normalized to zero). λ is assumed to be publicly observable and verifiable at period 1. For simplicity we assume the bank has no capital. Finally, there is no market for bank loans, but the bank's portfolio of loans can be liquidated (in lump sum fashion) at period 1 to yield a value λL, with $0 < L < 1$.

For reasons specified in the earlier sections, bank deposits are fully insured. Depositors can withdraw at either period 1 or period 2. The interest rate and the insurance premium are both assumed to be zero (this has no significant effect on the analysis).

The bank is subject to two sorts of shocks: a shock to liquidity demand by its depositors and a shock to the payoff on its loans. Requests for early withdrawal are made at period 1. The size of these requests is stochastic and denoted by ν, where $0 \leq \nu \leq 1$. If $\nu \leq 1 - \lambda$, then the liquid assets are used to pay depositors. If $\nu > 1 - \lambda$, then the bank's illiquid asset portfolio is liquidated, unless some lending of last resort is found.[12]

If the bank is liquidated at period 1 (or if there are insufficient funds at period 2 to pay remaining obligations), the bank is declared bankrupt, with attendant costs c. This bankruptcy

[12] If replacement deposits are also beneficiaries of the deposit insurance funds, then with sufficient advance notice it will always be possible for a bank to find substitute deposits at the riskless rate of interest for those withdrawn early. We are assuming that the lag is sufficiently great to trigger the wind-up of the firm and loss of DI's guarantees for additional depositors. Thus λ can also be interpreted as including investment in lines of credit and other sources of liquidity to ease these short-term problems when they arise.

cost captures the administrative costs of closing the bank and paying back depositors as well as the negative externalities associated with the bank failure. In the absence of regulatory intervention, the second period obligations of the bank are the payments owed to the remaining depositors. If the regulators have intervened, then the second period obligations of the bank include the amount owed to the regulators as a result of the intervention. We assume that this amount is in the form of a debt obligation.

The bank's period 2 payoff is partially predicted by signals of the profitability of the loans taken on. These signals are parameterized by the random variable u, observable to the bank. Up to this point, our framework is similar to that of Repullo (2000). In contrast to his model, however, we assume, first, that some of the uncertainty about the loan's period 2 payoff is not revealed by the signal u and, second, that this payoff also depends on interim actions taken by the bank. The remaining uncertainty is parameterized by the positive, independent random variable τ, whose expectation is normalized to 1. The period 2 payoff is either 0 or $\tau\lambda R(I)$, the latter with probability $w(I, u)$. The I refers to an interim investment decision by the bank, to which funds provided by the LLR can be diverted. We will assume that

$$R'(I) > 0$$

and

$$w(I, u)R(I) - w(0, u)R(0) < I$$

so that such diversion is not socially valuable. Thus the variable I captures the moral hazard generated by the LLR policy.[13] We will also assume that the probability $w(\cdot)$ takes the specific form

$$w(0, u) \equiv u$$

so that u parameterizes the chance of the project succeeding in the absence of funds diversion.

[13]Given the short term nature of the LLR loans, the possibilities for diversion may be limited. However, banks in need of such loans are frequently those with the greatest temptations to divert funding into wasteful attempts at resurrection.

Finally, we will assume that

$$E(u)[R(0) + c] > 1 + c$$

so that the expected return from lending (net of second period bankruptcy costs) exceeds the zero return from holding liquid assets.

As of the initial date, $t = 0$, the profitability signal u and the liquidity demand ν are independent random variables, with distributions $F(u)$ and $G(\nu)$, respectively. At period 1, only the bank observes both draws. By incurring a cost K and monitoring the bank at period 0, a regulator can observe u, the underlying condition of the bank's loan portfolio. The signal u is not verifiable. Thus, the decision to extend liquidity support to the bank cannot be specified ex ante as a function of the realization of this variable. We will assume that when monitoring occurs it is observable by the bank, and that monitoring cost K is small enough that information gathering is socially desirable. Finally, we will assume that the random variable which influences the payoff of successful banks, τ, is distributed according to the independent distribution $H(\tau)$, and is not observed until period 2. For simplicity we assume that the lower end of the support of τ is above $R(0)^{-1}$.[14]

With respect to deposit withdrawals, ν, we start by assuming, as Repullo does, that these are publicly observable. In the last section of our paper, we modify this assumption.

The objectives of regulators

A bank in financial distress will always accept terms for extension of credit up to the confiscation of all the bank's proceeds. However, the terms under which a regulatory agency is willing to extend credit will differ according to the agency's objectives, and so may diverge from the efficient levels.

The incentive structure confronting a regulator can be very complex. He may have budgetary responsibilities such that he is rewarded or punished for surpluses or cost overruns.

[14] This assumption simplifies the analysis of Section 5, by guaranteeing that a successful bank has at least enough funding to pay depositors, but does not have significant effects otherwise.

He may find some tasks very burdensome. For example, when banks appear sound, the careful monitoring of their operations may be tedious, and apparently unnecessary. Whether the monitoring is adequate is not likely to be observable at the time by parties outside the regulatory authority. A bank's failure, on the other hand, is publicly observed, and is likely to have political costs for the regulator, distinct from the social costs of the bankruptcy.[15]

A regulator's utility depends on the effort he expends on his work and on the performance measures by which that work is evaluated. Typical analyzes of employee performance assume a labor contract which ties the terms for compensation and promotion to measured standards of performance. A formulation positing this degree of detailed control over employment contracts seems inappropriate in this context. In particular, government oversight is unlikely to lead to the degree of commitment and control necessary to enforce such explicit standards. Government arrangements take into account only a limited set of criteria and a fairly general link between performance criteria and employee utility.

In the analysis that follows, we focus on two criteria — the revenues of the agency and whether or not the bank fails. We will assume that the DI regards the payments made to insured depositors as a cost. These payments, however, will not affect the performance evaluations of the regulators who run the lending of last resort function. Similarly, the regulators in charge of the lending of last resort function will receive credit or demerits in their performance evaluations for the revenues generated or lost by the authority through its lending activities. Finally, we will assume that by giving a regulatory authority the "responsibility" for bank failures, the government can make its regulators understand that such failures will count in their own evaluation. We model this problem by assuming that the regulator's utility function

[15] The costs to society of the bankruptcy are not only the direct costs of litigation and regulatory proceedings but also the costs resulting from the disruption of ownership and expertise associated with the reorganization. Ultimately these costs are borne because of the usefulness of bankruptcy as a disciplinary device vis-á-vis the owners, but we leave those costs and benefits behind the analysis and simply treat the social costs as fixed per bankruptcy.

is

$$U = Y - Ke_1 - \alpha c e_2$$

where Y is the net income accruing to the regulatory authority, e_1 is an indicator variable which is 1 if the regulator expends effort in monitoring the bank and zero otherwise, e_2 is an indicator variable which is 1 if the bank goes bankrupt and zero otherwise, and αc measures the regulator's personal bankruptcy cost.[16]

We will assume that K and αc are constant. However, different regulatory arrangements will alter their levels. For instance, if the regulatory structure places no responsibility for a bank failure on this particular regulator, then $\alpha = 0$. Moreover, in principle, the political cost of bankruptcy to the regulator (that is, the marginal rate of substitution in his utility function relative to the political benefit of revenues to the regulatory institution) can be greater or less than the social costs of the bankruptcy, that is, $\alpha \gtrless 1$.

The regulatory endgame

If a regulator takes a financial stake in a bank in return for lending funds, then the terms of the financial stake will also affect the bank's performance. Thus a regulator must establish terms based on the trade-off between revenue and bank performance. In this subsection, we will establish a model of this trade-off which will then be incorporated into the analysis of the rest of the paper.

Suppose the regulator has already decided to provide liquidity support to the bank and is now considering the terms to be required: specifically, the face value of the loan it extends, B. Increases in B increase the revenues that the regulatory authority will receive from the

[16] Of course the financial burden does not come out of a regulator's pockets. This burden is thus another form of political cost; it differs from the others discussed in that the magnitude of the political cost is not fixed, as in the case of political costs associated with the announcement of a bank failure, but variable, depending on the extent of the financial damage. If there are multiple regulators, then in principle they could each bear a cost associated with that damage. The actual magnitude of these costs is not the issue; rather, the important consideration is the divergence between the relative costs as viewed by the regulators and relative social costs.

bank and will increase the regulator's utility. On the other hand, increases in B increase the likelihood that the bank will be unable to pay the debt, increasing the possibility of bankruptcy. Thus a regulator will choose B^* to maximize his utility given he has decided to provide the bank with liquidity support. This requires him to maximize Π, where

$$\Pi = \int_{\tau} Min\Big\{\tau\lambda R(I), B\Big\} dH(\tau) - \alpha c H(\frac{B}{\lambda R(I)}).$$

Standard techniques guarantee that $B^*(\underset{-}{\alpha}, \underset{+}{\lambda})$. In other words, as regulators fear the political costs of bankruptcy, they moderate the terms they require to rescue a troubled bank. On the other hand, the bank resists investing in profitable lending because this increases the cost of last resort funding.

The regulator's decision as to how tough a bargain to drive with a troubled bank will also depend on the degree of uncertainty about the bank's future payoffs, τ. In the extreme where the distribution H degenerates to a point mass at 1 — that is, where there is no uncertainty regarding the ex-post payoff of a successful bank — the regulator can make a take-it-or-leave-it offer extracting the entirety of the ex-post surplus. In this case B and Π reduce to $\lambda R(I)$. This degenerate case is much simpler to analyze and will be used in the final section of this paper, which investigates regulatory competition.[17]

[17] Clearly regulators do not extract all the value available in banks which come to them for last resort loans. But why not? One reason of course is that in many cases the regulator is not literally the last resort; instead the regulator is in competition with alternative sources of funding, either private or public. A second reason is that the regulator is able to commit to setting a lending rate ahead of time. Both of these alternatives are examined below. When neither of these considerations is operative, then the rate set by the regulator can only be the rate which is in the regulator's best interest. That this rate does not extract all of the profit of the bank is ultimately due to the fact that it is not in the regulator's interest to do so. Our bankruptcy approach is the simplest structure to capture this idea.

3.1 Efficient regulation

Suppose we were to take the choice of λ as given, and assume that the regulator has already paid the monitoring costs K. From an efficiency perspective the two remaining issues are to ensure that no funds are diverted, that is

$$I^* = 0 \tag{1}$$

and that liquidation occurs efficiently — that is, liquidation does not occur if

$$u[\lambda R(0) + (1-\lambda)] + (1-u)[(1-\lambda) - c] > \lambda L + (1-\lambda) - c$$

and does occur if the inequality is reversed. In other words, there is a critical value u^*,

$$u^* \equiv \frac{\lambda L}{\lambda R(0) + c} \tag{2}$$

such that the bank should be liquidated if u falls below u^*.

Since the ex ante rate of return on loans exceeds the return on the liquid asset, it is efficient for the bank to put its entire portfolio into loans, that is, to set

$$\lambda^* = 1. \tag{3}$$

Finally, whether monitoring is valuable depends on a comparison of the increase in the efficiency of the liquidation decision given the information and the costs of monitoring. Using the first-best standard and assuming that

$$K < E_u[\max\{u(R(0)+c), L\}] - \max\{E(u)(R(0)+c), L\} \tag{4}$$

then the investment in information is socially valuable.

The ultimate objective of lawmakers is to choose the institutional allocation of bank regulation that implements the efficient outcome characterized by conditions (1) to (4). However, as we will see below, while some institutional allocations unambiguously dominate others, in general the choice between different allocations will involve trade-offs. In the rest of the paper, we will study several alternative institutional allocations of regulations, including a unified regulator, a single regulator with private lending, multiple regulators with specialized powers and multiple regulators that compete for last resort lending.

4 A single regulator

4.1 Unified regulation

We begin by imagining a single regulator that performs all functions: lending of last resort, deposit insurance and supervision. This unified regulator does not have the arbitrary authority to close the bank; the bank will be closed only if the regulator refuses to extend liquidity support to meet a liquidity shock.

First we consider the consequences for efficiency of closing the bank. Thus, let us assume that the regulator has observed both u and ν and that the bank turns out to have a liquidity shortfall of

$$\nu - (1 - \lambda) > 0.$$

The two issues in the arrangement are the amount of the loan and the terms of repayment. The loan amount is a simple matter: it should equal the liquidity shortfall. Any additional amount will be diverted, and any less will do no good. As for the terms of repayment, assume that the regulator, that acts as the LLR, makes his preferred fixed amount offer. We have already examined the determinants of the size of this offer. Since the LLR is also the DI, its payoff, if it does not lend the funds to keep the bank open, is

$$\lambda L + (1 - \lambda) - 1 - \alpha c$$

— that is, it receives the liquidation value of the bank, but it must pay off all depositors and it bears bankruptcy costs. If the bank continues to operate and the loans are unsuccessful, then the regulator receives

$$-(1 - \nu) - \alpha c.$$

Finally, given the fixed offer, if the bank continues to operate and the loans are successful, then the regulator receives the value

$$\Pi(\alpha c, \lambda R(0)) - (1 - \nu).$$

Thus the regulator ex-post will be willing to lend the amount needed to eliminate liquidity problems as long as $u > u_1$, with

$$u_1 = \frac{\lambda L}{\Pi + \alpha c}. \tag{5}$$

Note that if $\alpha = 1$, then, since $\Pi < \lambda R(0)$, there is insufficient forbearance ($u_1 > u^*$). As α increases, forbearance increases. In other words, the ability of the regulator to share in the value from a successful bank increases forbearance, as does an increase in the political cost of bankruptcy to the regulator.

Next we consider the incentives of this unified regulator to invest in monitoring activities. Monitoring costs K. In the absence of monitoring, the regulator will decide whether to offer to lend based on a comparison of the known value of liquidation

$$\lambda L + (1 - \lambda) - 1 - \alpha c$$

and the expectation of

$$E_u\{u\Pi - (1 - u)\alpha c\} - \lambda.$$

Therefore, if he does not monitor, his profits are

$$\max\{E(u)(\Pi + \alpha c), \lambda L\} - \alpha c - \lambda$$

in any realization in which the bank is liquidity-constrained.

If he monitors, his ex ante expected profits are

$$E_u[\max\{u(\Pi + \alpha c), \lambda L\}] - K - \alpha c - \lambda$$

— again, in any realization in which the bank is liquidity-constrained. Thus he will monitor if

$$K < \Big[E_u[\max\{u(\Pi + \alpha c), \lambda L\}] - \max\{E(u)(\Pi + \alpha c), \lambda L\}\Big] \Pr[\nu > (1 - \lambda)]. \tag{6}$$

In general there will be too little monitoring. If $\lambda < 1$, then there is less of the value of the bank at stake in the decision on early liquidation. Second, the regulator does not capture the full social value of the distressed bank. Finally, the regulator will not always have the power to close down the bank, since he is only called in to do so if there is a liquidity problem. All of these considerations reduce the value of information gathering.

It is clear that, unless the regulator can commit in advance to an agreement for lending, the bank has the incentive to keep $\lambda < 1$. For if $\lambda = 1$, then there will always be a liquidity need for borrowing, and the bank's owners will see some of their profits extracted by the LLR. If $\lambda < 1$, then as long as liquidity needs are less than $1 - \lambda$, the regulator will not be able to intervene and the bank will receive full profits.

To interpret these results, imagine the regulator valued bankruptcy at its social cost (ie $\alpha = 1$). From the ex-post point of view it is efficient to give the regulator the power to close the bank and appropriate its assets in all circumstances; for then it would consider the full social value of the assets in deciding whether to invest in the information and the closure decisions. However this would exacerbate the incentive problem of getting the bank to invest in illiquid assets. In the extreme, a unified authority able to extract the surplus of the bank in all circumstances would completely discourage ex ante investments. But more generally, the fact that a regulator imposes burdens on distressed banks in general discourages banks from taking on risky but socially efficient lending.

If the unified regulator does not have the authority to close illiquid banks, then if $\alpha = 1$, full extraction of surplus would lead to efficient levels of forbearance. Increases in α or rent extraction increase forbearance. Rent extraction in turn induces the bank to choose a suboptimal level of lending, $\lambda < 1$.[18]

4.2 A single regulator and private lending

Suppose, as is natural, that α is high enough that a unified regulator is too forbearing. In this case, one possible way to increase this regulator's incentive to close a troubled bank is to

[18] For example, in the extreme case where all rents were extracted the bank would choose λ to maximize

$$\int_u \big(\lambda R(0) - \lambda\big) G(1-\lambda) u dF(u) = E(u)\big(\lambda R(0) - \lambda\big) G(1-\lambda).$$

reduce his ability to profit from lending to the bank. We next examine this case. Consider a regulator who is allowed the unilateral right to close the bank, but is not allowed to extend liquidity support to the bank. In effect we are considering a situation in which a DI is given the right to close the bank.[19] For the moment assume there are no liquidity needs, but the DI continues to bear the financial burden of insuring depositors of the failed bank. If it closes the bank, it receives the liquidated value, less the costs of insured deposits and the political costs of a bankruptcy. If the bank remains open, it receives nothing if the bank is successful and receives the lower value of the bank less insured deposits and political costs if the bank fails.[20] An analysis paralleling the previous section's yields the result that the bank is closed when $u < u_2$, where

$$u_2 = \frac{\lambda L}{\lambda + \alpha c}. \tag{7}$$

If the political costs of bankruptcy are equal to the social costs, that is, $\alpha = 1$, then $u_2 > u^*$. In other words, this DI is too strict in its closure rule. The reason is that it does not reap the full rewards of keeping a successful bank open. On the other hand, if the political costs of bankruptcy are high, leading to excessive forbearance, $u_1 < u^*$, then the decision not to allow the insurance provider to share in the gains is useful in offsetting this tendency, since $u_2 > u_1$. The ability to share in the profits of a successful bank only exacerbates the regulator's incentive not to shut down an inefficient bank. For this reason, it is natural that regulatory regimes in which the deposit insurer is permitted to close a bank (by, for example, withdrawing insurance coverage) place limits on the ability of the same regulator to gain from the continuance of solvent banks.

As λ increases, forbearance decreases. Increasing the proportion of the firm's assets

[19] In this framework it is immediate that a supervisory agency with the authority to close a bank must have incentives linked to the financial costs of keeping the bank open. If it reaps neither financial cost nor deposit insurance cost from failure, then it always prefers forbearance, since the chance of resurrection reduces the political costs of bankruptcy. Such a regulator also does not invest in gathering information on the bank since he makes no decisions based on it.

[20] Recall that we assumed the distribution of τ is such that successful banks are able to pay depositors in full.

in illiquid loans increases the importance of the financial side of the decision to close a bank relative to the political benefits of the chance of resurrecting it. Because of this, giving the DI the unilateral power to close banks decreases the willingness of banks to engage in illiquid lending.[21]

How is this account modified when liquidity needs are no longer ignored? The simplest case to consider is one where emergency liquidity is available privately through competitive arrangements. Let us assume that there is no need for a lending of last resort function because the market is able to extend liquidity support to a bank that faces a liquidity shock. In this case, the key question is whether such liquidity is permitted to enjoy the benefits of the insurance arrangements. We consider two extreme cases: 1) emergency lending is fully insured, and 2) emergency lending is uninsured. In each case we treat in detail the effects on the DI's incentive to close the bank and, in a more cursory fashion, the effects on overprovision of liquidity.

4.2.1 Insured lenders

Suppose it were possible to limit the supply of liquidity to the efficient amount at a competitive price. Given the presence of deposit insurance this provision is riskless, and will be priced at an interest rate of 0. Thus from the point of view of the DI, the effect is the same as if the bank had no liquidity risk, that is, if $\nu = 0$ with certainty. Thus this is the case implicitly treated so far; the DI has greater incentives to close the bank than it would in the unitary situation.

Moreover, since the bank does not face any expropriation in the event of liquidity shortages, it is not discouraged from investing in illiquid loans. Since the lenders' payoffs are

[21] For example, in the extreme case where all rents are extracted from illiquid banks, the optimal level of λ maximizes

$$\int_{u \geq u_2(\lambda)} \big(\lambda R(0) - \lambda\big) G(1-\lambda) u dF(u) = \big(\lambda R(0) - \lambda\big) G(1-\lambda) \int_{u \geq u_2(\lambda)} u dF(u).$$

This expression differs from that in footnote (18) because the bank now succeeds only if $u \geq u_2(\lambda)$, whereas before it would do so for any value of u. This difference stems from the DI's power to close a liquid bank in the current institutional setting. Elementary maximization techniques show that this final term reduces the profit-maximizing level of λ for the bank.

insured, they do not need to be aware of the soundness of the underlying assets; the DI takes full responsibility for monitoring them. On the other hand, the insurance of the loans becomes an incentive to overprovision of liquidity: at the price of zero, the bank finds it worthwhile to take on additional liquidity.

4.2.2 Uninsured lenders

If private lenders are not subject to the deposit insurance umbrella, then competitive pricing will cause their loans to be more expensive. This has several consequences. Assuming that the lenders only supply an amount equal to the liquidity needs, then the cushion they provide causes the DI to be more forbearing. However, the increased expense causes the bank to be less inclined to attempt to borrow too much.

Specifically, suppose that once liquidity needs are determined, the bank will borrow $\nu - (1 - \lambda)$ by issuing debt which is not insured. (For simplicity assume that the liquidity lenders are able to observe u along with the deposit insurer; if not, the analysis is more complicated, but not fundamentally different.) Then with probability $1 - u$ the bank will fail, and the liquidity lenders will receive nothing. Thus they set a face value of at least $[\nu - (1 - \lambda)]/u$ for the debt. The payoff to the deposit insurer is

$$\lambda L + (1 - \lambda) - 1 - \alpha c$$

(the same as before) if the deposit insurer elects to shut down the bank. As before, the payoff is zero if the bank does not fail. But if the bank does fail, the deposit insurer's losses are now reduced by ν. Thus the deposit insurer chooses to shut the bank if $u < u_3(\nu)$ with

$$u_3(\nu) = \frac{\lambda L - [\nu - (1 - \lambda)]}{1 - \nu + \alpha c}. \tag{8}$$

Given that $u_3(\nu) < u_2$, then the DI is more forbearing when the bank borrows from private sources that do not benefit from insurance coverage. On the other hand, under these conditions the bank pays the entire expected price for borrowing. On the margin it bears the full burden of the reduction in expected payoff from the loan portfolio from a diversion of funds, eliminating its incentive to increase liquidity borrowing beyond the efficient level.

Interim conclusions

Thus far we have modeled the behavior of a single regulator, either a provider of both deposit insurance and lending of last resort services or a provider of deposit insurance in the presence of a competitive set of liquidity providers. We saw that the former arrangement will lead to insufficient bank monitoring and suboptimal investment in loans. It is also likely to lead to too much forbearance.

A possible remedy for the forbearance problem is to give the DI authority to close banks. In this case, it is important to magnify this authority's incentive to close troubled institutions by making sure that it does not profit excessively from lending of last resort. Since the authority to close a liquid bank will make the bank reluctant to grant even socially desirable loans, it is important to encourage this lending. One way to do so is to limit the ability of a regulator to profit from lending to illiquid banks. Lawmakers can require that lending of last resort occur at prespecified rates not linked to the bank's condition. In this case, it is important to have the DI insure this lending as well. The financial condition of the bank becomes immaterial to the LLR, and the DI bears sole responsibility for losses from bank insolvency, giving it added incentive to close a troubled bank. If lending of last resort were uninsured, this would increase the DI's incentives to forbear, and the LLR would be forced to become a monitor of bank safety as well.

An alternative way to limit excessive rent extraction is to ensure last resort lending is extended by competing private providers. As long as competition forces profits down to zero, the argument for the lending of last resort to be insured still applies. However, when liquidity is supplied privately, there is a countervailing consideration: when the providers are insured, there is a possibility that liquidity will be oversupplied. Although making the competitive private liquidity providers uninsured has other disadvantages, it does reduce the temptation for the liquidity providers to allow the bank to take on too much liquidity.

5 Multiple regulators

In this section we turn the liquidity providers into a more carefully specified institution providing lending of last resort services. We examine the implications of allowing the DI to compete with this separate institution for the provision of lending of last resort services. We consider settings both with symmetry and with asymmetry of information between these regulatory agencies. Having a separate agency provide lending of last resort services reduces forbearance on the part of the DI; allowing both agencies to compete in providing lending of last resort services increases forbearance in situations of extreme illiquidity, but encourages the bank to make more loans.

5.1 The full information case

The incentive to extend liquidity support to a bank will vary with the obligations of the LLR and the terms under which the LLR is able to extend this support. Recall that the whole point of publicly provided last resort lending is that (for whatever reason) no private entity is willing to make the loan. Therefore, the terms under which this liquidity support is extended will be determined largely by the LLR.

In the previous section we saw that despite the absence of regulatory competition, the uncertainty of the ex-post payoff of a successful bank would limit a regulator's incentive to extract benefits from a distressed bank. In this section, in order to make the analysis tractable, we assume that there is no uncertainty regarding the ex-post payoff of a successful bank, that is, $H(\tau) = 1$.

We start by assuming that both the signal on the profitability of the bank's loans, u, and that on the deposit withdrawals, ν, are publicly observable. Later on we will allow for asymmetry of information between the regulators.

5.1.1 Multiple regulators with specialized powers

Assume that the DI's power is restricted to choosing whether or not to close the bank, and a separate, specialized institution — call it a CB — gives the bank a take-it-or-leave-it offer for a liquidity loan, junior to the DI's claims. Thus the CB can expropriate all of the value of a successful illiquid firm less depositors' claims, but no value from an unsuccessful firm. In the event that the bank fails, the deposit insurer remains responsible only for late depositors (the CB having satisfied the early depositors). The CB makes the loan if

$$u[\lambda R(0) - (1-\nu)] - (1-u)\alpha c > \nu - (1-\lambda) - \alpha c$$

or $u > u_4(\nu)$ with

$$u_4(\nu) = \frac{\nu - (1-\lambda)}{\lambda R(0) - (1-\nu) + \alpha c}. \tag{9}$$

Note that as the bank's liquidity needs increase the CB's standards for lending become stricter. For sufficiently low liquidity shortfalls, standards become arbitrarily lax (see Figure 1).

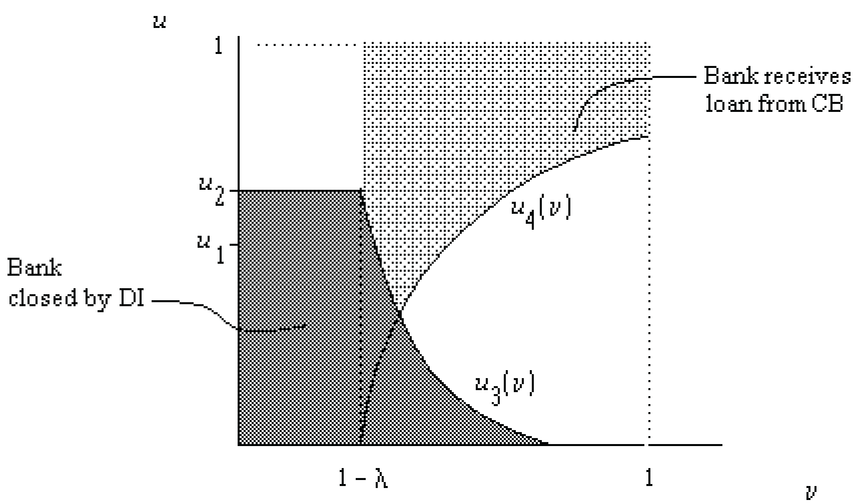

Figure 1: Policies of independent DI and specialist CB

This analysis implicitly assumes that the CB prefers to lend only up to the bank's liquidity needs. We can verify that this is indeed the case. Suppose the amount of the loan exceeded the liquidity needs of the bank. The excess would be diverted, and the diversion would increase the upside value of the bank by less than the cost of the funds. Thus an informed lender prefers not to engage in lending beyond the amount required for liquidity purposes.

The DI's decision to close the bank will depend on whether the CB is anticipated to provide the required liquidity. If the DI observes that the bank needs no loan, that is, $\nu < (1-\lambda)$, then its closure decision will be as described above (Section 4.2) in the case where funding was provided by (insured) private lenders: it will close the bank if $u < u_2$. If, on the other hand, the deposit insurer observes the bank will need a CB loan, then it becomes more forbearing. Since it will not bear responsibility for insuring the CB, it closes the bank only if $u < u_3(\nu)$ (see Figure 1).

There are two important differences between the behavior of private liquidity lenders and the behavior of a specialized CB. Since the CB extracts more surplus, the bank chooses to invest more in liquid assets than it would in the presence of competitive liquidity lenders. But more importantly, even if the bank were charged the same interest rate in both regimes, there would still exist a difference in behavior because private lenders do not bear any cost in the event the bank goes bankrupt and therefore are always willing to extend liquidity support. Because the CB bears that cost, it will not extend liquidity support if the bank needs a large liquidity infusion. Therefore, there will be cases where the DI will choose to let the bank continue, but the bank will fail because it is unable to obtain liquidity support (the lower right region of Figure 1).

Let us now compare the current structure to the unified regulator of the earlier section. When there is no uncertainty regarding ex-post payoff of a successful bank, B and Π both reduce to $\lambda R(I)$, implying $u_1 < u^*$. As indicated in the figure, u_1 is also lower than u_3 at low levels of ν and lower than u_4 at high levels of ν. In other words, forbearance is reduced at both high and low levels of bank illiquidity. (Forbearance is increased at intermediate levels, but it can be shown that for low values of c this intermediate region becomes vanishingly small.) Thus the introduction of a second regulator in general reduces the forbearance problem: at low levels of illiquidity the DI becomes less forbearing. At high levels of illiquidity, where the DI is more forbearing than the unified agency was, the CB now refuses to lend, thus forcing the bank into bankruptcy. Indeed it is possible that at either extreme the regulatory system will become too strict relative to efficient regulation.[22]

5.1.2 Multiple regulators: competition in last resort lending

So far we have seen that separating lending of last resort services from deposit insurance can reduce the DI's forbearance at low levels of illiquidity, while allowing the CB to maintain bank discipline at high levels of illiquidity. However, there are two problems with this arrangement. First, since the CB's decision to provide liquidity will depend on the amount of liquidity needed by the bank, circumstances can arise where it is efficient to provide liquidity but the loan becomes too expensive for the CB to contemplate. Second, even if the CB does provide liquidity, the lack of competition for the CB makes liquidity shortages prohibitively costly for the bank. Moreover, in earlier sections we have seen that allowing a DI the power to close a liquid bank discourages the bank from engaging in sufficient lending.

A natural remedy for all these problems is to allow both regulators to serve as lenders of last resort. First, the DI will take on lending to keep the bank open in situations where the CB would not find it advantageous to do so. Second, competition means that the charges for the lending will not be so prohibitive as to deter the bank from taking on an illiquid loan

[22] In this section, we assumed that the CB held a junior claim. If it held a claim senior to that of the deposit insurer, then it would extract all of the value of a successful, but illiquid firm. It would be willing to lend if $u > u_5(\nu)$, with

$$u_5(\nu) = \frac{\nu - (1-\lambda)}{\lambda R(0) + \alpha c}.$$

As expected, given λ the CB is more willing to extend liquidity support when it holds a senior claim, $u_5(\nu) < u_4(\nu)$. However, now the DI becomes too tough. Because the DI incurs the cost αc with certainty when the bank needs liquidity assistance, then whenever this happens it chooses to close the bank. As a result, for a given size of its portfolio of loans, λ, the DI chooses to close the bank whenever it observes $\nu > (1-\lambda)$, despite the fact that in some of these cases the CB is willing to extend liquidity support. Making the CB's claim senior also reduces the bank's choice of λ. Even though the CB is more willing to lend when it holds a senior claim, the DI is less forbearing in this case. In particular, it always chooses to close the bank in the region where the CB is now willing to lend.

portfolio. Finally, competition, by reducing the profits the DI receives from a successful bank, continues to mitigate against excessive forbearance in bank closure.

We continue to assume that both the DI and the CB observe u and ν at no cost. The DI is given the unilateral power to close the bank based on its observation and it is also given the power to offer liquidity loans. The bank enters an exclusive agreement with whichever institution it prefers. A loan from the CB is not insured by the DI.

We will need to consider how the presence of two regulators allows the distressed bank to benefit. Depending on valuations of u and ν, there are regions where either both the CB and the deposit insurer or neither of them are willing to pay up front unilaterally for a bailout. As long as only one of the regulators is willing to bail out the bank, the bank will receive nothing in the bailout. If both regulators are willing to bail out the bank, then there will be some value to the bank from the bailout. We take the extreme position that the regulators compete for the privilege of providing the bailout. A less extreme assumption is that the regulators collude, but that the collusion is imperfect. We use the simpler assumption as indicative of the considerations that will arise.

Suppose the bank determines the lender through an auction. The unusual aspect of this arrangement is that the loser is not indifferent as to whether the winner takes on the job — in other words, we are considering an auction of a good with externalities. The appendix lays out the payoffs in the full information case for a general model of this sort: we will simply apply those results.[23] The payoffs of the DI and CB are as follows. If no loan is made, the CB receives

$$-\alpha c$$

and the DI receives

$$\lambda L + (1 - \lambda) - 1 - \alpha c.$$

If the deposit insurer makes a loan extracting full surplus from the bank, the expected

[23] As an aid to understanding the issues, the appendix also presents a simpler case where CB lending is insured by the deposit insurer.

value to the CB is simply

$$-(1-u)(\alpha c).$$

The value to the deposit insurer is as described in the section on the unified regulator.

If the CB is making an uninsured loan to the bank, its ultimate payoff is dependent on the total amount of the liquidity shortfall — the larger the shortfall, the more the CB will lose in the event of failure. Correspondingly, the larger the liquidity shortfall, the more the deposit insurer gains if the CB does engage in the emergency lending, since its actions have the effect of replacing insured deposits with uninsured ones. When the CB makes a loan extracting full surplus from the bank, the expected value of the loan to the CB is

$$u[\lambda R(0) - (1-\nu))] + (1-u)(-\alpha c) - [\nu - (1-\lambda)]$$

and that to the deposit insurer is

$$-(1-u)[(1-\nu) + \alpha c]$$

Both of the regulators agree on the value of winning the loan versus letting the other regulator win the loan. This value is

$$u[\lambda R(0) - (1-\nu)] - [\nu - (1-\lambda)].$$

If this value is positive — that is, if $u > u_6$ with

$$u_6(\nu) = \frac{\nu - (1-\lambda)}{\lambda R(0) - (1-\nu)} \tag{10}$$

— then, provided that the deposit insurer does not exercise its right to withdraw the insurance coverage extended to the bank, the two regulators will compete for the chance to offer the loan to the bank. Since the lender's deposits are no longer insured, the maker of the loan sets a face value equal to $\frac{\nu-(1-\lambda)}{u}$, the value of the loan adjusted for the probability of losing it. This gives the winner zero expected profits, while the bank receives positive expected profits (see Figure 2).

If $u < u_6(\nu)$, then a rescue may or may not occur. The rescue will occur if *either* of the regulators wishes for it to occur. If $u > u_1$, the DI favors rescue — the same criterion as if it operated alone. If $u > u_4$, the CB favors rescue. Note that it can happen that both regulators prefer the rescue to occur, but that each prefers the other to take on the task. As a result, in this region the bank will obtain a liquidity loan from either the CB or the DI, but whoever makes the loan will be able to extract surplus from the bank.

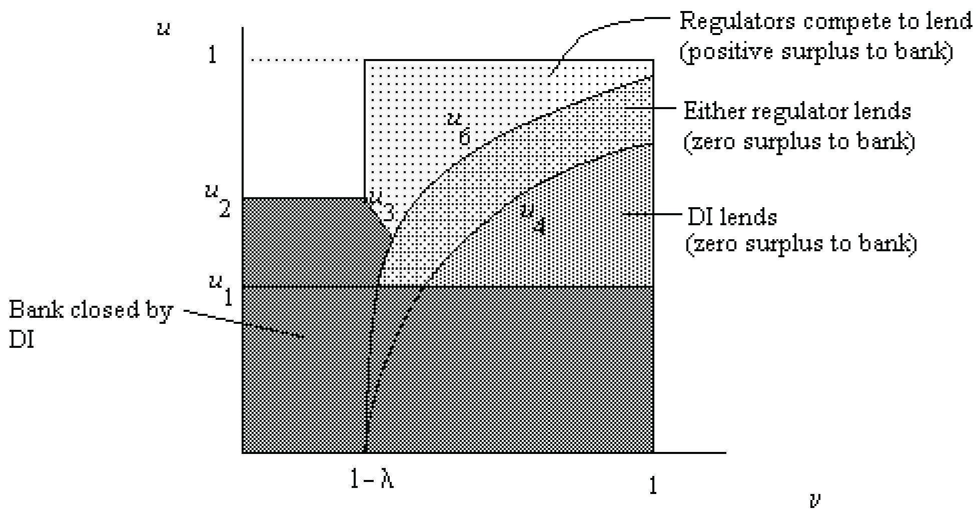

Figure 2: Policies of competing DI and CB

These decisions are made at the time when competition for the right to offer the loan. Before that point the DI has the unilateral power to close the bank. If the CB is not interested in lending, then the DI's closure criterion is identical to its funding criterion: $u > u_1$. If the DI does not profit from the lending, its closure decision is a more stringent one: $u > u_3$.

Let us compare the competitive arrangement with the arrangement where the CB had the monopoly in lending of last resort services. Holding λ constant and comparing Figure 1 with Figure 2, it becomes clear that, in general, the competition increases the likelihood that highly illiquid banks will be kept from bankruptcy. Whether this is desirable depends on how stringent the monopoly CB was in lending in such circumstances. The main difference between the regimes is that the bank now keeps the surplus, despite illiquidity in some circumstances, encouraging it to take on a higher level of lending.

5.2 The asymmetric information case

In order to examine the effects of having the two regulators privy to different information, we must strip the model down in an extreme fashion. We will not attempt to provide an analysis for all possible parameter values of the model; instead we will use the model to illustrate the possibilities that arise for particular parameter values and which differ from those outcomes noted by other analysts. We will not allow either regulator to unilaterally close the bank; instead the bank can only be closed if neither regulator extends the credit necessary for the bank to meet its liquidity obligations. We drop explicit consideration of the bank's choice of ex ante liquidity (which we set to $\lambda = 1$) and the regulator's choice of ex ante payment for information (we assume that if the regulator is able to gather the information, it does so); in each case these considerations will be addressed indirectly and informally by examining whether the payoffs in our stripped-down model would induce changes from this behavior. We greatly reduce the generality of the stochastic structure; we simply assume that the draws of u and ν come from independent two-point distributions. In each case we denote the two realizations by subscripts H and L (for high and low), and the probability of the low realizations by ρ_u and ρ_ν, respectively.

Thus the game involves each regulator making a loan offer to the bank (that is, a proposed pair (ν_0, B), where ν_0 is the initial payment to the bank and B is the repayment demanded from the bank) based on the information the regulator receives. The offer can of course be zero. The bank then chooses the preferred offer. If there is no offer or, equivalently, if the offer provides $\nu_0 < \nu$ or requires a repayment greater than the bank's value, the bank is bankrupted. If both offers are feasible, then the bank takes the preferred offer. Subject to the restrictions noted in the previous paragraph, the payoffs received by the regulators are as described in earlier sections; for convenience we repeat them here. If no loan is made, then the CB receives $-\alpha c$ and the DI receives $L - 1 - \alpha c$. If the DI's offer of (ν_0, B) is accepted, then the DI's payoff is

$$wB - (1 - w)(1 - \nu + \alpha c) - \nu_0$$

and the CB's payoff is $-(1-w)\alpha c$. If the CB's offer of (ν_0, B) is accepted, then the CB's payoff is

$$wB - (1-w)\alpha c - \nu_0$$

and the DI's payoff is $-(1-w)(1-\nu+\alpha c)$. Recall that $w(\nu_0 - \nu, u)$ is the probability of the bank's investment succeeding. As long as the loan provides the bank no excess liquidity, this equals u; but if the lending is above what is needed, then $w < u$. The size of this drop is a parameter of the model.

Repullo has argued that for low levels of liquidity shortage, the LLR function should be taken on by the DI, while for high levels it should be taken on by the CB. This result, however, ignores the strategic possibilities inherent in asymmetric information. Suppose, for example, that the CB has an advantage in determining ν. (This advantage could naturally arise as a by product of the CB's management of the payments system.) Given this advantage, and given the costs of overprovision of liquidity, it may well be that the DI confines itself to lending small amounts of liquidity, leaving the CB in sole control in the case of large loans. We consider two different cases:

Case 1: ν is known only by the CB; u is known only by the DI

In this case consider the following strategies: If the DI observes the high draw u_H, it offers $(\nu_L, R(0)-(1-\nu_L))$. If the DI observes the low draw u_L, it makes no offer. If the CB observes the high draw ν_H, it makes the offer $(\nu_H, R(0)-(1-\nu_H))$. If it observes the low draw ν_L, it makes no offer.

In other words, if the DI observes a high draw of u, it will offer a loan which is sufficient to save the bank if the liquidity needs are low, but insufficient to bail out the bank if liquidity needs are high. This offer extracts all the surplus if the bank is successful. If the CB observes a high draw of ν, it will also make an offer which extracts all surplus if the bank is successful.

Given these two strategies by the regulators, the bank's optimal response is as follows: If the bank faces a high draw of ν, then the CB's offer is the only feasible offer and the bank takes it. If the bank faces a low draw of ν, and a high draw of u, it only receives a feasible offer from the DI and it accepts it. If the draws of both ν and u are low, then the bank receives no rescue and is bankrupt.

The behavior we describe will be equilibrium behavior for the two regulators if the following conditions hold: 1. Offers which extract surplus from a bank with low u are worse for the regulator than no offer at all. 2. Offers to a bank with high u are desirable, but only if they do not provide excessive liquidity. 3. The CB's offer when ν is high is desirable on average: while it loses money when the draw of u is low, it makes money when it is high. These three conditions hold provided that u_L and ρ_u are sufficiently small, $R(0)$ is sufficiently large, and the value of $w(\nu_H - \nu_L, u_H)$ is sufficiently low. Given the other parameters of the model, values for these four parameters can always be found to satisfy these conditions and induce the described equilibrium.

If these requirements are satisfied, then the cost of potential overinvestment deters the DI from offering large lending. Instead the DI concentrates on small lending to solvent firms. The CB specializes in large liquidity loans and in the absence of information about the solvency of the banks simply lends regardless of quality when liquidity needs are high. Note that in this case the CB extracts all rents from high-volume liquidity lending, and the DI extracts rents from high-quality low-volume liquidity lending. For other parameterizations, there are opportunities for competition between the two to leave some rent for the bank.

Finally, note that in this environment neither party has an incentive to release its information to the other party. For if this were to happen, it would no longer be possible for that party to extract the rents it achieves. We illustrate this fact by considering a second case, in which the CB learns the DI's information:

Case 2: ν is known only by the CB; u is known by both the CB and the DI.

In this case, consider the following strategies: If the DI observes the high draw u_H, it offers $(\nu_L, \nu_L/u_H)$. If the DI observes the low draw u_L, it makes no offer.

If the CB observes u_L, it makes no offer. If it observes (ν_L, u_H), it makes the same offer as the DI. If it observes (ν_H, u_H), it makes the offer $(\nu_H, R(0) - (1 - \nu_H))$.

In other words, the two regulators avoid low-quality loans. They compete for small high-quality loans; the terms of the loans indicated are the competitive terms described in the full information sections of this paper. Because of its informational disadvantage, the DI does not attempt to offer large loans, and so the CB extracts surplus from large high-quality loans. This behavior is an equilibrium under the parameter restrictions as described in case 1.

Reallocating rents to the bank from the DI increases the bank's incentive to invest in loans, but reduces the DI's incentive to invest in information gathering. Moreover, if the DI were able to choose which information structure were to prevail (for example, if it had the option of disclosing information to the CB), it would prefer the CB to have less information.[24]

6 Final remarks

By implicitly assuming that regulation is managed by a single authority, most of the literature on bank regulation has ignored the question of the institutional allocation of regulatory powers. In practice, banks are regulated by overlapping authorities, often established with different mandates, some of which are likely to be in conflict. Even if their objectives could be specified so completely as to render them perfectly consonant, the incentive difficulties arising from the agency problem and imperfections in monitoring the behavior of the authorities would still lead to conflicts between the authorities' objectives.

A notable exception is Repullo (2000), but his analysis suffers from several limitations. We have extended Repullo's analysis to account for some of these limitations. For example, we have examined the effects of competition in provision of the lender of last resort function — both competition between regulators and private lenders and competition among the regulators themselves. We have considered some aspects of the design of the deposit insurance scheme, most notably the legal priority of the two authorities' claims on the bank's assets, and the effect of the DI's authority to withdraw insurance coverage extended to a bank and thus force it into

[24]Contrast this result with proposals that call for regulators to share information as needed.

bankruptcy even when the CB is willing to extend liquidity support to this bank. Finally, we have considered, through a simple set of examples, an issue which has been absent thus far from the debates on the institutional allocation of banking supervision: agencies' incentives to collect information about banks and their incentives to transmit this information to the other regulatory agencies.

Given regulatory authorities' typical reluctance to close failing banks, it is natural to focus on adjustments which reduce the temptation to regulatory forbearance. Two natural structures have emerged from our discussion. If it is feasible to prespecify the rates at which a LLR will lend, then we can make the lending of last resort function the exclusive province of one regulator. The other regulator, as provider of deposit insurance, does not obtain payments from successful banks and is empowered to close banks. The LLR's loans should be insured. In this structure, the DI has a strong incentive against forbearance, while the LLR can concern itself exclusively with liquidity.

A second natural structure has both the CB and the DI ready to act as lender of last resort, the competition between them making the prespecification of interest rates unnecessary. In this structure it is important for the CB to be uninsured by the DI in order to reduce temptation to overlend, although this somewhat increases the DI's temptation to forbear. In this structure, we found, like Repullo, a tendency for small liquidity shortfalls to be handled by the CB and large liquidity shortfalls to be handled by the DI, because of the differences in the costs of a bank failure to the two regulators. However, these results stem from quite different mechanisms; in our analysis it is a matter of competition between regulators, while for Repullo it is a matter of voluntary delegation of the job by one regulator to the other.

The significance of this distinction becomes apparent when we turn to the examples with asymmetric information. Our examples show how regulator's incentives distort their decisions to share information. Clearly this problem must be considered in allocating regulatory powers which are intensive in information gathering. This issue, however, becomes even more important when we consider the fact that some agencies have a natural advantage in the collection of certain information because of their activities. Thus conclusions should not be based on the assumption that agencies have perfect incentives to delegate activities based on the information they collect.

The incentives to collect supervisory information depend on the potential use of this information for the agency entrusted with this power. We have focused on gathering of information before a bank is in distress; it would also be worthwhile to consider the incentives of regulators to extract information from already distressed banks. Our examples are only suggestive, and therefore this appears to be a particularly fruitful topic for future research.

There are numerous other issues which can be profitably investigated in examining overlapping bank regulation. In examining informational advantages, we have considered the example of a CB's benefiting from information obtained through its role in the payments system. CBs may also derive advantages from their role in conducting monetary policy. This role has been key in the recent debates on the allocation of banking supervision, but these investigations have not taken into account regulatory incentives. Similarly, an understanding of these incentives can play a role in the debate on the design of deposit insurance and lending of last resort schemes, and whether these arrangements should be public or private.

Appendix: Bargaining under full information

Suppose two parties are bidding for a good under full information in a second price auction. The good is worth w_i to party i if he wins it. If the other party wins the good, the situation is worth l_i to party i. (We normalize so that, with neither party winning, the good is worth 0 to each.) We will consider all possible cases, including situations where for example w_i is negative (that is, the "good" is a bad). Denote the parties A and B.

Case I: $w_A < 0$ and $w_B < 0$.

In this case neither party bids for the good and the good goes unsold. Otherwise, at least one party opens the bidding at a price of zero and the good will eventually sell.

Case II: ($w_A > 0$ or $w_B > 0$) and ($w_A - l_A > 0$ or $w_B - l_B > 0$).

Then the good goes to the individual I, for whom $(w_i - l_i)$ is larger. Say this is party A. Then it goes for the price $[w_B - l_B]_+$.

Case III: $(w_A - l_A < 0$ and $w_B - l_B < 0)$ and $w_A > 0$ and $w_B < 0$.

Then the good goes to A at a price of zero.

Case IV: $(w_A - l_A < 0$ and $w_B - l_B < 0)$ and $w_B > 0$ and $w_A < 0$.

Then the good goes to B at a price of zero.

Case V: $(w_A - l_A < 0$ and $w_B - l_B < 0)$ and $w_B > 0$ and $w_A > 0$.

Then the good is allocated randomly at a price of zero.

Case V is the doubtful case it resembles a game of "chicken" or "belling the cat" as each party tries to wait for the other party to take the good. The results for this case in practice would depend on who has the last move.

Application: Deposit insurance for the CB

The simplest case to analyze turns out to be the case of allowing the LLR to have some insured deposits up to a fixed limit set initially. This is a free option for the LLR: it gets value if successful, and no worse off if unsuccessful. The following formulas form the basis of the analysis:

The LLR receives:

$$-\alpha c$$

if rescue does not occur; an expected payoff of

$$-(1-u)\alpha c$$

if the DI rescues the bank; and an expected payoff of

$$u(\lambda R - \lambda) - (1-u)\alpha c$$

if the LLR itself rescues the bank and extracts the entirety of the surplus.

The DI receives:

$$\lambda L - \lambda - \alpha c$$

if rescue does not occur;

$$(1-u)[(1-\lambda)-1-\alpha c]$$

if the LLR rescues the bank; and

$$u(\lambda R-\lambda)+(1-u)(-\lambda-\alpha c)$$

if it undertakes the rescue itself and extracts the surplus. Under such an arrangement, the LLR is always interested in lending, because he is financially protected from failure. Therefore he will always bid. The DI has to compare the profits from taking the job himself vs the profits if the LLR does (rather than the comparison to not doing it at all, which would be efficient). The difference is $u(\lambda R-\lambda)$. This is always positive, so the DI will always be willing to pay this amount to keep the loan. For the LLR the difference between winning the loan and having the rival regulator win the loan is also worth $u(\lambda R-\lambda)$. So in such a world, the two bidders in competition push the price this high, regardless of the values of u and ν.

The implementation of this price is completely natural: each regulator offers to supply the troubled bank with the shortfall of liquid assets, in the form of deposits. If these deposits are supplied by the LLR, then they are under the DI's coverage. If either of the regulators were to attempt to extract a premium for the loan, the other regulator would prefer to offer the loan on the better terms. Note, however, that this means that the bank is never denied liquidity funding. Moreover, if we allow the DI the discretion to close the bank early, that problem reduces to the considerations outlined before. In other words, if we had available the ability to place caps on the lending permitted to the LLR so as to ensure that there would be no overlending, this would be an effective way of ensuring that the bank retained its rents.

References

Acharya, S. and J.F. Dreyfus (1989) "Optimal Bank Reorganization Policies and the Pricing of Federal Deposit Insurance," Journal of Finance, 44(5), 1313-1333.

Allen, L. and A. Saunders (1993) "Forbearance and Valuation of Deposit Insurance as a Callable Put," Journal of Banking and Finance 17, 629-643.

Bagehot, W. (1873) *Lombard street: A Description of the Money Market.* London: H. S. King.

Barth, J.R., J. Caprio, and R. Levine (2001) "The Regulation and Supervision of Banks Around the World: A New Database," Mimeo, World Bank.

Birchler, U.W. (2000) "Bankruptcy Priority for Bank Deposits: A Contract Theoretic Explanation," Review of Financial Studies 13, 813-839.

Calomiris C.W. and C.M. Kahn (1991), "The Role of Demandable Debt in Structuring Optimal Banking Arrangements," American Economic Review 81(3), 497-513.

Campbell, T.S., Y.S. Chan, and A.M. Marino (1992) "An Incentive-Based Theory of bank Regulation," Journal of Financial Intermediation 2, 255-276.

Chan,Y. S., S. I, Greenbaum, and A. V. Thakor. 1992. "Is Fairly Priced Deposit Insurance Possible?" Journal of Finance 47:227-245.

Davis, S.M. and D.A. McManus (1991) "The Effects of Closure Policies on Bank Risk-Taking," Journal of Banking and Finance 15(4-5), 917-938.

Dewatripont, M. and J. Tirole (1994) "The Prudential Regulation of Banks," Cambridge, MA, MIT Press.

Diamond D.W. (1984) "Financial Intermediation and Delegated Monitoring," Review of Economic Studies, 393-414.

Diamond, D.W. and P.H. Dybvig (1983) "Bank Runs, Deposit Insurance and Liquidity," Journal of Political Economy 91, 401-419.

Diamond, D.W. and R.G. Rajan (1998) "Liquidity Risk, Liquidity Creation and Financial Fragility: A Theory of Banking," Mimeo, University of Chicago.

Flannery, M.J. (1996) "Financial Crises, Payment Systems Problems, and Discount Window Lending," Journal of Money, Credit and Banking 28(4), 804-824.

Flannery, M.J. (1994) "Debt Maturity and the Deadweight Cost of Leverage: Optimally Financing Banking Firms," American Economic Review 84, 320-331.

Freixas, X. (1999) "Optimal Bail Out Policy, Conditional and creative Ambiguity," Mimeo Universitat Pompeu Fabra, Barcelona.

Freixas, X., B. Parigi and J.C. Rochet (2000) "Systemic Risk, Interbank Relations and Liquidity Provision by the Central Bank," Journal of Money Credit and Banking 32(3), 611-638.

Freixas X. and J.C. Rochet (1997) "Fair Pricing of Deposit Insurance. Is it Possible? Yes. Is it Desirable? No." Mimeo, University Pompeu Fabra, Barcelona.

Fries, S., P.M. Barral and W. Perraudin (1997) "Optimal Bank Reorganization and the Fair Pricing of Deposit Guarantees," Journal of Banking and Finance 21, 441-468.

Gilbert, R.A. (1994) "Federal Reserve Lending to Banks that Failed: Implications for the Bank Insurance Fund," Federal Reserve Bank of ST. Louis Review 76(1), 3-18.

Goodfriend, M. and J.M. Lacker (1999) "Limited Commitment and Central Bank Lending," mimeo Federal Reserve Bank of Richmond.

Goodhart, C., P. Hartmann, D. Llewellyn, L. Rojas-Suárez and S. Weisbrod (1998) "Financial Regulation: Why, how, and where now?" New York: Routledge.

Goodhart, C., and D. Schoenmaker (1998) "Institutional Separation between Supervisory and Monetary Agencies," in *The Emerging Framework of Financial Regulation.* C. Goodhart Ed., Central Banking Publications Ltd, London.

Haubrich, J.G. (1996) "Combining Banking Supervision and Monetary Policy," Federal Reserve Bank of Cleveland Economic Commentary, November.

Kanatas G. (1986) "Deposit Insurance and the Discount Window: Pricing Under Asymmetric Information," Journal of Finance, 41(2), 437-450.

Kane, E.J. (1990) "Principal-Agent Problems in S&L Salvage," Journal of Finance 45(3), 755-764.

Kareken, J.H., and N. Wallace (1978) "Deposit Insurance and Bank Regulation: A Partial-Equilibrium Exposition," Journal of Business 51, 413-438.

Mailath, G.J. and L.J. Mester (1994) "A Positive Analysis of Bank Closure," Journal of Financial Intermediation 3(3), 272-299.

Merton, R.C. (1977) "An Analytic Derivation of the Cost of Deposit Insurance and Loan Guarantees," Journal of Banking and Finance 1, 512-520.

Osterberg, W.P. and J.B. Thomson (1999) "Depositor-Preference Laws and the Cost of Debt Capital," Federal Reserve Bank of Cleveland Economic Review 35(3), 10-20.

Pennacchi, G.G. (1987) "Alternative Forms of Deposit Insurance: Pricing and Bank Incentive Issues," Journal of Banking and Finance 11, 291-312.

Prati, A. and G.J. Schinasi (1999) "Financial Stability in European Economic and Monetary Union," mimeo, IMF.

Repullo, R. (2000) "Who Should act as a Lender of Last Resort? An Incomplete Contracts Model," Journal of Money Credit and Banking 32(3), 580-605.

Santos, J.A.C. (2001a) "Bank of England in Central Banking Theory," forthcoming in *The International Encyclopedia of Business and Management*, 2^{nd} edition Malcolm Warner ed, Thomson Learning, London.

Santos, J.A.C. (2001b) "Bank Capital Regulation in Contemporary Banking Theory: A Review of the Literature," *Financial Markets, Institutions and Instruments* 10(2), 41-84.

Sleet, C. and B.D. Smith (2000) "Deposit Insurance and Lender of Last Resort Functions," Journal of Money Credit and Banking 32(3), 518-575.

US House of Representatives (1991) "An Analysis of Federal Reserve Discount Window Loans to Failed Institutions," by the staff of the Committee on Banking, Finance and Urban Affairs.

Vives, X. (1999) "Banking Supervision in the European Monetary Union," mimeo Institut d'Anàlisi Econòmica, CSIC.

Recent BIS Working Papers

No	Title	Author
82 November 1999	Sacrifice ratios and the conduct of monetary policy in conditions of low inflation	Palle S Andersen and William L Wascher
83 January 2000	Switching from single to multiple bank lending relationships: determinants and implications	Luísa A Farinha and João A C Santos
84 January 2000	What have we learned from recent financial crises and policy responses?	William R White
85 January 2000	A defence of the expectations theory as a model of US long-term interest rates	Gregory D Sutton
86 March 2000	Information, liquidity and risk in the international interbank market: implicit guarantees and private credit market failure	Henri Bernard and Joseph Bisignano
87 May 2000	Monetary policy in an estimated optimisation-based model with sticky prices and wages	Jeffery D Amato and Thomas Laubach
88 June 2000	Evidence on the response of US banks to changes in capital requirements	Craig Furfine
89 August 2000	Forecast-based monetary policy	Jeffery D Amato and Thomas Laubach
90 September 2000	Bank capital regulation in contemporary banking theory: a review of the literature	João A C Santos
91 October 2000	Measuring potential vulnerabilities in emerging market economies	John Hawkins and Marc Klau
92 October 2000	Recent initiatives to improve the regulation and supervision of private capital flows	William R White
93 October 2000	Trading volumes, volatility and spreads in foreign exchange markets: evidence from emerging market countries	Gabriele Galati
94 November 2000	Corporate hedging: the impact of financial derivatives on the broad credit channel of monetary policy	Ingo Fender
95 November 2000	The impact of corporate risk management on monetary policy transmission: some empirical evidence	Ingo Fender
96 December 2000	The real-time predictive content of money for output	Jeffery D Amato and Norman N Swanson
97 December 2000	Information flows during the Asian crisis: evidence from closed-end funds	Benjamin H Cohen and Eli M Remolona
98 January 2001	Money and inflation in the euro area: a case for monetary indicators?	Stefan Gerlach and Lars E O Svensson
99 June 2001	The interbank market during a crisis	Craig Furfine

100 July 2001	The impact of the euro on Europe's financial markets	Gabriele Galati and Kostas Tsatsaronis
101 July 2001	Can liquidity risk be subsumed in credit risk? A case study from Brady bond prices.	Henri Pagès