Allocating Bank Regulatory Powers:

Lender of Last Resort, Deposit Insurance and Supervision

Charles M. Kahn*

Department of Finance
University of Illinois
1206 S. Sixth St.
Champaign, IL 61820
Email: c-kahn@uiuc.edu

João A. C. Santos*

Research Department
Federal Reserve Bank of New York
33 Liberty St.
New York, NY 10045
E-mail: joao.santos@ny.frb.org

February 4, 2002

JEL classification: G21, G28

Keywords: Lender of last resort, deposit insurance, supervision.

*The authors thank Claudio Borio, Kostas Tsatsaronis, Xavier Freixas, Mark Carey, Jim Wilcox, Charles Kramer and seminar participants at the Bank for International Settlements, Federal Reserve Bank of New York, Bank of Japan, IMF, the 2001 Federal Reserve Bank of Chicago Bank Structure Conference, the 2001 EFA and FMA and the 2002 AFA/NAEFA meetings 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 or the Federal Reserve System.

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 these problems 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.

When there is 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.[1]

Banks' simultaneous provision of liquidity insurance to depositors and monitoring services to investors leads to a mismatch between liquid liabilities and illiquid assets.[2] 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. In contrast, when there is some uncertainty about a bank's financial condition the market mechanisms might fail to insure banks against liquidity shocks.[3] This market failure provides a rationale for establishing a LLR and for giving it authority to supervise banks in order to have access to private information and consequently to be able to evaluate their financial condition more accurately than the market. Note though that even

[1] Throughout the paper we use the terminology "banking regulation" in a broad sense, that is, to include not only formal rules but also supervision, deposit insurance and lending of last resort.

[2] 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.

[3] 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.

if the LLR supervises banks, residual information asymmetry will prevent it from perfectly distinguishing between insolvency and illiquidity. Therefore, 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.

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 a full guarantee, the insurance provider diminishes depositors' incentive to demand an interest rate commensurate with the bank's risk.[4] Furthermore, by charging the bank a flat premium, the insurance provider does not make the bank internalize the cost of risk, thus giving it an incentive to increase risk.[5] 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.

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. Consequently, 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 not only their design but also their assignment to authorities.

The institutional allocation of bank regulation is important because regulatory agencies are often established with different mandates, some of which are likely to be in conflict. 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 would still lead to conflicts between the authorities' objectives. For example, the assignment of the authority to close banks to an agency other

[4]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.

[5]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.

than the DI may lead to excessive forbearance 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 agency from another's policies. 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 responsible for the conflict. Prompt corrective action schemes have the effect of reducing the discretion of the agency charged with the authority to close banks.[7] Regulations that impose penalties on the LLR when its loans lead to losses to the insurance fund in turn have the effect of increasing the LLR's incentives to lend to solvent banks.[8]

The recent debate on whether supervision should be performed by central banks has raised policymakers' awareness of the potential conflicts of interest between regulatory functions and of addressing these conflicts by reallocating regulatory responsibilities. This debate, however, has focused on the question of whether supervision should come under the jurisdiction

[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 defines several trigger points based on the 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.

of the central bank or be placed in an independent agency.[9] In general, it has not considered the institutional allocation of the other regulatory functions and the assignment of supervision to a regulator other than the CB or an independent agency. Yet, there are significant differences on the institutional allocation of bank regulation across countries. For example, the lending of last resort function is almost always the responsibility of CBs, but in Germany, it is managed by the Liko Bank, a private company owned by banks and the CB. Deposit insurance is usually managed by a public agency, but in the Netherlands and Spain it is managed by the CB. Finally, supervision is generally performed by the CB or an independent agency, but in the United States, Canada and Italy the DI has some supervisory responsibilities.[10]

Our paper expands the literature on the institutional allocation of bank regulation by studying the optimal institutional assignment of a broad set of regulations. Specifically, we examine the institutional allocation of the lending of last resort, deposit insurance and supervision (monitoring and authority to close banks) functions. In addition, we investigate the interplay between the institutional allocation of these regulations and the design of both the deposit insurance scheme and the lending of last resort contract.

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 DI, provided that the interest rates on these 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.

[9] See Haubrich (1996) and Goodhart and Schoenmaker (1998) for the arguments presented in this debate.

[10] See Santos (2001a) for a discussion on the institutional allocation of bank regulation in several countries.

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 compares it with our contribution. 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 most studies have considered each regulation separately. For example, 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 cost 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)).[11] An aspect absent from this literature is the interaction between regulators themselves because it usually 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.[12]

Repullo (2000) considers the interaction between regulators by studying the optimal 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 reason is that a regulator that does not internalize the full cost of default tends to be too strict. However, a regulator that only internalizes the costs of liquidity provision is 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, and 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

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

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

either direction but we focus on the more natural case where regulators are biased towards forbearance. Furthermore, 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. Finally, in addition to the study of the optimal allocation of bank regulation, we also investigate the implications resulting from the relative priorities of the DI's claims and those of the LLR.

3 The model

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. The bank chooses to invest a fraction λ of these deposits in "loans" — an illiquid asset that yields a random payoff $\lambda\tilde{Z}$ 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. 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 $0 < L < 1$.

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). For simplicity we assume the bank has no capital.

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. Stochastic liquidity demand denoted by ν comes in the form of requests for early withdrawal in period 1, with $0 \leq \nu \leq 1$. If $\nu \leq 1 - \lambda$, the liquid assets are used to pay depositors. If $\nu > 1 - \lambda$, the bank's illiquid asset portfolio is liquidated, unless some LLR is found.[13] We assume that if the LLR extends liquidity support to the bank

[13]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

it does so in the form of a debt obligation. If instead the bank is liquidated at period 1 (or if there are insufficient funds at period 2 to pay remaining obligations), the bank will be declared bankrupt, with attendant costs c. This bankruptcy cost captures the administrative costs of closing the bank and paying back depositors as well as the negative externalities associated with the bank failure.

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 technology 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. The remaining uncertainty is revealed only at date 2 and is parameterized by a random variable $\tilde{\tau}$. Second, we assume that the loan's period 2 payoff also depends on interim actions taken by the bank. At period 1 the bank can divert some of the funds provided by the LLR and make an interim investment λI. This interim investment is intended to capture the moral hazard generated by the LLR policy.[14] We summarize these ideas in the following assumption:

Assumption 1 *If the bank invests λ in loans at period 0 and makes an additional investment $\lambda I \geq 0$ at period 1 using funds from a lender of last resort, it will receive at period 2 $\lambda \tilde{Z}$ where*

$$\lambda \tilde{Z} = \begin{cases} \lambda \tilde{\tau} R(I) & \text{with probability} \quad w(I)u \\ 0 & \text{with probability} \quad 1 - w(I)u \end{cases}$$

We normalize the function $w(\cdot)$ so that $w(0) = 1$. We will also make the following substantive assumption regarding w:

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.

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

Assumption 2 *The bank's diversion of lending of last resort funds at date 1 is profitable, but not socially valuable, that is,*

$$R'(I) > 1 \qquad and \qquad w'(0) = 0 \qquad but \qquad w(I)uE(\tilde{\tau})R(I) - w(0)uE(\tilde{\tau})R(0) < I.$$

Assumption 3 *The expected return from bank lending (net of second period bankruptcy costs) in the absence of funds diversion exceeds the zero return from holding liquid assets, that is,*

$$E(\tilde{u})[E(\tilde{\tau})R(0) + c] > 1 + c.$$

The next set of assumptions characterize the risks faced by the bank in our model.

Assumption 4 *As of date* 1, *the positive random variable which determines the payoff of successful banks,* $\tilde{\tau}$, *follows the independent distribution* $H(\tau)$, *assumed to have an increasing hazard function. The realization of this variable at date* 2 *is publicly observable. The expected value of this variable is normalized to* 1 *and its support is assumed to be larger than* $R(0)^{-1}$, *that is,*

$$E(\tilde{\tau}) = \int_{\underline{\tau}}^{\overline{\tau}} \tau dH(\tau) = 1 \qquad and \qquad \underline{\tau} \geq R(0)^{-1}.$$

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.

Assumption 5 *As of date* 0, *the deposit withdrawals at date* 1, $\tilde{\nu}$, *are an independent random variable with distribution* $G(\nu)$. *These withdrawals are publicly observable at date* 1.

In the last section of our paper, we modify this assumption and consider the case of asymmetry of information between the regulatory agencies regarding the bank's liquidity needs.

Assumption 6 *As of date 0, profitability signal of the bank's portfolio of loans,* $\tilde{u}$, *is an independent random variable with distribution* $F(u)$. *At date 1, only the bank observes the* *underlying condition of its loan portfolio. By incurring a cost K and monitoring the bank at date* 0, *however, a regulator can observe* u. K *is small enough that information gathering is socially desirable, that is,*

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

We assume that when monitoring occurs it is observable by the bank. The signal u, however, is not verifiable. This implies that the decision to extend liquidity support to the bank cannot be specified ex ante as a function of the condition of the bank's portfolio of loans. For simplicity we assume that the liquidation decision is made by the regulator without knowledge of the bank's liquidity choice; this omits some additional strategic considerations which, while of interest, are secondary to our main concerns.

Thus far we have modeled a bank that faces risks of illiquidity and insolvency, and which is able to divert funds it receives from a LLR. Both risks are relevant for bank regulation. The decision to extend credit to an illiquid bank can stave off the costs of liquidation, some of which will fall on the regulator, 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 these reasons, the objectives of regulators will play a key role on their decision to extend credit to an illiquid bank and the terms under which they will be willing to extend this credit.

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 incentives, 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. 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 analysis 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. This is summarized in the following assumption.

Assumption 7 *The regulator's utility function is*

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

[15]The costs to society of the bankruptcy are not only the costs of litigation and regulatory proceedings but also the costs resulting from the disruption of ownership and expertise caused by the reorganization. Ultimately these costs are borne because of the social value of bankruptcy as a financial resolution and as an incentive device, but we leave those costs and benefits behind the analysis and simply treat the ex-post social costs as fixed per bankruptcy.

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 assume that K and αc are constant. However, different regulatory arrangements will alter their levels. For instance, if a regulatory structure places no responsibility for a bank failure on a given regulator, then its $\alpha = 0$. Moreover, in principle, the political cost of bankruptcy to the regulator (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; however, we will focus on the case where $\alpha > 1$, that is, the case where the regulator's costs of bankruptcy exceed the social costs of bankruptcy.

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 the 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 B of the loan it extends. Increases in B increase the revenues that the regulatory authority will receive from the bank and will increase the regulator's utility. On the other hand, increases in B

[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 socal costs and the relative costs as viewed by the regulators.

increase the likelihood that the bank will be unable to pay the debt, increasing the possibility of bankruptcy. Thus, the regulator will choose B^* to maximize his utility given he has decided to provide the bank with liquidity support. Let Ψ denote the regulator's income net of the bankruptcy costs when he demands a payment B^*. Then we have

$$\Psi = \int_\tau \min\{\tau\lambda R(I), B^*\}dH(\tau) - \alpha c H(\frac{B^*}{\lambda R(I)}).$$

Standard techniques guarantee that B^* decreases with α and increases with λ. 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. Note that 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. Increased uncertainty weakens the regulator's bargaining position.

3.1 Efficient regulation

Based on the assumptions we have made above, the efficient solution to our model is characterized by the four results summarized in proposition 1.

Proposition 1 *Under the efficient regulation:*

(i) the regulator monitors the bank all the time,

(ii) the bank invests all of its deposits in loans, $\lambda^* = 1$,

(iii) the regulator liquidates the bank when its financial condition is lower than u^*,

(iv) the regulator's lending of last resort equals the bank's liquidity shortfall, $I^* = 0$.

Proof: Start by assuming the regulator has already paid the monitoring costs K. Assumption (2) guarantees that it is not efficient for the regulator to extend last resort funding in excess of the bank's liquidity shortfall, which implies that

$$I^* = 0.$$

Next consider the regulator's liquidation decision at date 1. Efficiency dictates that the bank should be liquidated if

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

and should not be liquidated if the inequality is reversed. Thus, there is a critical value u^*,

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

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

By assumption (3), it is efficient for the bank to put its entire portfolio into loans, that is, to set

$$\lambda^* = 1.$$

Finally, assumption (6) guarantees us that the investment in information is socially valuable—that is, the increased efficiency of the regulatory decisions with the information exceeds the cost of monitoring. *QED*

The ultimate objective of lawmakers is to choose the institutional allocation of bank regulation that implements the efficient outcome characterized in proposition (1). However, information asymmetries and other frictions such as regulator's political costs of bankruptcy will make it difficult to achieve that goal. 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, both in settings with symmetry and asymmetry of information between the regulators.

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. We assume that this unified regulator does not have the unilateral authority to close the bank; the bank will be closed only if the regulator refuses to extend liquidity support to meet a liquidity shock. Proposition (2) shows that this leads to important deviations from the efficient regulation. At the end of the section, we note how these results would change if this unified regulator were also to have unilateral authority to close the bank.

Proposition 2 *Under a unified regulator without unilateral authority to close banks:*

(i) there is too little bank monitoring,

(ii) there is too little bank investment in loans, $\lambda < \lambda^*$,

(iii) for high political costs of bankruptcy there is excessive forbearance, $u_1 < u^*$,

(iv) the regulator's lending of last resort equals the bank's liquidity shortfall, $I^* = 0$.

Proof: Suppose that, having observed both u and ν, the regulator declares itself willing to lend. Suppose the bank has a liquidity shortfall of

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

Then the regulator will choose to lend an amount equal to the liquidity shortfall at the preferred repayment level B^*. 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 the regulator receives

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

Alternatively, if the loans are successful, the regulator receives the value

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

Thus the regulator ex-post will chose not to liquidate the bank as long as $u > u_1$, with

$$u_1 \equiv \frac{\lambda L}{\Psi + \alpha c},$$

which is less than u^* for α sufficiently high.

Next we consider the incentives of this unified regulator to invest in monitoring activities. Monitoring costs are 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

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

Therefore, if he does not monitor, his profits are

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

in any realization where the bank is liquidity-constrained.

If he monitors, his ex ante expected profits are

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

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

$$K < \left[E_u\Big[\max\{u(\Psi + \alpha c), \lambda L\}\Big] - \max\{E(\tilde{u})(\Psi + \alpha c), \lambda L\}\right] \Pr[\nu > (1 - \lambda)].$$

Calculations in Appendix A demonstrate that the right side of this inequality is less than the right side of assumption (6). Thus, there will be situations in which monitoring does not occur even though it is efficient.

Finally, we need to show that the bank will choose to invest some of its deposits in liquidity rather than in loans. 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.[17] 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. *QED*

Before we consider the next regulatory arrangement, it is worth analyzing some implications of the unified arrangement considered here. Note that for small liquidity shocks there will always be excessive forbearance in this unified arrangement. When $\nu \leq (1 - \lambda)$, because the bank does not need a loan and the regulator does not have the unilateral right to close banks, the bank will continue in operation regardless of its financial condition, u. For larger liquidity shocks that force the bank to search for a liquidity loan the direction of any distortion will depend on the biases of the regulators. For $\alpha = 1$, since $\Psi < \lambda R(0)$, there is insufficient forbearance ($u_1 > u^*$). Efficient forbearance would be achieved only if the regulator were to extract the entire surplus of the bank. Increases in α or rent extraction ability increase forbearance. However, rent extraction induces the bank to choose a suboptimal level of lending, $\lambda < 1$.

There are several reasons that the regulator monitors too little. First, since $\lambda < 1$, there is less of the value of the bank at stake in the decision on early liquidation. Since the regulator has a bias towards forbearance, learning that the bank should be closed is less valuable information. 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.

How would these results change if this unified regulator also had unilateral authority to close the bank — that is, if he had authority to close the bank even when it did not need a LLR loan? Imagine this regulator valued bankruptcy at its social cost (ie $\alpha = 1$). In this case, from the ex-post point of view it would be efficient to give the regulator the power to close the bank and appropriate its assets in all circumstances; for then it would consider the

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

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

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 identified above 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 will discourage banks from taking on risky but socially efficient lending.

4.2 A single regulator and private lending

As we saw in the previous section, the unified regulator has too little incentive to engage in monitoring and is likely to be too forbearing of unprofitable banks. Its ex post power leads regulated banks to underinvest in risky lending. As the next proposition shows, one possible way to increase this regulator's incentive to close a troubled bank is to reduce his ability to profit from lending to the bank. This, however, also comes at a cost.

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 banks that face a liquidity shock. One way to guarantee the market provides full protection to banks in the presence of information frictions is to permit the providers of last resort lending to enjoy the benefits of the insurance arrangement. But this entails an overprovision of lender-of-last-resort funding. At the end of this subsection we briefly discuss what would happen if private lenders were not able to benefit from the insurance coverage.

Proposition 3 *Assume a single regulator with unilateral power to close banks and without authority to extend last resort funding. If this regulator is required to insure funds of private lenders of last resort, then*

(i) the bank invests efficiently in loans, $\lambda^* = 1$,

(ii) for high political costs of bankruptcy, there is excessive forbearance, but this problem is less acute than that which existed in the unified arrangement, $u_1 < u_2 < u^*$,

(iii) there is moral hazard due to excessive availability of last resort funding, $I > I^*$,

(iv) the following two conditions are sufficient for information gathering to occur more frequently than under the unified regulation of the previous section:

(a) in the single regulation regime always keeping the bank open is more profitable than always liquidating the bank

(b) in the unified regulation regime the regulator extracts a sufficiently large portion of the surplus of liquidity constrained banks.

Proof: The bank's expected profits are

$$E(\tau)w(I)u\lambda[R(I) - I - 1].$$

To maximize this expression, the bank will choose $I > 0$ and $\lambda = 1$ (recall that $R' > 1$ by assumption (2)). In the current arrangement, since the lenders' payoffs are insured, they do not need to be aware of the soundness of the underlying assets; the DI takes full responsibility for monitoring them. The insurance coverage given to such loans provides an incentive to overprovision of liquidity: at the price of zero, the bank finds it worthwhile to take on additional liquidity, $I > 0$, thus giving rise to moral hazard. As for the bank's investment in loans, since the bank does not face any expropriation in the event of liquidity shortages, it is not discouraged from investing in illiquid loans and chooses $\lambda^* = 1$.[18]

Next, consider the regulator's incentives. If it closes the bank, it receives the liquidated value, less the costs of insured deposits and the political costs of a bankruptcy

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

[18] By assuming that the regulator's closure choice is made without observing the allocation of liquid versus illiquid loans, we have eliminated one more channel for strategic interaction between regulator and bank. The regulator anticipates the extent to which the bank will take on illiquid loans when deciding on its closure policy, but it does not react to the bank's decision. If instead it observed and reacted to that decision, then, the expressions for u_2 and u_1 show that as λ increases, forbearance decreases. In order to increase forbearance, the bank will in general choose less illiquid lending.

If the bank remains open, the regulator 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.[19] Thus the expected payoff is

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

An analysis paralleling the previous proof shows that the bank is closed when $u < u_2$, where

$$u_2 \equiv \frac{\lambda(L + I)}{w(I)(\lambda(1 + I) + \alpha c)}.$$

Calculations in Appendix A demonstrate that $u_2 > u_1$; and for α large, $u_2 < u^*$.

Finally we prove the last claim of the proposition. In the unified arrangement, information gathering increases the expected payoff of the regulator by the amount

$$\int^{u_1} L\lambda - u(\Psi + \alpha c) du,$$

where the integrand is positive for $u < u_1$. In the single regulator case of this section, information gathering increases the expected payoff of the regulator by the amount

$$\int^{u_2} L + I - wu(\alpha c + (I + 1)) du,$$

where again the integrand is positive for $u < u_2$. A sufficient condition for the latter expression to be greater is $\Psi > 1$. *QED*

The regulator we have defined in proposition (3) is in essence a DI which is 1) allowed the unilateral right to close banks, 2) required to insure private lenders of last resort, 3) forbidden to compete with the private sector in the provision of emergency liquidity.[20] If the

[19] Recall that assumption (4) guarantees us that the distribution of τ is such that successful banks are able to pay depositors in full.

[20] 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.

political costs of bankruptcy are high, leading to excessive forbearance in the unified setting, $u_1 < u^*$, then the decision not to allow the insurance provider to share in the gains is useful in offsetting this tendency because $u_2 > u_1$. To put it differently, 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.

4.2.1 Uninsured lenders

As we discussed in the introduction, asymmetry of information may lead to a market failure in the interbank market. Nonetheless, let us see for the purpose of comparing with the previous results what would happen if private lenders were not subject to the deposit insurance umbrella.

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.) Given that with probability $1 - u$ the bank will fail, and the liquidity lenders will receive nothing, then they will set a face value of at least $[\nu - (1 - \lambda)]/u$ for their debt. Under these circumstances, the payoff to the DI is

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

(the same as before) if it elects to shut down the bank. If the DI does not shut down the bank, then its payoff is zero (the same as before) if the bank does not fail, but if the bank does fail, the DI's losses are now reduced by ν. Thus the DI chooses to shut the bank if $u < u_3(\nu)$ with

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

We can now see some of the implications of having competitive private lending uninsured. 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, $u_3(\nu) < u_2$. The increase cost in the last resort funding that comes with the withdrawal of deposit insurance causes the bank to be less inclined to attempt to borrow too much. In fact because 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, thus 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 is likely to lead to too much forbearance. It will also lead to insufficient bank monitoring and suboptimal investment in loans.

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. Making the competitive private liquidity providers uninsured does reduce the temptation for them to allow the bank to take on too much liquidity, at the likely cost of increased forbearance.

5 Multiple regulators

Because of the problems that may arise with private provision of last resort funding, in this section we turn the private liquidity providers into a more carefully specified institution. We examine the implications of allowing the DI to compete with this separate institution for the provision of lending of last resort services in settings both with symmetry and with asymmetry of information between these regulatory agencies.

5.1 No asymmetry of information between regulators

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.

We will start by assuming that both the signal on the profitability of the bank's loans, u, and that on the deposit withdrawals, ν, are observable by both regulators at no cost. Later on we will allow for asymmetry of information between the regulators.

5.1.1 Multiple regulators with specialized powers

As we saw before, moving lending of last resort out of the unified regulator and requiring it to insure the competitive private lending, improves the regulator's incentives to close a troubled bank, but it gives private participants an incentive to over extend liquidity support to the bank giving rise to moral hazard. What will happen if lending of last resort is instead extended by a public agency like the central bank (CB)?

When we studied the unified regulatory arrangement, we showed that despite the absence of regulatory competition in the provision of liquidity, the uncertainty of the ex-post payoff of a successful bank limited a regulator's incentive to extract rents 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, $H(\tau) = 1$. In this case, the LLR can give the bank a take-it-or-leave-it offer for a liquidity loan, which we assume to be 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.[21]

Proposition 4 *Under a multiple regulator arrangement where the DI has the unilateral right to close banks, and a separate, specialized institution extends (uninsured) liquidity support*

(i) there is too little bank investment in loans, and the underinvestment problem is more severe than that which existed in the unified arrangement,

(ii) for high political costs of bankruptcy, there is excessive forbearance. The comparison of level of forbearance with the unified case is ambiguous: for intermediate liquidity shortfalls the problem is more acute, but for high and low liquidity shortfalls forbearance is less acute than that which existed in the unified arrangement.

(iii) the regulator's lending of last resort equals the bank's liquidity shortfall, $I^* = 0$, *as in the unified arrangement.*

Proof: It is straightforward to see that CB's ability to extract rents when the bank needs a liquidity loan gives an incentive to the bank to hold some of its deposits in liquidity, $\lambda < 1$.

[21]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.

Moreover, as we show in Appendix A, the bank is now less willing to invest in loans than it was under the unified arrangement. This results from the attribution of the authority to unilaterally close banks to the DI.

To see whether the bank will be able to continue after date 1, we need to identify under what conditions the CB is willing to extend it a loan and the DI is willing to let it continue in operation. Let us first study the CB's emergency lending decision. Under the current arrangement, in the event that the bank fails, the DI remains responsible only for late depositors (the CB having satisfied the early depositors). Thus, the CB makes the loan if

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

or $u \geq u_4(\nu)$ with

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

Note that as the bank's liquidity needs increase the CB's standards for lending become stricter (see Figure 1).

Let us now study the DI's decision to close the bank. This decision 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, $\nu \leq (1-\lambda)$, then its closure decision will be as described in 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 DI observes that the bank will need a CB loan, that is, $\nu > (1-\lambda)$, 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).

Based on these results, it becomes clear that for large values of α there is excessive forbearance under the current arrangement because for $\nu \leq (1-\lambda)$ we have $u_2 < u^*$ and for $\nu > (1-\lambda)$ we have $Max\{u_3(\nu), u_4(\nu)\} < u^*$.

How do these results compare to the unified arrangement? Under the assumption made in this section that there is no uncertainty regarding the ex-post payoff of a successful bank, B and Ψ both reduce to $\lambda R(I)$, implying that $u_1 < u^*$ for $\alpha > 1$. As indicated in Figure

1, u_1 is also lower than u_3 at low levels of ν and lower than u_4 at high levels of ν. Thus, forbearance is reduced at both high and low levels of bank illiquidity. Forbearance is increased at intermediate levels.

So far in this proof we implicitly assumed that the CB prefers to lend only up to the bank's liquidity needs. We can verify that this is indeed the case, guaranteeing therefore the absence of moral hazard in connection with lending of last resort. 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. As a result, we will have $I = 0$. *QED*

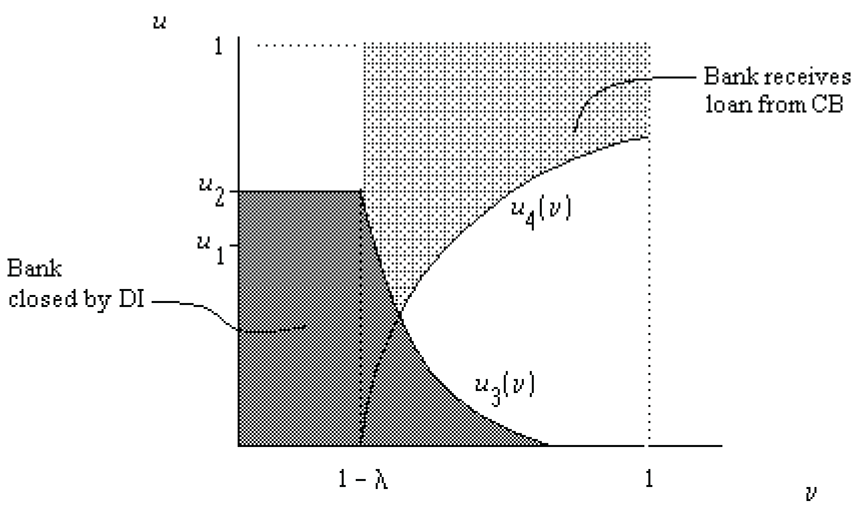

Figure 1: Policies of independent DI and specialist CB

While the degree of forbearance can be greater or less with a unified regulator than with a single regulator, it can be shown that for low values of c this intermediate region described in the theorem above becomes vanishingly small. That is to say, for low values of c, introduction of a second regulator generally 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. Indeed it is possible that at either extreme the regulatory system will become too strict relative to efficient regulation.[22]

To conclude this section, let us briefly compare the present arrangement with the institutional arrangement where private lenders extend liquidity support which is insured. There are two important differences between the behavior of private liquidity lenders and the behavior of a specialized CB. First, Since the CB extracts some surplus, the bank chooses to invest more in liquid assets than it would in the presence of competitive liquidity lenders. 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).

Finally, under the specialized last resort lending arrangement, there is, for small liquidity shortfalls, an aggravation in the excess forbearance problem that existed in the insured competitive arrangement because $u^* > u_2 > Max\{u_3(\nu), u_4(\nu)\}$ (see Figure 1), but there is also a potential improvement in that problem for large liquidity shortfalls because for certain combinations of parameters $u_4(\nu) > u_2$.

[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 $\nu > (1-\lambda)$. Making the CB's claim senior also reduces the bank's choice of λ. The reason is that even though the CB is more willing to lend when it holds a senior claim, the DI is less forbearing in this case (the DI always chooses to close the bank in the region where the CB is now willing to lend).

5.1.2 Multiple regulators: competition in lending of last resort

So far we have seen that separating lending of last resort services from the DI and giving them to the CB can reduce the DI's excessive incentive to forbear. 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 efficient lending.

A natural remedy for 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 may not be so prohibitive as to deter the bank from taking on an illiquid loan 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.

We assume the bank determines the lender through a competitive 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. Appendix A lays out the equilibrium payoffs in the full information case for a general model of this sort: in the proof which follows, we will simply apply those results.[23]

Proposition 5 *Under a multiple regulator arrangement where the DI has the unilateral right to close banks and is allowed to compete with a separate, specialized institution for the provision of liquidity support*

(i) *there is too little bank investment in loans*

(ii) *for high political costs of bankruptcy, there is excessive forbearance, but this problem is less acute than that which existed in the unified arrangement,*

(iii) *the regulator's lending of last resort equals the bank's liquidity shortfall,* $I^* = 0$, *as in the unified arrangement.*

Proof: In the auction the competing regulators specify the level of I as part of their competing bids. I is chosen to maximize the sum of the surpluses to the bank and the winning regulator. Since neither regulator can shift its insurance costs to the other regulator, this sum is maximized by choosing $I = 0$, and all competing bids will be for the minimum loan necessary to prevent liquidity shortfall.

If no loan is made, the CB receives

$$-\alpha c$$

and the DI receives

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

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

If the DI makes a loan extracting full surplus from the bank, the expected value to the CB is

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

The value to the DI is

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

If instead the CB makes the loan, the expected value of the loan to the CB is[24]

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

and that to the deposit insurer is

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

Both 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 $u \geq u_6$ with

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

— then, provided that the DI 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).

[24]Note that if the CB makes 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 DI gains if the CB does engage in the emergency lending, since its actions have the effect of replacing insured deposits with uninsured ones.

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.

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: $u \leq u_1$. If the DI does not profit from the lending, its closure decision is a more stringent one: $u > u_3$.

Given that for high values of α, as we saw before $u_2 < u^*$, then based on Figure 2 it becomes apparent that in the present arrangement there is excessive forbearance. Based on that figure it is also straightforward to see that this problem is now less acute than that which existed in the unified arrangement.[25]

Moreover, given that in the present arrangement, as illustrated in Figure 2, for certain combinations of u and ν the CB and the DI are willing to provide liquidity assistance only if they do it alone, and given that in these cases they will extract rents, then the bank will find it profitable to protect itself by holding some of its deposits in liquidity, choosing a $\lambda < \lambda^* = 1$. *QED*

How does the bank's choice of investment level compare with the choice under the unified regulator? There are two differences between these institutional arrangements that have countervailing impacts. First, in contrast with the unified regulator, in the present arrangement, when the bank does not need a liquidity loan it may still be closed because the DI has the authority to unilaterally close banks. *Ceteris paribus* this reduces λ.[26] Second,

[25]Recall that under the unified arrangement the bank would be allowed to continue if it did not need a liquidity loan, regardless of its financial condition, and would be closed in case it needed a loan and its financial condition was such that $u < u_1$.

[26]See computation for proposition 4 in Appendix A for proof.

also in contrast with the unified regulator, in the present arrangement when the bank needs emergency liquidity support, in some cases because both the CB and the DI are willing to compete for the right to do it, the bank gets to keep its rents, whereas under the unified regulator it would loose them. *Ceteris paribus* this difference increases λ.

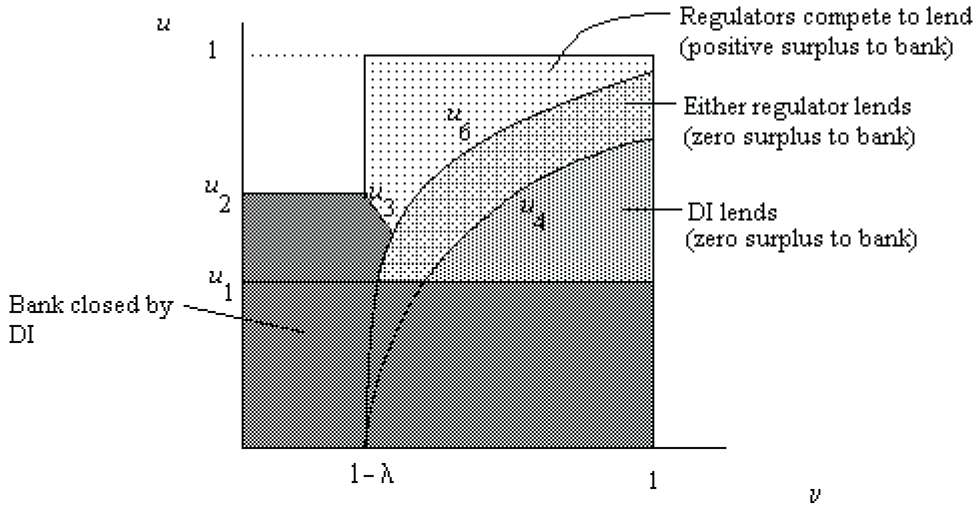

Figure 2: Policies of competing DI and CB

To finish this subsection, let us briefly 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 Asymmetry of information between regulators

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 next two different cases. In both cases we will assume that ν is known only by the CB. In contrast, in one case we will assume that u is known only by the DI and in the other it is known by both the CB and the DI.

Let us analyze our first case where we assume that ν is known only by the CB and 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:

Lets now analyze our second where we assume that ν is known only by the CB and 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.[27]

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 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

[27]This result that regulatory agencies may not have an incentive to share the information they gather stands in sharp contrast to the proposals in the ongoing debate on the institutional allocation of bank supervision that call for regulators to share information as needed.

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 A: Calculations for proofs of propositions

Calculation for proposition 2: Suppose

$$\frac{\lambda L}{\Psi + \alpha c} < \frac{L}{R+c}$$

and

$$\frac{\lambda L}{\Psi + \alpha c} < E(\tilde{u})$$

—for α large, both inequalities hold. Then

$$\begin{aligned}
&\Pr(\nu > 1-\lambda)[E_u \max\{u(\Psi+\alpha c), \lambda L\} - \max\{E(\tilde{u})(\Psi+\alpha c), \lambda L\}] \\
&< [E_u \max\{u(\Psi+\alpha c), \lambda L\} - \max\{E(\tilde{u})(\Psi+\alpha c), \lambda L\}] \\
&= E_u \max\{0, \lambda L - u(\Psi+\alpha c)\} \\
&= \int_0^{\frac{\lambda L}{\Psi+\alpha c}} \lambda L - u\left(\Psi + ac\right) dF(u) \\
&< \int_0^{\frac{L}{R+c}} L(1 - u\left(\frac{\Psi+ac}{\lambda L}\right))dF(u) \\
&< \int_0^{\frac{L}{R+c}} L(1 - u\left(\frac{R+c}{L}\right))dF(u) \\
&= E_u[\max\{u(R+c), L\}] - E(u)(R+c)
\end{aligned}$$

which, because of assumption (3), equals the right side of assumption (6).

Calculation for proposition 3: Given that u_2 is increasing in I and in λ we can prove the inequality for $I = 0$. In this case $u_2 \geq u_1$ if $\Psi \geq \lambda$. Recall that

$$\Psi = \int_{\underline{\tau}}^{\bar{\tau}} \min\left\{\tau\lambda R(0), B^*\right\} dH(\tau) - \alpha c H(\frac{B^*}{\lambda R(0)}).$$

Note that when $B^* = \underline{\tau}\lambda R(0)$, we have $H(\cdot) = 0$ and $\min\left\{\tau\lambda R(0), B^*\right\} = B^*$, implying $\Psi = B^*$. Recall also that by assumption (5) $\underline{\tau} \geq R(0)^{-1}$, which implies our result $\Psi \geq \lambda$. To conclude our proof note that the LLR will choose a level of B different from B^* only if that increases Ψ, reinforcing our conclusion that $\Psi \geq \lambda$.

Calculation for proposition 4: In the extreme case where all rents are extracted from illiquid banks, under the unified arrangement the optimal level of λ maximizes

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

and under the present arrangement it maximizes

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

The difference in the two functions is due to the fact that under the present arrangement the bank will continue after date 1 only if $u \geq u_2(\lambda)$, whereas before it would do so for any value of u. Elementary maximization techniques show that this final term reduces the profit-maximizing level of λ for the bank.

Calculation for proposition 5: The seller auctions a good whose quality q is a variable under the seller's control. The quality of the good is contractable and therefore part of the terms of the auction. The value of a good of quality q to recipient i is $V_i(q)$. The cost of the good to the seller is $c(q, i)$. The sale of the good to one of the bidders imposes an externality on the other bidder, which varies with the quality of the good. Let $l_i(q)$ represent the payoff to the losing bidder i when the other bidder receives a good of quality q. We normalize so that, with neither party winning, the good is worth 0 to everybody.

For simplicity we will describe the auction as a variant of a second-price auction. In the full information case we are considering, the outcomes will not depend on whether we use a first-price or second-price formulation. A bid specifies the quality of the good to be made, and a proposed profit for the seller. The seller chooses one of the two bids (or neither). The winning bidder gets the quality requested in his bid, pays the seller the cost of producing a good of that quality and in addition pays a profit to the seller equal to that bid by the *other* bidder.

Clearly, if i wins the good, the quality he specifies will be the quality which maximizes

$$V_i(q) - c(q, i).$$

Denote this quality as q_i^* and assume it is unique. Define

$$w_i = V_i(q_i^*) - c(q_i^*, i)$$

and define

$$l_i = l_i(q_{-i}^*)$$

where $-i$ denotes the other bidder. 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. Suppose the bank needs a lending of last resort loan. If the bank is not rescued, the

LLR receives:

$$-\alpha c.$$

If the DI rescues the bank, the LLR receives an expected payoff of

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

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.

Lets now investigate the DI. If the bank is not rescued, the DI receives:

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

If the LLR rescues the bank, the DI receives an expected payoff of

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

and

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

if the DI 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.

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." in the *International Encyclopedia of Business and Management*, 2nd edition, volume 1, *Accounting to Coase*, 342-352, Malcolm Warner ed, Thomson Learning, London, 2001.

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.