Systemic Risk and Deposit Insurance Premiums

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Abstract

When there are widespread bank failures, deposit insurance agencies such as the Federal Deposit Insurance Corporation (FDIC) find it difficult to sell failed banks at attractive prices. Thus, the deposit insurance fund suffers higher drawdowns per dollar of insured deposit when there is a systemic crisis. In turn, the actuarially-fair deposit insurance premium that is charged ex ante to banks increases in joint failure risk in addition to individual failure risk. Further, since bank closure policies reflect greater forbearance in a systemic crisis, banks have incentives to herd. The incentive-efficient premium that accounts for such moral hazard requires a higher charge for joint failure risk than the actuarially-fair one. Similarly, as large bank failures are more likely to be associated with asset fire sales (and regulatory forbearance), the efficient premium for large banks is higher per dollar of insured deposits compared to that for small banks.

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1 Introduction

While systemic risk – the risk of wholesale failure of banks and other financial institutions – is generally considered to be the primary rationale for supervision and regulation of the banking industry, almost all regulatory rules treat bank failure risk in isolation. In particular, they ignore the very features that create systemic risk in the first place, such as correlation among banks’ investments (Acharya, 2009, Acharya and Yorulmazer 2007, 2008), large size of some banks1 (O’Hara and Shaw, 1990) that leads to fire-sale related pecuniary externalities, and bank inter-connectedness (Allen and Gale, 2000, Kahn and Santos, 2005). In this paper, we aim to fill this important gap in the design of regulatory tools by providing a normative analysis of how deposit insurance premium should be structured to take account of systemic risk.

Demand deposits are explicitly or implicitly insured in most countries of the world up to some threshold amount per individual (or deposit account). While regulators in some countries have realized the need to set up a deposit insurance fund only during the 2007-2009 crisis, such funds have been established in many countries much earlier. Demirgüç-Kunt et al. (2005) show that except for a few, most countries have deposit insurance. Furthermore, during the financial crisis of 2007-2009, some countries, including developed countries such as Australia and New Zealand, introduced guarantees for the first time, whereas a significant majority of others increased their insurance coverage. In most cases, the capital of these deposit insurance funds is the reserve built up over time through collection of insurance pre-

We argue below that the extent of systemic risk in the financial sector is a key determinant of efficient deposit insurance premiums. The basic argument is as follows. When a bank with insured deposits fails, the deposit insurance fund takes over the bank and sells it as a going concern or piece-meal. During periods with widespread bank failures, it is difficult to sell failed banks at attractive prices since other banks are also experiencing financial constraints (Shleifer and Vishny, 1992, Allen and Gale, 1994). Hence, in a systemic crisis, the deposit insurance fund suffers from low recovery from liquidation of failed banks’ assets. This, in turn, leads to higher drawdowns per dollar of insured deposits. This argument gives our first result that the actuarially-fair deposit insurance premium, the premium that exactly covers the expected cost to the deposit insurance provider, should not only increase in individual bank failure risk but also in joint bank failure risk.2

1Only recently, the FDIC announced that there is going to be a special assessment collected on September 30, 2009, which will be computed based on total assets (minus tier 1 capital). For more details, see the link: http://www.fdic.gov/deposit/insurance/assessments/proposed.html

2Pennachi (2006) shows that if insurance premiums are set to a bank’s expected losses and fail to include a
Also, the failures of large banks lead to greater fire-sale discounts. This has the potential to generate a significant pecuniary externality that can have adverse contagion-style effects on other banks and the real economy (compared to the effects stemming from the failure of smaller banks).\(^3\) Hence, the resolution of big banks is more costly for the deposit insurance regulator, directly in terms of losses from liquidating big banks and indirectly from contagion effects. This leads to our second result that the premium for large banks should be higher per dollar of insured deposit compared to small banks.

Furthermore, bank closure policies reflect a time-inconsistency problem (see, for example, Mailath and Mester, 1994, and Acharya and Yorulmazer, 2007, 2008). In particular, the regulators would ex ante like to commit to be tough on banks even when there are wholesale failures to discourage them from ending up in that situation. However, this is not credible ex post and the regulators show greater forbearance during systemic crises. While such forbearance has featured in the current crisis from most regulators around the world, it has a strong set of precedents. For example, Hoggarth, Reidhill and Sinclair (2004) study resolution policies adopted in 33 banking crises over the world during 1977–2002. They document that when faced with individual bank failures, authorities have usually sought a private sector resolution where the losses have been passed onto existing shareholders, managers and sometimes uninsured creditors, but not taxpayers. However, government involvement has been an important feature of the resolution process during systemic crises: at early stages, liquidity support from central banks and blanket government guarantees have been granted, usually at a cost to the budget; bank liquidations have been very rare and creditors have rarely suffered any losses.

Such forbearance during systemic crisis creates incentives for banks to herd and become inter-connected so that when they fail they fail with others and this increases their chance of a bailout. Given this collective moral hazard, we obtain our third and final result that the incentive-efficient premium that discourages banks from excessive correlation in their investments features a higher charge for joint bank failure risk than the actuarially-fair premium. In other words, from a normative standpoint, the deposit insurance premium charged to banks is increasing in systemic risk.

While these three principles to determine efficient deposit insurance premiums apply generally, it is useful to consider them in the context of how premiums have been priced in the United States. To this end, we provide below a discussion of the Federal Deposit Insurance Corporation (FDIC), the deposit insurance regulator, and the premium schemes that have prevailed so far in the United States. This discussion is largely based on Pennacchi (2009)

\(^3\)Such effects have epitomized the current crisis, especially the failure of Lehman Brothers and (effectively of) A.I.G., though these are not deposit-insured entities.
and Cooley (2009).\(^4\)

As a response to the devastating effects of the Great Depression, to insure deposits of commercial banks and to prevent banking panics, the FDIC was set up in 1933. The FDIC’s reserves began with a $289 million capital injection from the US Treasury and the Federal Reserve in 1934. Throughout most of the FDIC’s history, the deposit insurance premiums have been independent of the risk of banks, mostly due to the difficulty in assessing banks’ risk. During the period 1935-1990, the FDIC charged flat deposit insurance premiums at the rate of approximately 8.3 cents per $100 insured deposits. However, starting in 1950, some of the collected premiums started being rebated. The rebates have been adjusted to target the amount of FDIC reserves in its Deposit Insurance Fund (DIF).

While the banking industry usually wanted deposit insurance assessments to be set at a relatively low level, the FDIC wanted premiums to be high enough so that the reserves could cover future claims from bank failures. In 1980, the DIF was given a range of between 1.1 and 1.4 percent of total insured deposits. As a result of a large number of bank failures during the 1980s, the DIF depleted and the Financial Institutions Reform, Recovery and Enforcement Act of 1989 (FIRREA) mandated that the premiums be set to achieve a Designated Reserve Ratio (DRR) of reserves to total insured deposits of 1.25 percent. Figure 1 shows the total insured deposits by the FDIC and Figure 2 shows the balances of DIF and the reserve ratio for the period 1990-2008.

The bank failures of the 1980s and early 1990s led to reforms in the supervision and regulation of banks such as the Federal Deposit Insurance Corporation Improvement Act (FDICIA) in 1991 that introduced several non-discretionary rules. In particular, FDICIA required the FDIC to set risk-based premiums, where premiums differed depending on three levels of a bank’s capitalization (well-, adequately- and under-capitalized) and three supervisory rating groups (rating 1 or 2, rating 3, and rating 4 or 5). However, the new rules have not been very effective in discriminating between banks and during 1996-2006, over 90 percent of all banks were categorized in the lowest risk category (well-capitalized, rating 1 or 2).

Further, the FDICIA and the Deposit Insurance Act of 1996 specified that if DIF reserves exceed the DRR of 1.25 percent, the FDIC was prohibited from charging any insurance premiums to banks in the lowest category. During the period 1996-2006, DIF reserves were above 1.25 percent of insured deposits and the majority of banks were classified in the lowest risk category and did not pay for deposit insurance.

The Federal Deposit Insurance Reform Act of 2005 (FDIRA) brought some changes to the setting of insurance premiums. In particular, instead of a hard target of 1.25 percent, the DRR was given the range of 1.15 percent to 1.50 percent. When DIF reserves exceed 1.50 percent (1.35 percent) 100 percent (50 percent) of the surplus would be rebated to banks. If

\(^4\)Also, see Saunders and Cornett (2007).
DIF reserves fall below 1.15 percent, the FDIC must restore the fund and raise premiums to a level sufficient to return reserves to the DRR range within five years.

During the crisis of 2007-2009, the reserves of DIF have been hit hard. The reserves fell to 1.01 percent of insured deposits on June, 30, 2008, and they decreased by $15.7 billion (45 percent) to $18.9 billion in the fourth quarter of 2008, plunging the reserve ratio to 0.4 percent of insured deposits, its lowest level since June 30, 1993. In the first week of March 2009, the FDIC announced that it planned to charge 20 cents for every $100 insured domestic deposits to restore the DIF. On March 5, 2009, Sheila Bair, Chairperson of FDIC, said the FDIC would lower the charge to around 10 basis points if its borrowing authority were increased. Senators Dodd and Mike Crapo, introduced a bill that would permanently raise FDIC’s borrowing authority to $100 billion, from $30 billion, and would also temporarily allow the FDIC to borrow as much as $500 billion in consultation with the president and other regulators.

This discussion confirms our starting assertion that deposit insurance premiums have either been risk insensitive or relied only on individual bank failure risk and never on systemic risk. Further, even when premiums have been risk sensitive, the focus has been on maintaining reserves at an “appropriate” level. This is reflected in effectively returning the premiums to banks when the deposit insurance fund’s reserves become sufficiently high relative to the size of insured deposits. This kind of premium scheme is divorced from incentive properties. The rationale for charging banks a premium on a continual basis based on individual and systemic risk, regardless of deposit insurance fund’s size, is that it causes banks to internalize the costs of their failures on the fund and rest of the economy. Since a systemic crisis would most likely cause the fund to fall short and dip into taxpayer funds, the incentive-efficient use of excess fund reserves is as return to taxpayers rather than to insured banks.

The model we have developed to provide normative analysis of deposit insurance premiums is purposely simple. It is meant to illustrate the straightforward nature of our three results on the efficient design of premium schemes. In practice, quantifying systemic risk can be a challenge, but recent advances on this front (see, for instance, Adrian and Brunnermeier, 2008, and Acharya, Pedersen, Philippon and Richardson, 2009) present the opportunity to employ them in revisions of future deposit insurance schemes.


Very recently, two more failures depleted the insurance fund further. On May 1, 2009, Federal regulators shut down Silverton Bank, the fifth-largest bank to fail during the financial crisis of 2007-2009. The FDIC estimated the failure would cost the DIF $1.3 billion. And, on May 21, 2009, Federal regulators seized BankUnited FSB with an estimated cost of $4.9 billion to the DIF.
of fairly pricing deposit insurance (Freixas and Rochet, 1998), deposit insurance and the
degree of government regulatory control over banks (Pennacchi, 1987b), and, more closely,
deposit insurance pricing in the presence of regulatory forbearance in closing banks (Allen and
Saunders, 1993, and Dreyfus, Saunders and Allen, 1994). However, our paper has important
differences from the literature cited since the main purpose of our paper is to analyze pricing of
deposit insurance that takes account of systemic risk and important features that contribute
to systemic risk such as correlation among banks’ investments, large size of some banks
that leads to fire-sale related pecuniary externalities, and bank inter-connectedness (also see
Pennacchi, 2006).

The rest of the article is organized as follows. Section 2 lays out the model. Section
3 derives the actuarially-fair deposit insurance premium as a function of systemic risk and
separately for large and small banks. Section 4 considers the role of forbearance and derives
the incentive-efficient deposit insurance premium taking into account all potential costs asso-
ciated with the resolution of failed banks such as costs of inefficient liquidations and bailouts,
and compares it to the actuarially-fair premium. Section 5 concludes.

2 Model

We use the set-up in Acharya and Yorulmazer (2007). We consider an economy with three
dates – \( t = 0, 1, 2 \), two banks – Bank \( A \) and Bank \( B \), bank owners, depositors, outside
investors, and a regulator. Each bank can borrow from a continuum of depositors of measure
1. Bank owners as well as depositors are risk-neutral, and obtain a time-additive utility \( w_t \)
where \( w_t \) is the expected wealth at time \( t \). Depositors receive a unit of endowment at \( t = 0 \)
and \( t = 1 \). Depositors also have access to a reservation investment opportunity that gives
them a utility of 1 per unit of investment. In each period, that is at date \( t = 0 \) and \( t = 1 \),
depositors choose to invest their good in this reservation opportunity or in their bank.

Deposits take the form of a simple debt contract with maturity of one period. In particular,
the promised deposit rate is not contingent on investment decisions of the bank or on realized
returns. In order to keep the model simple and yet capture the fact that there are limits to
equity financing, we do not consider any bank financing other than deposits.

Banks require one unit of wealth to invest in a risky technology. The risky technology is
to be thought of as a portfolio of loans to firms in the corporate sector. The performance of
the corporate sector determines its random output at date \( t + 1 \). We assume that all firms
in the sector can either repay fully the borrowed bank loans or they default on these loans.
In case of a default, we assume for simplicity that there is no repayment.

Suppose \( R \) is the promised return on a bank loan. We denote the random repayment on
this loan as $\tilde{R}$, $\tilde{R} \in \{0, R\}$. The probability that the return from these loans is high ($R$) in period $t$ is $\alpha_t$:

$$\tilde{R} = \begin{cases} R & \text{with probability } \alpha_t, \\ 0 & \text{with probability } 1 - \alpha_t. \end{cases}$$ (1)

We assume that the returns in the two periods are independent but allow the probability of high return to be different in the two periods. This helps isolate the effect of each probability on our results.

In addition to banks and depositors, there are outside investors who always have funds to purchase banking assets were these assets to be liquidated. However, outsiders do not have the skills to generate the full value from banking assets. To capture this, we assume that outsiders cannot generate $R$ in the high state but only $(R - \Delta)$. Thus, when the banking assets are liquidated to outsiders, there may be a social welfare loss due to misallocation of these assets. We will come back to this point in Section 4 when we investigate whether actuarially-fair deposit insurance can prevent systemic risk.

The notion that outsiders may not be able to use the banking assets as efficiently as the existing bank owners is akin to the notion of asset-specificity, first introduced in the corporate-finance literature by Williamson (1988) and Shleifer and Vishny (1992). In summary, this literature suggests that firms whose assets tend to be specific, that is, whose assets cannot be readily redeployed by firms outside of the industry, are likely to experience lower liquidation values because they may suffer from “fire-sale” discounts in cash auctions for asset sales, especially when firms within an industry get simultaneously into financial or economic distress.\(^6\) In the evidence of such specificity for banks and financial institutions, James (1991) studies the losses from bank failures in the United States during the period 1985 through mid-year 1988, and documents that “there is significant going concern value that is preserved if the failed bank is sold to another bank (a “live bank” transaction) but is lost if the failed bank is liquidated by the FDIC.”

Finally, there is a regulator in our model. The deposits are fully insured by the regulator and the regulator charges deposit insurance premiums. Since deposits are fully insured, they are riskless. Hence, the rate of return on deposits is equal to the rate of return from the storage technology, that is, the deposit rate is equal to 1 in both periods. For simplicity, we assume that banks pay the insurance premiums using their retained earnings from earlier investments before $t = 0$.

\(^6\)There is strong empirical support for this idea in the corporate-finance literature, as shown, for example, by Pulvino (1998) for the airline industry, and by Acharya, Bharath, and Srinivasan (2007) for the entire universe of defaulted firms in the US over the period 1981 to 1999 (see also Berger, Ofek, and Swary (1996) and Stromberg (2000)).
If the return from the first-period investment is high, then the bank operates one more period and makes the second-period investment.\(^7\) For a bank to continue operating, it needs 1 unit to pay old deposits and an additional 1 unit to undertake the second period investment, a total of 2 units. Since available deposits for a bank amount to only one unit (the \(t = 1\) endowment of its depositors), if the return from the first-period investment is low, then the bank is in default, it is closed and its assets are sold (we talk about bailouts and recapitalization in Section 4).\(^8\) We assume that if there is a surviving bank, then it has resources from its first-period profits to purchase the failed bank.

The possible states at date 1 are given as follows, where \(S\) indicates survival and \(F\) indicates failure:

- \(SS\) : Both banks had the high return, and they operate in the second period.
- \(SF\) : Bank \(A\) had the high return, while Bank \(B\) had the low return. Bank \(B\) is acquired by bank \(A\).
- \(FS\) : This is the symmetric version of state \(SF\).
- \(FF\) : Both banks failed.

**Correlation of bank returns:** A crucial aspect of our model is that banks can choose the correlation of the returns from their investments by choosing the industries they invest in. At date 0, banks borrow deposits and then they choose the composition of loans that compose their respective portfolios. This choice determines the level of correlation between the returns from their respective investments. We refer to this correlation as “inter-bank correlation”.

We suppose that there are two possible industries in which banks can invest, denoted as 1 and 2. Bank \(A\) (\(B\)) can lend to firms \(A_1\) and \(A_2\) (\(B_1\) and \(B_2\)) in industries 1 and 2, respectively. If in equilibrium banks choose to lend to firms in the same industry, specifically they either lend to \(A_1\) and \(B_1\), or they lend to \(A_2\) and \(B_2\), then their returns are assumed to be perfectly correlated. However, if they choose different industries, then their returns are less than perfectly correlated, say independent. When banks invest in the same industry, the correlation of banks’ returns is \(\rho = 1\), whereas, when they invest in different industries, we have \(\rho = 0\). This gives us the joint distribution of bank returns as given in Table 1. Note that the individual probability of each bank succeeding or failing is constant (\(\alpha_0\) and \(1 - \alpha_0\), respectively), irrespective of the correlation in their returns.\(^9\)

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\(^7\)For simplicity, we assume that the bank does not reinvest its profits from the first investment, for example, distributes them as dividends.

\(^8\)In this model, the asset to be sold is the franchise value of the bank, that is, the expected future profit from the second period investment the bank can take.

\(^9\)Our results go through as long as the probabilities of states \(SS\) and \(FF\) are higher when banks invest
3 Actuarially-fair insurance without bailouts

In this section, we assume that the regulator sells the assets of the failed banks. We analyze regulatory intervention in the form of recapitalization and bailouts in Section 4.

Next, we show that actuarially-fair deposit insurance premium, the premium that is equal to the expected value of the payments from the insurance fund to the bank’s depositors, depends on the correlation structure in banks’ investments.

Since deposits are fully insured, the deposit rate in both periods is equal to 1.

In state $FF$, both banks fail and sale to another bank is not a possible option. Thus the failed banks’ assets are sold to outsiders, which can also be thought of as the liquidation of the banks’ assets. Note that the outsiders cannot generate $R$ from the banking assets but only $R - \Delta$. Thus, they are willing to pay a price of at most $p$ for the failed banks’ assets where

$$p^{FF} = p = \alpha_1(R - \Delta - 1).$$  \hspace{1cm} (2)

We can think of $p$ as the liquidation value of the bank.

In states $SF$ or $FS$, the surviving bank can acquire the failed bank’s assets. Note that a surviving bank can generate the full value of $R$ from these assets. Thus these assets are worth $\bar{p}$ for the surviving bank, where

$$\bar{p} = \alpha_1(R - 1).$$  \hspace{1cm} (3)

Note that $\bar{p} > p$. We assume that neither the regulator, nor the surviving bank has the full bargaining power for the sale of the failed banks’ assets. Thus, the price, denoted as $p^{SF}$ lies somewhere between $p$ and $\bar{p}$, that is, $p^{SF} \in (p, \bar{p})$.

When banks invest in the same industry with probability $(1 - \alpha_0)$ both banks fail and the proceeds from the sale of the failed banks’ assets are equal to $p^{FF} = p$. Let $q_s$ be the insurance premium when banks invest in the same industry, where

$$q_s = (1 - \alpha_0)(1 - p).$$  \hspace{1cm} (4)

When banks invest in different industries, with probability $\alpha_0(1 - \alpha_0)$ only one bank fails and the proceeds from the sale is $p^{SF}$ and with probability $(1 - \alpha_0)^2$ both banks fail and in the same industry compared to the case when they invest in different industries.
the proceeds from the sale of the failed banks’ assets are equal to \( p^{\text{FF}} = \frac{p}{2} \). Let \( q_d \) be the insurance premium when banks invest in different industries, where

\[
q_d = \alpha_0 (1 - \alpha_0) (1 - p^{SF}) + (1 - \alpha_0)^2 (1 - p) = q_s - \alpha_0(1 - \alpha_0)(p^{SF} - \frac{p}{2}). \tag{5}
\]

Since the proceeds from the sale of failed banks’ assets is lower when both banks fail, the loss to the insurance fund is higher when both banks fail. Thus, the actuarially-fair insurance premiums should be higher when banks invest in the same industry, that is, \( q_s > q_d \).

**Result 1:** *(Correlation and actuarially-fair insurance premiums)* The actuarially-fair insurance premium depends on the correlation between banks’ returns and should be higher when banks invest in the same industry, and is given as \( q_s = q_d + \alpha_0(1 - \alpha_0)(p^{SF} - \frac{p}{2}) > q_d \).

**Size:** Next, we show that the insurance premium should depend on bank size as well. Suppose instead of two equal-sized banks, we let Bank A be the large bank with size of depositors much larger than 1, while we keep the size of Bank B at 1.

We assume that if the regulator decides to liquidate the small bank, the big bank (or some other bank in the industry) has enough funds to purchase the small bank and can run it efficiently. Thus, assuming that all bargaining power does not lie with the regulator or the acquiring bank, when the small bank is liquidated, the liquidation value is assumed to be \( p_{\text{small}} \in \left( p, \frac{p}{2} \right) \).

However, the size of Bank A is large enough so that the small bank cannot acquire and run the large bank efficiently. Thus, when the big bank is liquidated, it can only be purchased by outside investors and the price per unit of big bank’s assets is \( p_{\text{big}} = \frac{p}{2} \). Hence, the actuarially-fair insurance premiums depend on the size of the bank. In particular, we get:

**Result 2:** *(Size and actuarially-fair insurance premiums)* Actuarially-fair premium per dollar of insured deposits for the big bank is higher compared to the small bank and

\[
q_{\text{small}} = (1 - \alpha_0)(1 - p_{\text{small}}) < (1 - \alpha_0)(1 - p) = q_{\text{big}}. \tag{6}
\]

So far, we restricted the actions of the regulator to the provision of deposit insurance and the resolution of bank failures only through sales. Since failure of large banks or many banks at the same time can result in more adverse effects on the rest of the economy, it is more likely that, in such cases, the regulators show forbearance or intervene in the form of bailouts or capital injections resulting in fiscal costs. This, in turn, strengthens our argument that size and correlation should be an important component of insurance premiums. In the next section, we analyze insurance premiums in the presence of bailouts and recapitalizations taking into account costs associated with the resolution of failed banks such as cost of liquidations and bailouts in detail.
4 Resolution and insurance premiums

In this section, first we analyze the regulator’s problem of resolving bank failures where the regulator can bail out and recapitalize failed banks, in addition to selling failed banks to a surviving bank (if any) or to outsiders. We show that in case of joint failure of banks the regulator may prefer to bail out or recapitalize failed banks ex post (too-many-to-fail guarantees). However, such guarantees create incentives for banks to herd and take correlated investments, which makes the joint failure state, that is, the state of systemic crisis, more likely in the first place.

Next, we derive the full-cost insurance premiums that take into account all social costs of bank failures including costs of inefficient liquidations and bailouts and show that these premiums should be higher than the actuarially-fair insurance premiums derived in Section 3. Further, we analyze how the regulator can employ insurance premiums as a regulatory tool to minimize the occurrence of systemic crisis by preventing banks from choosing highly correlated investments. We call the premiums that take into account all social costs of bank failures and at the same give banks incentives to choose the low correlation the incentive-efficient full-cost insurance premiums.

4.1 Resolution of bank failures

Since there is no social welfare loss when assets stay within the banking system, the regulator does not have any incentive to intervene (in the form of bailouts) in states $SS$, $SF$ and $FS$. However, in state $FF$, assets of failed banks can be purchased only by outside investors resulting in misallocation cost. Hence, the regulator compares the welfare loss resulting from asset sales to outsiders with the cost of bailing out the failed banks. If it turns out that the welfare loss from inefficient liquidation is greater, then the regulator may decide to intervene in the form of bailouts and recapitalizations. The regulator’s ex-post decision is thus more involved in state $FF$ and we examine it fully. In order to analyze the regulator’s decision to bail out or close failed banks, we make the following assumptions:

(i) The regulator incurs a cost of $f(x)$ when it injects $x$ units of funds into the banking sector. We assume this cost function is increasing, $f' > 0$, and for simplicity, we consider a linear cost function: $f(x) = ax, a > 0$. While we do not model this cost explicitly, we have in mind fiscal and opportunity costs to the regulator from providing funds with immediacy to the banking sector. Thus, if the regulator bails out only one bank (both banks), it incurs a bailout cost of $a$ ($2a$).

The fiscal costs of providing funds to the banking sector with immediacy can be linked to a variety of sources, most notably, (a) distortionary effects of tax increases required to
fund deposit insurance and bailouts; and, (b) the likely effect of government deficits on the country’s exchange rate, manifested in the fact that banking crises and currency crises have often occurred as “twins” in many countries (especially, in emerging market countries). Ultimately, the fiscal cost we have in mind is one of immediacy: Government expenditures and inflows during the regular course of events are smooth, relative to the potentially rapid growth of “off-balance-sheet contingent liabilities” such as costs of bank bailouts, etc.10

(ii) If the regulator decides not to bail out a failed bank, the existing depositors are paid back through deposit insurance and the failed bank’s assets are sold to outsiders. The crucial difference between bailouts and asset sales from an ex-post standpoint is that proceeds from asset sales lower the fiscal cost from immediate provision of deposit insurance, whereas bailouts produce no such proceeds. In other words, bailouts entail an opportunity cost to the regulator in fiscal terms.

Under these assumptions, the regulator’s resolution policy can be characterized as follows. The regulator’s objective in state $FF$ is to maximize the total expected output of the banking sector net of any bailout or liquidation costs. We denote this as $E(\Pi_{2}^{ff})$. Thus, if both banks are closed, the regulator’s objective function takes the value

$$E(\Pi_{2}^{ff}) = 2[\alpha_1(R - \Delta) - 1],$$

which is the liquidation value of banking assets to outsiders. This equals $[2(\alpha_1 R - 1) - 2\alpha_1\Delta]$, the difference between the banking sector output in each of the states $SS$, $SF$, and $FS$, minus the liquidation costs from closing both banks.

If both banks are bailed out, then the regulator’s objective function takes the value

$$E(\Pi_{2}^{ff}) = 2(\alpha_1 R - 1) - f(2),$$

as the bailout costs are now based on the total amount of funds, 2, injected into the banking sector with immediacy.11

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10See, for example, the discussion on fiscal costs associated with banking collapses and bailouts in Calomiris (1998). Hoggarth, Reis and Saporta (2002) find that the cumulative output losses have amounted to a whopping 15-20% annual GDP in the banking crises of the past 25 years. Caprio and Klingebiel (1996) argue that the bailout of the thrift industry cost $180 billion (3.2% of GDP) in the US in the late 1980s. They also document that the estimated cost of bailouts were 16.8% for Spain, 6.4% for Sweden and 8% for Finland. Honohan and Klingebiel (2000) find that countries spent 12.8% of their GDP to clean up their banking systems whereas Claessens, Djankov and Klingebiel (1999) set the cost at 15-50% of GDP. Also, see Panageas (2009) for an analysis of the optimal financing of government interventions.

11With the linear fiscal cost function $f(\cdot)$, the regulator either bails out both banks or liquidates them both. With a strictly convex fiscal cost function $f(\cdot)$, there may be cases where it is optimal to bailout one bank and liquidate the other since the marginal cost of bailouts increases as more banks are bailed out. See Acharya and Yorulmazer (2007) for a discussion.
Comparing these objective-function evaluations, we obtain the following resolution policy for the regulator in state $FF$. It has the intuitive property that if liquidation costs ($\alpha_1 \Delta$) are sufficiently high, and/or the costs of bailouts ($f(.)$) are not too steep, then there are “too many (banks) to fail” and the regulator prefers to rescue failed banks.

**Resolution:** When both banks fail (state $FF$), the regulator takes the following actions:

(i) If $\alpha_1 \Delta \leq f(1)$, then both banks’ assets are sold to outsiders.

(ii) If $\alpha_1 \Delta > f(1)$, then the regulator bails out both banks.

Thus, the expected second-period profits of the bank depend on the regulator’s decision:

$$E(\pi_{2}^{ff}) = \begin{cases} 
0 & \text{if } \alpha_1 \Delta \leq f(1) \\
\bar{p} & \text{if } \alpha_1 \Delta > f(1) 
\end{cases}.$$  \hspace{1cm} (9)

Note that in either case, in state $FF$, there is a social welfare loss resulting from bailout or liquidation, whereas no such cost arise in states $SF$ or $FS$. Thus, the socially optimal outcome is achieved when the probability of state $FF$ is minimum, that is, when banks invest in different industries.

### 4.2 Systemic risk and insurance premiums

First we derive the *full-cost insurance premiums*, the premiums that take into account all social costs of bank failures including costs of liquidations and bailouts. Note that the actuarially-fair insurance premiums in Section 3 take into account only the expected payments to the depositors, and, thus, miss the social costs of bank failures such as costs of liquidations and bailouts.

We can show that the full-cost insurance premiums $\tilde{q}_s$ and $\tilde{q}_d$ when banks invest the same industry and different industries, respectively, are given as:

$$\tilde{q}_s = (1 - \alpha_0) \left[ (1 - \bar{p}) + \min \{\alpha_1 \Delta, f(1)\} \right] > q_s,$$

and

$$\tilde{q}_d = \alpha_0 (1 - \alpha_0) (1 - p^{SF}) + (1 - \alpha_0)^2 \left[ (1 - \bar{p}) + \min \{\alpha_1 \Delta, f(1)\} \right] > q_d.$$ \hspace{1cm} (10)

We can get the relation between these insurance premiums as follows:

$$\tilde{q}_s = \tilde{q}_d + \alpha_0 (1 - \alpha_0) \left[ (p^{SF} - \bar{p}) + \min \{\alpha_1 \Delta, f(1)\} \right] > \tilde{q}_d.$$ \hspace{1cm} (11)
As in the case of actuarially-fair insurance premiums, the loss to the regulator through the insurance fund is higher when both banks fail. Furthermore, the joint failure state is always associated with social costs such as costs from inefficient liquidations or bailouts, whereas such costs can be avoided in the individual failure states. Thus, the full-cost insurance premiums are higher than the actuarially-fair insurance premiums, that is, \( q_s > q_d \) and \( \tilde{q}_s > \tilde{q}_d \).

Next, we investigate banks’ choice of correlation in their investments and find the incentive-efficient insurance premiums \( \tilde{q}_s \) and \( \tilde{q}_d \) that induce banks to choose the low correlation. Also, we combine our results with the previous discussion to find the incentive-efficient full-cost insurance premiums that take into account all costs associated with the resolution of failed banks, and, at the same time incentivize banks to choose the low correlation.

In the first period, both banks are identical. Hence, we consider a representative bank. Formally, the objective of each bank is to choose the level of inter-bank correlation \( \rho \) at date 0 that maximizes

\[
E(\pi_1(\rho)) + E(\pi_2(\rho)),
\]

where discounting has been ignored since it does not affect any of the results. Recall that if banks invest in different industries, then inter-bank correlation \( \rho \) equals 0, else it equals 1.

Note that when banks invest in the same industry, \( \Pr(SF) = 0 \), so that

\[
E(\pi_2(1)) = \alpha_0 \ E(\pi_2^{ss}) + (1 - \alpha_0) \ E(\pi_2^{sf}) - \tilde{q}_s. \tag{14}
\]

When banks invest in different industries we obtain that

\[
E(\pi_2(0)) = \alpha_0^2 \ E(\pi_2^{ss}) + \alpha_0(1 - \alpha_0) \ E(\pi_2^{sf}) + (1 - \alpha_0)^2 \ E(\pi_2^{ff}) - \tilde{q}_d. \tag{15}
\]

We know that \( E(\pi_2^{sf}) = E(\pi_2^{ss}) + (\bar{p} - p^{sf}) \). Thus, we can write

\[
E(\pi_2(0)) = \alpha_0 \ E(\pi_2^{ss}) + \alpha_0(1 - \alpha_0) \ (\bar{p} - p^{SF}) + (1 - \alpha_0)^2 \ E(\pi_2^{ff}) - \tilde{q}_d, \tag{16}
\]

which gives us

\[
E(\pi_2(1)) - E(\pi_2(0)) = \alpha_0(1 - \alpha_0) \left[ E(\pi_2^{ff}) - (\bar{p} - p^{SF}) \right] + \tilde{q}_d - \tilde{q}_s. \tag{17}
\]

Hence, the only terms that affect the choice of inter-bank correlation are the subsidy failed banks’ receive \( E(\pi_2^{ff}) \) from a bailout in state \( FF \), the discount the surviving bank gets in state \( SF \) from acquiring the failed bank’s assets, and the deposit insurance premiums \( \tilde{q}_s \) and
\( \hat{q}_s = \alpha_0(1 - \alpha_0) \left[ E(\pi_{2}^{ff}) - (\bar{p} - p^{SF}) \right] + \hat{q}_d. \)  

Note that when the regulator chooses to liquidate the failed bank, rather than bailing it out, there is no bailout subsidy and the full-cost insurance premiums \( \bar{q}_s \) and \( \bar{q}_d \) are at the same time incentive-efficient, that is, they induce banks to choose the low correlation. However, when the regulator bails out failed banks, the subsidy from the bailout creates a wedge between the incentive-efficient premium \( \hat{q}_s \) and the full-cost insurance premium \( \bar{q}_s \). Combining this with the previous result on the insurance premium, we get the incentive-efficient full-cost premiums as \( \bar{q}_d \) when banks invest in different industries and \( \bar{q}_s = \max \{ \bar{q}_s, \hat{q}_s \} \) when banks invest in different industries. When the regulator charges the premiums \( (\bar{q}_s, \bar{q}_d) \), banks choose the low correlation (incentive-efficient) and pay for the entire expected cost associated with their failure including the costs of inefficient liquidations and bailouts. We obtain the following result:

**Result 3:** (Incentive-efficient full-cost premiums) The insurance premiums that induce banks to choose the low correlation and that cover all expected costs associated with bank failures are \( \bar{q}_d \) and \( \bar{q}_s = \max \{ \bar{q}_s, \hat{q}_s \} \), when banks invest in different industries and the same industry, respectively. Furthermore, we obtain \( \bar{q}_s > q_s \) and \( \bar{q}_d > q_d \), and the wedge between the insurance premiums \( \bar{q}_s \) and \( \bar{q}_d \) is higher compared to the corresponding wedge for the actuarially-fair insurance premiums, that is, \( \bar{q}_s - \bar{q}_d > q_s - q_d \).

Note that the insurance premiums with regulatory intervention in the form of bailouts are different from the ones without such regulatory intervention. Given that the regulator may not be credible in closing banks during systemic crises, which creates incentives for banks to invest in the same industry ex ante, deposit insurance premiums may act as a tool to alleviate the time-inconsistency problem inherent in the regulator’s policy.

We observe government bailouts during banking crises, more so when the crisis is systemic. Thus, banks may have private benefits from choosing correlated investments such as possible bailouts. In those cases, the actuarially-fair premium (which may no longer be fair from a social welfare point of view) may not be enough to prevent banks from choosing highly correlated investments. If we think that the social costs of bank failures (either misallocation costs due to liquidation and destruction of value or costs of bailouts) increase in a convex fashion as the number of failures increase, then the regulator would like to prevent states where many banks fail, that is, the regulator would like to prevent banks from getting over-exposed to common risk factors. In those cases, the actuarially-fair premium may not prevent
banks from investing in the same industry, that is, it may not prevent systemic bank failures. Thus, to prevent systemic risk, all costs of failures should be priced in and the premium when banks invest in the same industry should be higher.

The practical design of regulatory tools to address the important contributors to systemic risk such as correlation and size can be difficult and potentially costly from a political point of view. An alternative way of addressing these issues can be to use closure rules that can address these issues. One possibility is to employ taxpayer funds not to guarantee bank debt but to make transfers to healthier institutions and enable them to acquire failed banks at higher prices than they would with just private funds (Acharya and Yorulmazer, 2008). Such mechanisms, however, have their limits as larger banks emerge from resolution of crises, and in general, such rules suffer too from time-inconsistency.

5 Conclusion

We showed that efficient setting of deposit insurance premiums should take into account systemic risk which justifies the presence of such insurance in the first place. Some of the major factors that lead to systemic risk include correlation among banks' returns, bank size, and inter-connectedness. These factors need to be explicitly and continually employed in the setting of deposit insurance premiums. In this paper, our focus has been the pricing of deposit insurance. While, the same principles apply to the design of other regulatory tools such as capital and liquidity requirements (Acharya, 2009), an interesting question is the effectiveness of different regulatory rules in addressing different sources of systemic risk.\textsuperscript{12} Systemic risk is a negative externality from one financial institution’s failure on other institutions and the economy, with significant welfare costs when it materializes in the form of widespread failures. Its efficient levels require regulation – much like regulation of pollution through a tax – but the regulation will be effective only if it is tied to the extent of systemic risk.

6 References


\textsuperscript{12}Sharpe (1978) shows that in the absence of moral hazard and information frictions there is an isomorphism between risk-based insurance premiums and risk-related capital standards. Flannery (1991), however, shows that when there is asymmetry of information this isomorphism no longer holds.


### Table 1: Joint probability of bank returns.

<table>
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<td>High (R)</td>
<td>Low (0)</td>
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<td>αᵢ(1 − αᵢ)</td>
<td>(1 − αᵢ)^2</td>
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Table 1: Joint probability of bank returns.
Figure 1: Total deposits insured by FDIC (Source: FDIC).

Figure 2: Balances of DIF and the reserve ratio (Source: FDIC).