Can Risk-Based Deposit Insurance Premiums Control Moral Hazard?

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Calls for deposit insurance reform regularly sound the refrain to make deposit insurance premiums more risk based.[1] Those who support such a change believe that risk-based premiums will discourage insured banks from taking excessive risk because a bank facing higher premiums will think twice before undertaking a risky activity.

This logic seems impeccable: Let banks face the true cost of risk and they will appropriately balance the tradeoff between risk and return. While seemingly correct from the standard perspective of price theory, this argument requires the deposit insurer to be able to observe the risk characteristics of a bank's investment portfolio. There are good reasons to think that this is not the case; it is hard for outsiders to evaluate a bank loan or a complicated portfolio of financial derivatives. Under these conditions, risk-based deposit insurance premiums are not enough to control moral hazard. Instead, other devices such as performance-based insurance payments and supervisory monitoring are needed as well.

When one party to a transaction has information that the other party does not have, economists describe the transaction as one with *private information*. Various types of information may be private, but I am concerned with a payoff-relevant action. This model is sometimes referred to as the moral-hazard or hidden-action model. In this article, the action that may be hidden from others is the risk characteristics of a bank's investment decisions. The economic literature on moral hazard emphasizes the importance of state-contingent payments

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[1] For recent examples, see FDIC (2000) or Blinder and Wescott (2001).

for giving people the right incentives.[2] A simple example of state contingencies is a salary plus a commission. Sales representatives are frequently paid this way to give them an incentive to work hard. In contrast, risk-based deposit insurance premiums are not state contingent. They are entirely ex ante. As we will see, this limits their usefulness as a tool to control moral hazard.

I have three goals in this article. The first goal is to show what risk-based deposit insurance premiums can and cannot do. Risk-based premiums are useful for preventing transfers between different risk classes of banks, but they cannot control moral hazard. This idea is not new. It appears to be widely known among banking economists, but it rarely seems to have been formally expressed.[3] The second goal is to illustrate how state contingencies in deposit insurance payments can be used to control moral hazard. As indicated above, this illustration will use a model with private information. The final goal is to formally develop a role for supervisory activities like safety and soundness exams. These exams are modeled as a costly means for reducing the amount of private information between the deposit insurer and the bank.[4] Most of the literature on bank regulation takes the amount of private information as given. But as long as these supervisory activities reduce private information, they play a crucial role in any well-designed deposit insurance system.

The ideas in this article can be expressed with an analogy to an insurance contract. In dealing with different risks, insurance companies do more than adjust premiums. They also alter deductible amounts, copayment rates, and the probability of inspections. These contractual features are designed to prevent the insured from altering the risks it faces in a way that is detrimental to the insurance company, while still providing a degree of insurance. Of course, these characteristics of the insurance contract change with the risks, so in that sense well-designed deposit insurance contracts are risk based. Nevertheless, the premium level is not the only thing that changes. The analogy carries through to deposit insurance, which is why a well-designed deposit insurance system needs to do more than make premiums risk based.

1. THE MODEL

There is a deposit insurer who insures the depositors of one bank. The insurer is risk-neutral and has access to outside funds, so it has enough resources to cover its exposure. For simplicity, I assume that the bank is fully funded by

[2] For a survey of moral-hazard models, see Hart and Holmstrom (1987) or Prescott (1999).

[3] One exception is John, John, and Senbet (1991), and there are probably others as well.

[4] There is a literature on costly monitoring and auditing. Examples include Townsend (1979) and Dye (1986).

deposits.[5] I also ignore any liquidity or payment services provided by deposits. For my purposes, it is sufficient to treat deposits as just another form of debt. These deposits are fully insured and pay a gross rate of return of one.

The bank has access to several investment strategies. Each strategy requires one unit of capital to be invested. I assume that because of investment indivisibilities, the bank can engage in only one strategy at a time. The return r of each investment strategy i is uncertain. The probability distribution of returns for a given investment strategy is written $f(r|i)$. For simplicity, I assume that only a finite number of returns are possible. The bank is risk neutral but has limited liability. If the investment's return is less than one, the depositors receive everything produced by the bank plus enough of a payment from the deposit insurer that they receive the guaranteed gross return of one. If the return is greater than one, depositors receive a payment of one, any charges imposed by the deposit insurer are paid by the bank, and the bank keeps the remainder (if any) of its return.

The objective in this economy is to design the deposit insurance scheme so that the bank chooses the highest net present value investment project. Because of deposit insurance, however, meeting this objective is not straightforward. In the following sections, I work through the following three variations on the environment.

1. In the first variation, I assume that the deposit insurer observes the bank's investment strategy. Risk-based premiums are sufficient to control risk in this case.

2. In the second variation, I assume that the deposit insurer no longer observes the bank's investment strategy. This is the hidden-action or moral-hazard model. Risk-based premiums do not control moral hazard in this case and state-contingent payments are needed.

3. In the final variation, I develop a role for safety and soundness exams. The deposit insurer may spend resources that reduce (but do not eliminate) private information. In the example, the optimal deposit insurance system requires an exam in addition to state-contingent payments.

Full Information

In this section, I assume that the bank's investment decision is observed by the deposit insurer. In this case, economists say there is *full information*. It is under full-information conditions that risk-based deposit insurance premiums can succeed.

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5 For a related analysis of capital regulations, see Marshall and Prescott (2001) and Prescott (2001).

Table 1 Probability Distribution of Returns

	Return			
Investment	0.9	1.05	1.20	$E(r\|i)$
i_s	0.1	0.6	0.3	1.08
i_r	0.3	0.3	0.4	1.065

Notes: Probabilities and expected return of each investment strategy. The row labeled i_s corresponds to the high-mean, low-risk strategy, while the row labeled i_r corresponds to the low-mean, high-risk strategy. The last column lists the expected return or mean.

I illustrate this point with a simple example. Assume that the bank can choose between two investment choices. One of these choices is a low-risk, high-mean strategy, i_s, while the other is a high-risk, low-mean strategy, i_r.[6] There are three possible returns: a low one of 0.9, a medium one of 1.05, and a high one of 1.2. Table 1 lists the probability distribution of returns $f(r|i)$ as well as the expected return.

The socially desirable investment strategy is i_s. Its expected output is higher than that of the risky investment strategy i_r. The distribution of returns also differs between the two strategies. The safe strategy usually produces the medium return of 1.05, while the risky strategy is much more likely to produce either low or high returns.

Without Deposit Insurance

Without deposit insurance, the market prices deposits to reflect risk. If the risk-free rate on deposits were zero and the bank took investment strategy i_s, the depositors of the bank (assumed to be risk neutral) would require that the deposits pay 1.011 if the bank is solvent. This would give depositors an expected payoff of $0.1(0.9)+0.9(1.011) \approx 1.0$, which is equal to their expected payoff if they invested in risk-free assets. Alternatively, if the bank took investment strategy i_r, a similar analysis would find that depositors would require a payment of approximately 1.0429 to compensate them for the increased chance of the low return.

[6] Restricting the bank to two investment strategies is done mainly for expository purposes. Marshall and Prescott (2001) study a model where the bank can choose both the mean and variance characteristics of its loan portfolio. They find that the two investment strategies that mattered the most for deposit insurance are the low-risk, high-mean strategy and the high-risk, low-mean strategy. Restricting the investment strategies to these two choices is a stand-in for the more complicated problem.

The bank's payoff is the difference between its return and its payment to depositors. In either case, the expected gross return to depositors is 1.0, so the bank's expected payoff is

$$E(r|i) - 1.0. \tag{1}$$

Faced with this tradeoff, the bank would take the socially desirable investment strategy, i_s, because $E(r|i_s) - 1 > E(r|i_r) - 1$.

With Deposit Insurance

Improperly priced deposit insurance may distort the bank's preference-ordering over these choices. To see this distortion, consider the situation where the deposit insurance premium is independent of the bank's investment strategy.[7] Because of deposit insurance, depositors always receive 1.0. With limited liability, the bank's payoff function is $\max\{r - 1 - p, 0\}$, where 1 is the payment to depositors and p is the premium.[8] When the premium is set to zero, the bank's expected utility is

$$\sum_{r \geq 1.0} f(r|i)(r - 1.0) = E(r|i) - 1.0 + \sum_{r < 1.0} f(r|i)(1.0 - r). \tag{2}$$

Compared with equation (1), the bank's payoff without deposit insurance, the bank's utility under deposit insurance contains an additional term. This additional term is sometimes referred to as the value of the deposit insurance put option. It can be considered a put option because it allows the bank to dump its liabilities on the deposit insurer at a strike price of zero. It is valuable because with deposit insurance, risk is not reflected in the price of deposits. The lower rate paid on deposits leads to an increased payoff to the bank, the amount of which is the additional term. In essence it is a transfer from the deposit insurer to the bank; it also illustrates why underpriced deposit insurance can lead to a taste for risk. This last term increases as the expected transfer from the deposit insurer increases.

This taste for risk matters in the example. If premiums are set to zero, the bank prefers the risky strategy despite the higher expected return of the safe strategy. In particular, the return to the bank of the risky strategy is $0.3(0.0) + 0.3(0.05) + 0.4(0.2) = 0.095$, while the corresponding return of the safe strategy is only $0.1(0.0) + 0.6(0.05) + 0.3(0.2) = 0.09$.

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[7] For early work identifying the risk-taking incentives created by deposit insurance, see Merton (1977) and Kareken and Wallace (1978).

[8] In practice, banks pay any premiums before investing the funds. Throughout this article I assume premiums are paid after the fact and use as our operational definition of a premium a constant payment that is made subject to limited liability. This assumption is made because I do not want to worry about how the deposit insurer invests the premiums it collects. The assumption does not alter the results.

Risk-based premiums can deal with these perverse incentives but only if the deposit insurer observes the investment strategy taken by the bank and makes the premiums dependent on it. Let the insurer index premiums by the bank's risk strategy, p_i, and set premiums to be actuarially fair.[9] The premium level for a given investment strategy i must satisfy

$$\sum_{r \geq 1.0+p_i} f(r|i)p_i + \sum_{1.0 \leq r < 1.0+p_i} f(r|i)(r-1.0) = \sum_{r<1.0} f(r|i)(1.0-r). \quad (3)$$

The left-hand side is the expected value of collected premiums. The second term on the left-hand side reflects the amount of funds collected by the insurer if the bank produces enough to pay depositors but not enough to pay the full amount of the premium. The right-hand side of equation (3) is the expected transfer made by the deposit insurer to depositors. Later it will be convenient to write (3) as

$$\sum_{r \geq 1.0+p_i} f(r|i)p_i = \sum_{r<1.0+p_i} f(r|i)(1.0-r).$$

Under this actuarially fair, risk-based premium schedule, the bank's expected payoff is

$$\begin{aligned}
\sum_{r \geq 1.0+p_i} (r-1.0-p_i) &= E(r|i) - \sum_{r<1.0+p_i} f(r|i)r - \sum_{r \geq 1.0+p_i} f(r|i)1.0 \\
&\quad - \sum_{r \geq 1.0+p_i} f(r|i)p_i \\
&= E(r|i) - \sum_{r<1.0+p_i} f(r|i)r - \sum_{r \geq 1.0+p_i} f(r|i)1.0 \\
&\quad - \sum_{r<1.0+p_i} f(r|i)(1.0-r) \\
&= E(r|i) - 1.0. \quad (4)
\end{aligned}$$

This equation is identical to equation (1), which describes the expected payoff to the bank under the no deposit insurance case. There is equivalence because in the risk-based deposit insurance premium case, the premiums are set to exactly offset the expected payments made by the deposit insurer. In the context of equation (2), the premiums paid exactly offset the value to the bank of the deposit insurance put option. Consequently, just as in the no deposit insurance case, the bank will choose the safe investment strategy because it has the highest expected return.

[9] Analysis of deposit insurance usually operates under the assumption that actuarially fair deposit insurance is desirable. This mode of operation is based on the view that transfers to or from taxpayers are undesirable. For a deposit insurance model that argues that this view may be incorrect, see Boyd, Chang, and Smith (2001).

In the numerical example, the actuarially fair deposit insurance premium for investment strategy i_s is 0.011. (Recall that in this article the premium is being assessed after the return is realized, and to be consistent with limited liability the bank cannot pay its premium if it produces the low return of 0.9.) The corresponding premium for the i_r investment strategy is 0.0429. With these investment-dependent premiums the expected payoff to the bank of i_s is 0.08, while the corresponding payoff to the bank if it takes i_r is 0.065. Consequently, with risk-based deposit insurance premiums, the bank chooses the socially desirable investment.

This example illustrates the argument behind risk-based deposit insurance premiums. Risk-based premiums control risk because premiums can be made explicitly on the investment strategy, and if they are set to keep deposit insurance fairly priced, the bank faces the true costs of its investment decision. But this result depends on the insurer being able to ascertain just how risky a strategy the bank is taking, which it must be able to do in order to set the premiums properly. It is by no means clear, however, that assessing the bank's strategy is an easy task. As I mentioned earlier, the quality of a bank loan may be hard to determine, let alone the quality of an entire portfolio. Just witness the enormous debate and controversy over how to make the Basle capital regulations reflect risk more accurately.[10] In the next section, I will illustrate just how important the full-information assumption is and how the conclusions change when it is dropped. Those results will form the basis for my argument that risk-based premiums alone cannot control moral hazard.

Private Information

To illustrate the second variation on the environment, where the bank's investment strategy is private information, let us continue with the numerical example. The deposit insurer sets a risk-based premium of 0.011 if the bank takes the safe strategy and 0.0429 if it takes the risky strategy. But to implement this policy, the insurer has to know which strategy the bank takes. For the reasons described above, this knowledge is not easy to ascertain. What if the bank claims it is taking the safe strategy but is actually taking the risky strategy?

I can evaluate this possibility by setting the premium to 0.011, that of the safe strategy, and evaluating the expected payoff to the bank if it takes the risky strategy. Its payoff in this case is $0.3(0) + 0.3(1.05 - 1 - 0.011) + 0.4(1.2 - 1 - 0.011) = 0.0872$. This expected payoff is greater than 0.08, which is

[10] The 1988 Basle Accord assigned risk weights to different classes of assets and then set a minimum capital requirement based on the sum of these risks. There has been widespread dissatisfaction with the Accord because all loans of a particular class, such as Commercial and Industrial loans, are treated as equally risky. A major reconsideration of the Accord is underway right now, and the proposals for reform are based on trying to better ascertain risks at the level of individual loans.

what the bank would get if it took the safe strategy. This evaluation suggests that the insurer cannot use the risk-based premium schedule analyzed above to implement i_s.

Unlike in the previous section, the insurer does not observe the bank's investment strategy and the bank is therefore able to say that it is taking one strategy while it is really taking a different one. Economists say there is *private information* when information relevant to a transaction or a contractual arrangement is known to only one of the participants. In the context of deposit insurance pricing, private information puts limits on the types of pricing schemes that can be used. Economists deal with these limits by requiring contracts, or in this case pricing schemes, to be *incentive compatible*. A deposit insurance pricing scheme and an investment strategy are incentive compatible if under the scheme it is in the bank's best interest to take the investment strategy. In contrast, there is no such requirement in the full-information case. If the bank changes its strategy, the premium level can change with it.

As the above analysis indicates, a fixed premium and the socially desirable investment strategy i_s are not incentive compatible. The insurer can do better, however, if it does not restrict itself solely to premiums but also allows payments to depend on the realized return. More formally, I write these payments as $p(r)$. A deposit insurance premium is a special case of this function in which $p(r)$ equals a constant.[11] With this notation, I can more formally define incentive compatibility.

Definition 1 *A deposit insurance price system $p(r)$ and investment strategy i is incentive compatible if for all alternative investment strategies i'*

$$\sum_r f(r|i) \max\{r - p(r) - 1.0, 0\} \geq \sum_r f(r|i') \max\{r - p(r) - 1.0, 0\}.$$

In words, this definition says that for a given deposit insurance price system $p(r)$, the expected payoff a bank receives from taking investment i must be more than it would receive if it took any other possible investment strategy i'. For example, the safe investment strategy i_s is not incentive compatible when the fixed premium is set to 0.011. The risky investment strategy i_r, however, is incentive compatible for that same premium.

With private information, state-contingent payments may improve upon risk-based premiums (which are not state contingent). To see this, consider the following deposit insurance pricing scheme. If the bank produces the high return, charge it 0.053, and if it produces the middle return, rebate to it 0.01. Of course, no payments are made if the bank produces the low return since the bank fails in this event.

[11] Technically, in this article $p(r)$ is only a constant when the bank has enough funds to pay the premium.

The safe investment strategy is incentive compatible for this deposit insurance pricing system. If the bank chooses the safe investment strategy, it receives 0.08. (The number is unchanged from above since the price schedule was chosen to be actuarially fair.) Furthermore, incentive compatibility holds because the expected payoff to the bank from taking the risky strategy is now only 0.077.

This effect can be seen more formally through an analysis of the *likelihood ratios*. In moral hazard problems with recommended strategy i, the likelihood ratio for a given return r is the probability of r, given alternative investment strategy i' divided by the corresponding probability if the recommended strategy was taken. More formally, the ratio is $\frac{f(r|i')}{f(r|i)}$. Examination of the incentive constraint reveals the following. If $p(r)$ is set high when $\frac{p(r|i')}{p(r|i)}$ is high, a bank that takes i' is punished relatively more than a bank that takes the desired i. Similarly, if $p(r)$ is set low (or even negative) when this fraction is low, a bank that takes i' is rewarded relatively less than a bank that takes the desired i.

In this example, the likelihood ratio (when $i = i_s$ and $i' = i_r$) is high for the high return and low for the middle return. This property of the ratio generates the seemingly paradoxical result that the payment is higher if the highest return is produced.[12] But in this example, a low payment for the high return would give the bank too much of an incentive to take the risky investment strategy.[13] Finally, it is worth noting that the likelihood ratio is high for the low return as well, but because of limited liability the bank cannot make payments to the insurer.

Figure 1 illustrates why this pricing scheme is effective. The solid line depicts the payoff to the bank if it faces a fixed premium. The dashed line with the stars reports the payoff from a pricing schedule that collects all payments from the bank when the bank does very well. Notice how the shapes of the two functions differ. The solid line is convex, which means it rewards risk-taking.[14] The dashed line with the stars, while convex in portions, is basically a concave function. It does not reward risk-taking.

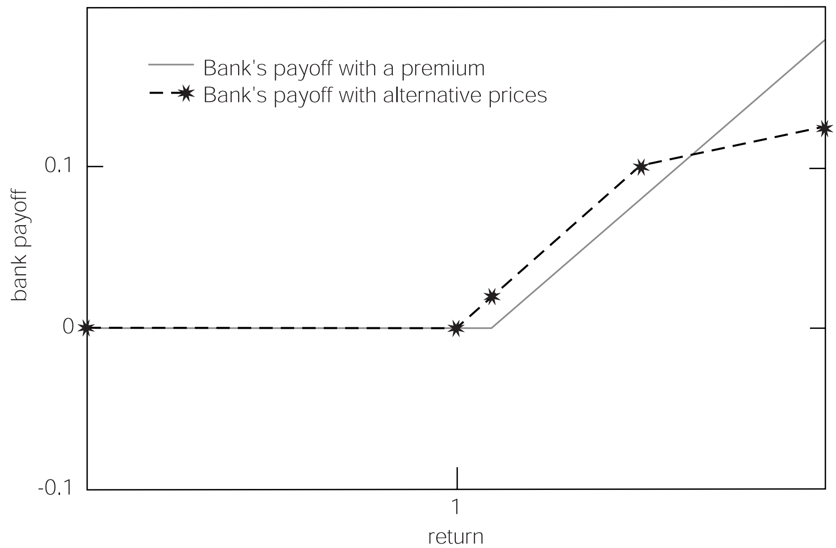
The lesson of this example is that risk-based premiums cannot control moral hazard on their own. Private information requires richer deposit insurance pricing schemes that take advantage of state-contingent pricing. This is not to say that risk-based premiums are not useful but that they are only one component of the entire deposit insurance price system. For example, if

[12] For similar results in the context of bank capital regulations, see Marshall and Prescott (2001) or Prescott (2001).

[13] One potential problem with this pricing scheme is that high returns could also reflect innovation. High payments for high returns would then have the undesirable effect of punishing innovation. The proper balance of these considerations is an open research question.

[14] In the full-information case, this shape did not cause the bank to prefer the risky investment because the premium level could change with investment strategy. Under private information, the premium does not change with the strategy so the convex shape becomes a problem.

Figure 1 Bank's Payoff as a Function of the Return



Notes: The solid line depicts the bank's payoff as a function of the return if it pays a fixed premium of 0.02. The dashed line with the stars represents the bank's payoff for a deposit insurance pricing system that charges no premium but requires a payment if the bank produces a return greater than 1.1. For both payoff functions, the horizontal portion reflects limited liability. Because of limited liability, a bank facing a fixed premium has a convex payoff function. Payoff functions with this shape create a taste for risk. (To see this draw a line between a return on the horizontal portion of the payoff function and a return on the increasing portion. Randomizing over these two returns is preferred to the certain production of the expected amount.) A bank that faces the alternative price schedule has a payoff function that is almost concave, with only a portion being convex. Concave payoff functions create a distaste for risk.

some investment decisions are easy to observe, like the class of investments a bank specializes in, then the analysis will contain elements of both the full information and private information models. In this case, there could be one pricing scheme for banks that specialize in real estate lending and another pricing scheme for banks that hold safe assets like Treasuries. The real estate lending bank might face high premiums plus state-contingent payments, while the Treasury-holding bank might face low premiums and relatively non-state-contingent payments. The pricing scheme is risk based as advocated by proponents of risk-based deposit insurance premiums, but, as my analysis suggests, the pricing scheme would also be state contingent.

Changing the Information Structure

The previous analysis focused on how a price system with state-contingent pricing could improve upon narrow risk-based premium systems. Indeed, the state-contingent price system was successful at implementing the safe, socially desirable investment strategy. The example should not be taken, however, to mean that state-contingent pricing can control all of the moral hazard created by deposit insurance. In many moral hazard problems, the best incentive-compatible contract only partially mitigates the moral hazard.

In this section, I consider the third variation on the environment by providing a private information environment where the insurer can take some costly action that lets it observe some of the private information. This analysis can be used to form the basis for analyzing numerous supervisory activities like safety and soundness exams, audits, and off-site surveillance. As we will see, these activities can play a crucial role in a well-designed deposit insurance pricing system.

To illustrate this principle, I return to the example used in the above section. Now, however, I assume that it costs the bank effort and resources to screen its investment portfolio in order to identify the i_s investment strategy. If the bank does not supply this effort, it cannot take the i_s strategy. The effort cost translates directly into a utility loss to the bank that corresponds to a drop in its payoff of 0.05 units. This loss is not affected by limited liability. The idea is that this loss corresponds to effort by bank management. The bank can choose not to supply the screening effort. If it takes this route, it saves utility but must choose investment strategy i_r. As before, I assume that the socially desirable investment strategy is for the bank to take i_s.[15]

The incentive problem here is more severe than in the previous example. Before it was only necessary to worry that the bank might take the risky strategy. Now, however, it is also necessary to worry that the bank might not screen its portfolio and then take the risky strategy by default. If it does not screen its portfolio, it saves on the utility cost of 0.05. This additional saving is important for the incentive constraints. In particular, the safe investment strategy cannot be implemented with the deposit insurance pricing schedule examined above. Furthermore, this strategy cannot be implemented for any actuarially fair deposit insurance pricing scheme.[16]

[15] In making this assumption, I am ignoring the utility cost to the bank in my welfare calculation. This assumption keeps the problem simple.

[16] For the example, an actuarially fair pricing scheme must satisfy

$$0.6p(r_m) + 0.3p(r_h) \quad = \quad 0.01,$$

where $p(r_m)$ is the payment made if the medium return is generated and $p(r_h)$ is the payment made if the high return is generated. The right-hand side is 0.01 because that is the expected payment made by the deposit insurer to the depositors.

For i_s to be incentive compatible, the pricing scheme must satisfy the incentive compatibility

What is the insurer to do? Let us make one last addition to the environment and allow the insurer to spend 0.02 units examining the bank. By examining the bank, the insurer does not observe which investment strategy the bank takes, but it can tell if it expended the effort to properly screen the projects. Observing this effort could be interpreted as examiners checking bank lending procedures or resources devoted to risk management.

If the insurer examines the bank, the problem is identical to that of the previous section except that now the insurer also has to make up the examination cost of 0.02 units from its pricing scheme. It can recover these funds by setting the rebate to zero and raising the charge on the high return to 0.10. Under this deposit insurance pricing and inspection system, it is incentive compatible for the bank to screen and then take the safe investment strategy. The exam prevents the bank from not screening and once it screens, the state-contingent payments convince the bank to take the safe investment strategy. Finally, the deposit insurance price system is actuarially fair (including examination costs), so no resources are transferred in or out of the banking system in expectation.

The key feature of this example is the way in which the examination policy changes the information structure of the bank. In this example, the information is revealed in a straightforward manner. More generally, examinations or other types of supervisory monitoring may only reveal signals that are partially correlated with the true action. Or, supervisors may want to use the information they receive from inexpensive information gathering methods, like balance sheet observations, to decide whether or not they should gather more information using more costly methods like on-site exams. All these possibilities can be added to the framework developed in this article.

2. CONCLUSION

This article argues that risk-based deposit insurance premiums alone cannot control moral hazard in deposit insurance. The examples demonstrate how richer procedures with more complicated pricing schedules and examination procedures can be more useful than risk-based deposit premiums. The critical factor in the analysis is private information.

Interesting parallels to the analysis exist in markets without government insurance. As was discussed earlier, insurance contracts include deductibles and copayments and may allow for audits to control moral hazard.[17] Banks

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constraint

$$-0.3p(r_m) + 0.1p(r_h) \geq 0.055.$$

Furthermore, the payments are subject to limited liability, which means that $p(r_m) \leq 0.05$ and $p(r_h) \leq 0.2$. A simple graph reveals that there is no pair $(p(r_m), p(r_h))$ that satisfies these four equations.

[17] Experience rating is an important tool used by insurance companies that was not addressed

also take several actions to mitigate the private information of their borrowers. For example, they regularly impose covenants on their borrowers' actions and they often list conditions under which they can call a loan.[18] Just as there is more to the price of a bank loan than the interest rate, there is more to pricing deposit insurance than insurance premium levels.

REFERENCES

Black, Fisher, Merton H. Miller, and Richard A. Posner. 1978. "An Approach to the Regulation of Bank Holding Companies." *Journal of Business* 51: 379–412.

Blinder, Alan S., and Robert F. Wescott. 2001. "Reform of Deposit Insurance: A Report to the FDIC." (March).

Boyd, John H., Chun Chang, and Bruce D. Smith. 2001. "Deposit Insurance: A Reconsideration." Manuscript, Carlson School of Management, University of Minnesota.

Dye, Ronald A. 1986. "Optimal Monitoring Policies in Agencies." *RAND Journal of Economics* 17: 339–50.

Federal Deposit Insurance Corporation. 2000. "Options Paper." (March).

Hart, Oliver D., and Bengt Holmstrom. 1987. "The Theory of Contracts." In *Advances in Economic Theory: Fifth World Congress,* ed. Truman F. Bewley. Cambridge: Cambridge University Press: 71–155.

John, Kose, Teresa A. John, and Lemma W. Senbet. 1991. "Risk-Shifting Incentives of Depository Institutions: A New Perspective on Federal Deposit Insurance Reform." *Journal of Banking and Finance* 15: 895–915.

Kareken, John H., and Neil Wallace. 1978. "Deposit Insurance and Bank Regulation: A Partial-Equilibrium Exposition." *Journal of Business* 51: 413–38.

Keeley, M. C. 1990. "Deposit Insurance, Risk, and Market Power in Banking." *American Economic Review* 80: 1183–1200.

in this article. Indeed, an experience rating may be a partial substitute for state-contingent payments by the bank. This omission was made for simplicity; static models are a lot easier to work with than dynamic ones. Nevertheless, this tool may be very important and deserves to receive more attention than it has received from the bank regulation literature.

[18] For examples and further discussion of the parallels between private lending and how bank regulation should be structured, see Black, Miller, and Posner (1978).

Marshall, David A., and Edward S. Prescott. 2001. "Bank Capital Regulation With and Without State-Contingent Penalties." *Carnegie-Rochester Conference on Public Policy.* Forthcoming.

Merton, Robert C. 1977. "An Analytic Derivation of the Cost of Deposit Insurance Guarantees." *Journal of Banking and Finance* 1: 3–11.

Prescott, Edward S. 1999. "A Primer on Moral-Hazard Models." Federal Reserve Bank of Richmond *Economic Quarterly* 85 (Winter): 47–77.

______________. 2001. "Regulating Bank Capital Structure to Control Risk." Federal Reserve Bank of Richmond *Economic Quarterly* 87 (Summer): 35–52.