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Deposit Insurance, Capital Requirements, and Financial Stability

By Richard W. Kopcke*

Abstract

This paper assesses the effects of insurance and capital requirements on assets' equilibrium returns in a capital-asset-pricing model in which intermediaries possess better information than the public about the yields on a set of assets. Equilibrium returns depend on two risk premiums that intermediaries incur on their liabilities: an explicit premium that reflects the public's view of the risks inherent in intermediaries' assets and an implicit premium that reflects intermediaries' risk of losing a share of their rent by leveraging their capital. Insurance reduces intermediaries' cost of funds, thereby reducing risk premiums on assets and stabilizing equilibrium returns when the public's assessment of yields changes. Because fair insurance premiums typically are small compared to intermediaries' own implicit premiums, any subsidy that low insurance premiums might confer does not induce intermediaries to increase their leverage excessively. Greater capital requirements increase intermediaries' implicit risk premium and diminish their capacity to stabilize equilibrium returns. When the yields of assets fall significantly, both insurance and capital requirements can precipitate disintermediation abruptly. This disintermediation can occur most frequently when intermediaries must maintain their scale of operations in order to earn their rent. Because financial stability ultimately depends on the stability of returns on capital goods, macroeconomic policy ultimately underwrites the lower cost of capital promised by insurance and the security promised by capital requirements.

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Capital markets transfer resources from savers to investors most efficiently when all savers are informed equally well about the prospective returns offered by competing investment opportunities. When opportunities do not receive adequate analysis and coverage in public markets, financial institutions and other intermediaries that possess more incisive, proprietary information can help allocate capital among projects and price the cost of capital more efficiently (Gurley and Shaw 1955, 1960; Leland and Pyle 1977; Diamond 1984; Bolton and Freixas 2000; Ackerlof 1970). Without these intermediaries, investors who lack a sufficiently broad public following can pay, from their point of view, an excessive price to obtain funds from savers who regard their expected returns or the volatility of their returns too pessimistically. In these circumstances, intermediaries, which are best able to monitor these investors and limit their risks, can profit by issuing their own securities in public markets in order to acquire the liabilities of these investors. Intermediaries can both offer funds on more attractive terms to investors and obtain funds on attractive terms from savers who value the additional security provided by intermediaries' capital. Through this arbitrage, intermediaries capture a portion of the excess return that savers require of investors to cover the risk they incur by leveraging their capital.

Intermediaries' capacity for bearing risk limits their role in capital markets. This limit depends on intermediaries' assessment of the risk-adjusted return that they receive by leveraging their capital. It also depends on the public's assessment of the risks that are inherent in intermediaries' own liabilities. Other things equal, as intermediaries' leverage increases, their capital provides their creditors less protection, and their cost of funds rises as the risk in their liabilities more closely resembles that in their assets. Intermediation stops once intermediaries' diminishing margin for profit no longer adequately covers their growing risks.

This limit to intermediation, in turn, influences the stability of capital markets. Within this limit, just as intermediation reduces the cost of capital for investors, it also can diminish the volatility of yields as the public's assessment of the return on investments shifts. At this limit, the cost of capital rises more abruptly and the value of assets falls more sharply as the public becomes more wary of the return on investments. The resulting capital losses can even precipitate disintermediation. The extent of intermediation depends on intermediaries' capacity to manage their risks and returns in response to changing market conditions. Policies that attempt to secure individual intermediaries by restricting, or even reducing their ability to manage risk, especially when the public becomes more wary of the returns to investments, also restrict or reduce their latitude for intermediation. Such conservative policies ironically can increase the risk of financial crises, which debilitate intermediaries.

This paper analyzes intermediaries' capacity for bearing risk within a capital-asset-pricing model that is modified to allow the public's assessment of the returns and risks for some assets to differ from the assessments of intermediaries. Using partial-equilibrium analysis – the supplies of assets and savings do not vary with returns – the model describes the risk premiums that the public requires of assets and of intermediaries' liabilities, premiums which reflect its assessment of assets' returns, the composition of its portfolio, the composition of intermediaries' portfolios, and the presence of deposit insurance or capital requirements. At the same time, intermediaries' demand for assets depends on their cost of funds and the net excess return they expect to earn on their assets compared to the risks they assume by leveraging their capital. The model also describes the response of returns, risk premiums, and the volume of intermediation when the public's assessment of assets' returns changes or when the return on investors' capital goods falls sharply.

In this model, the extent of intermediation can contract with capital requirements and expand with insurance. Capital requirements reinforce intermediaries' incentive to adjust their leverage when the public's assessment of the returns on their assets changes, in order to maintain an optimal return on capital and to protect the value of their franchise. Insurance tends to insulate intermediaries' cost of funds from public opinion, which permits them more leeway in counterbalancing shifts in those opinions. In this case, intermediaries can stabilize capital markets, up to a point, by increasing their leverage when the public becomes more wary of returns.

Both insurance and capital requirements can increase the risk of financial crises by increasing the likelihood of disintermediation. Crises arise in this model when assets' values fall and the public's assessment of returns deteriorates sufficiently to induce intermediaries to shrink as they attempt to avoid excessive risks and maintain an optimal risk-adjusted return on capital. In these cases, insurance and capital requirements tend to diminish intermediaries' capacity to bear risk, and equilibrium returns rise substantially as the public's assessments displace those of intermediaries in pricing assets.

The first section of this paper presents the model and defines the risk premiums that intermediaries incur by issuing liabilities. The second section shows how these risk premiums influence the volume of intermediation and equilibrium returns on assets in the steady state. It also introduces insurance and capital requirements, explaining how they affect risk premiums. The third section examines the response of intermediation and equilibrium returns to changes in public assessments of assets and changes in the value of wealth when intermediaries are covered by insurance and capital requirements. This section compares the results when intermediaries can shrink without penalty when necessary in order to control their risks to the results when intermediaries must maintain their scale of operations in order to earn their rent. This section also considers the benefits of relaxing capital requirements when the values of assets fall substantially. The concluding section summarizes this paper and observes that financial stability ultimately depends on the correspondence between the regulatory policies that govern intermediaries and the strategies of fiscal and monetary policies.

I. The Model

Savers invest their financial wealth in three types of primary security that trade in competitive financial markets. The first offers a constant rate of return r_1. The rates of return on the remaining two securities are random variables. The first risky security represents financial instruments that are equally familiar to all investors; the second, securities that are most familiar to those who possess proprietary information about these assets. Savers allocate their wealth to maximize their expected utility, a function of the distribution of the return on their wealth, W, (Pyle 1971; Hart and Jaffee 1974):[1]

[1] Savers exhibit constant absolute risk aversion with regard to returns; otherwise, their taste for bearing risk is independent of their wealth. Utility is not a function of consumption because this paper imposes a constant supply of saving (and assets) so that equilibrium interest rates fully reflect any changes in risk premiums, highlighting the pricing instead of the accumulation of assets. Because returns in any period are independent of those in other periods and

$$\max_{\mathbf{s}} \; \mathrm{E}\left[-e^{-\lambda \mathbf{s}'\mathbf{r}}\right] \;\equiv\; \max_{\mathbf{s}} \; [\mathbf{s}'\bar{\mathbf{r}} \;-\; \frac{\lambda}{2}\mathbf{s}' \Sigma \mathbf{s}],$$

$$\mathbf{s}'\mathbf{r} = \; r_1 \, s_1 \; + \; \sum_{j=2}^{3} r_j s_j \;\; , \qquad \mathbf{s}'\mathbf{1} \; = \; 1 \, , \tag{1}$$

$$\mathbf{r} = \begin{pmatrix} r_1 \\ r_2 \\ r_3 \end{pmatrix} \sim N\left(\bar{\mathbf{r}} = \begin{pmatrix} \bar{r}_1 \\ \bar{r}_2 \\ \bar{r}_3 \end{pmatrix}, \; \begin{pmatrix} 0 & 0 & 0 \\ 0 & \sigma_2^2 & \rho\sigma_2\sigma_3 \\ 0 & \rho\sigma_2\sigma_3 & \sigma_3^2 \end{pmatrix} = \begin{pmatrix} 0 & 0 \\ 0 & \Sigma \end{pmatrix} \right) \, ,$$

where λ represents savers' aversion to the volatility of returns, **s** is the allocation of wealth among the three securities, **r** is the rate of return on the securities, and **Σ** is variance of the returns for the two risky securities.

The model partitions savers into two groups, those who possess proprietary information regarding the returns on the third asset and those who do not. Savers with proprietary information monitor the investors who issue the third asset more closely, thereby obtaining both better knowledge about the prospects for these investors and the capacity to influence their activities (Gurley and Shaw 1955, 1956, 1960; Leland and Pyle 1977; Townsend 1979; Diamond 1984; Ramakrishnan and Thakor 1984; Fama 1985). As a result of their information and influence, these savers can assume the role of financial intermediaries ("banks") who generally expect to

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assessments evolve as random walks, savers optimize their utility each period.

earn a greater return with less risk from their investment in the third asset (proprietary assets or "loans")[2] Banks also can be less averse to risk than other savers.

This model emphasizes intermediaries' role in making financial markets more efficient by investing on behalf of the public when the public lacks full information about some assets. It does not represent the other services and functions that intermediaries typically offer their customers, which include economies in diversifying or managing assets, pooling insurable risks, transforming assets, tax shelters, maintaining records or preparing statements, transmitting or receiving assets, safekeeping, and completing payments. This model also imposes no reserve requirements on deposits. Consequently, the intermediaries in this model tend to invest more of their portfolios in proprietary assets than those that provide a variety of services.

The Cost of Deposits

Proprietary information encourages banks not only to make loans but also to leverage their investment by issuing securities ("deposits") that bear a fixed rate of interest. Deposits in a solvent bank resemble risk-free assets. The bank's capital is a reserve that allows it to guarantee the rate of interest on its deposits despite variations in the returns on its risky assets, a guarantee that is broken only if the bank becomes insolvent. Depending on the odds that a bank might fail, the interest rate on its deposits exceeds the risk-free rate of interest (r_1) by a premium that equals

[2] The term "bank" is conventional, convenient, and concise; it is not comprehensive. In practice, intermediaries comprise many financial and nonfinancial enterprises. Not only do nonfinancial corporations provide internal capital markets for funding their own projects, but they also apply their proprietary knowledge to support the investments of others through equity investments, loans, mergers, leases, joint development or marketing agreements, and other lliances (Gomes-Casseres 1996; Navin and Sears 1955; Baskin 1988; Baskin and Miranti 1997; Carosso 1970).

depositors' expected loss due to its insolvency. The depositors' expected return therefore equals the risk-free rate of interest.[3] Because deposits essentially represent a short position in the risk-free asset for a bank,[4] its balance sheet comprises the market value of its capital (W^b), its deposits (D= -$s_1^b W^b$), and the market value of its assets (A^b=W^b(s_2^b+s_3^b)):

$$W^b = A^b - D = W^b \cdot \mathbf{1}'\mathbf{s}^b. \tag{2}$$

The risk premium required by depositors can be regarded as the value of the put option that they assume as a result of their bank's limited liability (Merton 1977; Sharpe 1978; Buser et al. 1981; Pennachi 1987; Cummins 1988; Kane 1995). From the viewpoint of a bank, the value of this put option (per dollar of deposits) equals the expected value of the loss it avoids should its liabilities exceed the market value of its assets, its return on capital fall below – 100%:

$$p^b = \int_{\mathbf{r}'\mathbf{s}^b < -1} W^b (1 + \mathbf{r}'\mathbf{s}^b) \ \text{pdf}^{\,\text{b}}(\mathbf{r}) \, d\mathbf{r} \ / \ D, \tag{3}$$

where pdf^b is the bank's assessment of the distribution function for assets' returns. If depositors shared their bank's assessments of its return on assets, then they would value the put option the same as the bank. In this case, the bank's expected cost of issuing deposits would equal the risk-

[3] The gross rate of interest on risk-free securities might exceed that on deposits when banks charge their depositors (possibly implicit) fees for their services. But depositors also avoid the transactions and management costs that investments in risk-free securities entail.

[4] Because this model isolates the intermediary's function of investing on behalf of the public, the intermediary would not profit by issuing deposits to hold risk-free assets, which it typically would hold in the course of providing other services to its customers.

free rate of interest. But, as generally assumed here, when depositors foresee a greater variance or a lower mean for the return on the bank's loans than does the bank, then they require a premium that exceeds the value of the put option to the bank:

$$\delta \;=\; p^d - p^b = \int_{\mathbf{r}'\mathbf{s}^b<-1} W^b(1+\mathbf{r}'\mathbf{s}^b)\;(\mathrm{pdf}^{\mathrm{d}}(\mathbf{r}) - \mathrm{pdf}^{\mathrm{b}}(\mathbf{r}))\; d\mathbf{r} \;\;/\;\; D. \qquad (4)$$

Accordingly, the bank's expected cost of deposits exceeds the risk-free rate by δ, an excess risk premium that rises as its depositors become relatively more pessimistic about the risks or expected returns on its loans.

Banks not only perceive the odds of insolvency differently than their depositors, they also perceive its cost differently. The value of a bank's capital to the bank exceeds its market value, because the bank expects to earn an economic rent from its loans, $\overline{r}_3^{\,b} = \overline{r}_3 + \mu$.[5] The present value of this rent per dollar of capital equals μs_3^b divided by the bank's expected return on capital. When a bank loses a portion of its capital, it loses a commensurate share of its capitalized rent unless it assumes more leverage. Binding capital requirements, $W^b \geq \mathbf{k}'\mathbf{s}^b \cdot W^b$, also might reduce its rent per dollar of capital by limiting its holdings of loans relative to its capital, s_3^b.[6] Therefore,

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[5] Although this profit may be no more than a normal return to the bank for having obtained its proprietary information, economies of scale in acquiring, managing, and applying this information can provide each bank a rent (Leland and Pyle 1977; Diamond 1984; Ramakrisnan and Thakor 1984; Haubrich 1989; Broecker 1990).

[6] The cost of this call against a bank's rent is diminished, of course, if the bank's capital or solvency requirements are not strictly enforced. This specification of γ assumes that regulators may intervene as soon as capital becomes deficient and that $\mathbf{k}$ is an effective rather than a nominal requirement (Acharya and Dreyfus 1988).

the bank's effective cost of deposits exceeds the risk-free rate of interest both by δ and by its risk of losing a share of its rent should its capital become deficient:

$$\gamma = cap\ rent\ [\int_{1+\mathbf{r}'\mathbf{s}^b + p^d s_1^b \le 0} \mathrm{pdf}^b(\mathbf{r})\, d\mathbf{r} \;+ \int_{\mathbf{k}'\mathbf{s}^b \,\ge\, 1+\mathbf{r}'\mathbf{s}^b + p^d s_1^b > 0} \frac{\mathbf{k}'\mathbf{s}^b - (\mathbf{1}+\mathbf{r})'\mathbf{s}^b - p^d s_1^b)}{\mathbf{k}'\mathbf{s}^b}\ \mathrm{pdf}^b(\mathbf{r})\, d\mathbf{r}\ ]\ /\ D$$

(5)

$$cap\ rent = \frac{\mu s_3^b}{\bar{\mathbf{r}}'\mathbf{s}^b + (\delta+\gamma)s_1^b + \mu s_3^b} W_0^b.$$

The first term represents the bank's expected loss of capitalized rent due to insolvency; the second, its expected loss when its capital requirement exceeds its capital, $\mathbf{k}'\mathbf{s}^b > (\mathbf{1}+\mathbf{r})'\mathbf{s}^b$.[7]

The effective cost of deposits for banks, therefore, equals the risk-free rate of return plus two excess risk premiums, δ and γ. The first premium compensates depositors for their expected losses should the bank fail. The second, an implicit premium, compensates banks for their expected loss of rents should they lose a portion of their capital. δ rises with depositors' assessment of the volatility of the return on banks' assets; γ rises with banks' assessments. Both premiums rise as banks assume more leverage. Other things equal, γ increases with capital requirements and can increase with rents. The greater its rent, the greater is a bank's potential loss, but its probability of experiencing a loss also falls as its expected return on capital increases with its rent. δ does not vary with capital requirements or with rents.

[7] When a bank's capital is deficient, its existing owners lose their claim to the rent provided by those assets that no longer are supported by its capital (Pennachi 1987). They either sell these assets or obtain the necessary capital from others.

Equilibrium Risk Premiums and Rates of Interest

The first-order conditions for the maximization of expected utility, conditional on expectations of returns and volatilities, yield the net demands for the three assets by banks and by the public (Lintner 1965):

$$\begin{pmatrix} s_2^d \\ s_3^d \end{pmatrix} = \left(\Sigma^d \lambda^d\right)^{-1} \begin{pmatrix} \bar{r}_2 - r_1 \\ \bar{r}_3 - r_1 \end{pmatrix} ,$$

$$\begin{pmatrix} s_2^b \\ s_3^b \end{pmatrix} = \left(\Sigma^b \lambda^b\right)^{-1} \begin{pmatrix} \bar{r}_2 - (r_1 + \delta + \gamma) \\ (\bar{r}_3 + \mu) - (r_1 + \delta + \gamma) \end{pmatrix} , \qquad (6)$$

$$s_1^d = 1 - s_2^d - s_3^d , \quad \underline{s}^d \geq 0 ,$$
$$s_1^b = 1 - s_2^b - s_3^b , \quad s_2^b, s_3^b \geq 0 .$$

The matrix Σ for banks is the same as that for depositors, except that the variance of the return on loans can be less for banks. Banks may short the risk-free asset by issuing deposits; otherwise, banks' and depositors' positions may not be negative. The values of δ and γ depend partly on the composition of banks' balance sheets; consequently, these equations simultaneously determine the net demands for assets and the two risk premiums on deposits from market rates of return, given banks' and depositors' assessments of the returns on risky assets. Other things equal, banks' demand for risky assets and supply of deposits increase with μ-(δ+γ), σ_3^d/σ_3^b, or λ^d/λ^b. Because δ and γ rise with leverage, a bank's incentive to assume more leverage diminishes as the difference between its rent and the excess premium on its deposits, μ-(δ+γ), shrinks.

The first-order conditions show that banks should tend to specialize. Just as banks' ability to earn a rent on their loans encourages them to assume leverage, it also encourages them to invest a greater share of their portfolios in loans. Although banks can benefit from holding nonproprietary assets in order to diversify their portfolios, both their margin on nonproprietary assets – $\overline{r_2} - (r_1 + \delta + \gamma)$ – and their incentive to diversify their assets diminish as the risk premiums on their deposits increase with their leverage.[8]

The value of the supply of assets in equilibrium, W, equals the sum of the wealth of banks, W^b, and other savers, W^d. Given the rate of interest on the risk-free asset, r_1, the equilibrium rates of interest on risky assets and the risk premiums on deposits equate the net demands for assets with their supplies, $\mathbf{s}W$:

$$\begin{pmatrix} s_2 \\ s_3 \end{pmatrix} W = \begin{pmatrix} s_2^d \\ s_3^d \end{pmatrix} W^d + \begin{pmatrix} s_2^b \\ s_3^b \end{pmatrix} W^b,$$

$$s_1 = 1 - s_2 - s_3 \qquad (7)$$

$$W = W^d + W^b.$$

Equilibrium returns on all risky assets tend to fall as the risk premium on banks' deposits (δ+γ) falls and the share of loans held by banks rises. Although depositors generally view loans as especially risky assets, they hold loans in order to diversify the risk in their portfolios. Consequently, as banks hold a greater share of loans, the equilibrium return on loans falls more

8 As mentioned before, this conclusion applies only to intermediaries' investing on behalf of the public when the public lacks full information. In performing their other functions, intermediaries typically hold a variety of assets in order to serve their customers and control their risks.

rapidly than that on nonproprietary assets, because depositors require compensation for the greater risk that they assume by investing a greater share of their portfolio in nonproprietary assets. In some unusual circumstances, an especially large expansion of banks' investment in loans can increase the equilibrium return on other risky assets as depositors' portfolios become less diversified. Because the supply of assets and the net wealth of savers are equivalent, the wealth of depositors and banks changes if and only if the supply of assets changes.

II. Steady-State Equilibrium

When the relative supplies of each security are constant and savers' assessments of the returns on these securities are not changing, then the model of the previous section is in a steady state. The expected returns, risk premiums, and cost of funds in this equilibrium conform to the optimal allocation of assets and division of risks among banks and their depositors. In these circumstances, any changes in savers' assessments of risk or their capacity to bear risk are reflected entirely in steady-state returns and risk premiums. The introduction of insurance tends to reduce returns and risk premiums, while capital requirements tend to increase them. Moreover, banks' risk of failing to meet their capital requirement tends to increase as their requirement increases.

In this paper's model, banks do not assume much leverage, even when their aversion to risk is relatively low, unless they expect to profit from their proprietary information. When banks expect to earn rents, their leverage is limited by their incentive to protect their franchise and maintain an adequate risk-adjusted return on capital. Deposit insurance reduces both depositors' risk and banks' cost of funds, which encourages banks to assume more leverage, thereby reducing the equilibrium return on loans compared to the return on other risky assets. Yet even with insurance, banks do not assume enough leverage either to put their capital to very great risk or to warrant, from their point of view, paying a substantial premium for deposit insurance. Capital requirements, on the other hand, reduce banks' capacity for bearing risk and increase their effective cost of deposits, which induces them to assume less leverage and increases the equilibrium return for loans.

Steady-States without Deposit Insurance or Capital Requirements

For the following examples, the net supply of the risk-free asset accounts for 5 percent of total wealth. The two risky assets each represent 47.5 percent of wealth. The capital of banks is 5 percent of wealth. The model fixes the rate of interest on the risk-free asset at 1 percent. Banks assess the standard deviation of the returns on both risky assets as 10 percent. Depositors assess the standard deviation for the nonproprietary risky asset as 10 percent; their assessment of the standard deviation for proprietary assets can exceed 10 percent. For all, the correlation coefficient between the returns on the risky assets is 0.6.

When banks and their depositors assess assets similarly, their demands for risky assets are similar. But, when banks are less averse to risk and foresee less risk or higher returns from investing in loans, the equilibrium yield on loans falls relative to other yields as banks assume more leverage. Banks' willingness to assume leverage is limited because their expected return on capital falls and the volatility of their return on capital rises with leverage. When depositors either are much more averse to risk than banks or foresee much more risk from holding loans than do banks, they require banks to pay a substantial risk premium on their deposits, which further limits banks' incentive for assuming more leverage.

When bankers and depositors have the same aversion to risk and assess the returns on loans the same (Tables 1a and 1b, column 1), the portfolios of banks and depositors are identical, and the equilibrium rate of return for both risky assets is the same. As the banks' aversion to risk falls (columns 5 and 9), they assume more leverage, and the returns required of both risky assets fall as banks manage more of the risky assets on behalf of their depositors. In all three columns, the banks assume no more than a negligible risk of defaulting on their deposits, and depositors require no excess risk premium.

When banks expect to earn a 1-percentage-point rent on loans (columns 2, 6, and 10), they invest a greater share of their portfolio in this asset and increase their leverage. Although banks also bid down the equilibrium return moderately on this asset while paying higher rates on their deposits, they retain much of their rent in their profit margin to compensate for the greater volatility of their return on capital due to their greater leverage. With a lower degree of risk aversion, banks are more willing to accept lower returns on loans and offer greater returns on their deposits, because they are willing to accept a lower expected return on capital for their risk. But even when banks' aversion is only one-sixth that of others (column 10), their leverage does not rise enough to increase substantially either the interest rate on deposits or their risk of losing their rents. The premium in the return on loans does not fall sufficiently to discourage depositors from continuing to hold some of these assets in order to diversify the risk in their portfolios.

The equilibrium return for loans rises considerably when depositors regard their returns twice as volatile as banks (columns 3, 7, and 11). In this case, banks assume more leverage and shift their assets entirely into loans, thereby raising both the banks' expected return on capital and the volatility of their return on capital (columns 7 and 11). Because banks' expected return on capital seems low relative to the volatility of their return on capital from the viewpoint of their depositors, banks' ability to bid down the return on loans is limited by the greater excess risk premium that they must pay on their deposits. This greater premium also deters banks from investing in assets other than loans. As explained in the discussion of equations (6), banks have a strong incentive to specialize. With greater leverage, the risk premium they pay on their deposits exceeds the net advantage they derive from holding a more diversified portfolio.[9] Banks are more willing to pay a greater premium on deposits, the lower is their aversion to risk or the greater are their rents. But, even in these cases, they do not assume enough leverage either to bear a very great risk of losing their rent or to warrant paying, from their point of view, a sizable deposit insurance premium.

The steady-state properties of this model indicate that risk premiums do not respond symmetrically to shifts in savers' confidence (Figure 1). For any rent that banks can earn on loans, the additional risk premium on loans, r_3-r_2, rises by an increasing amount as depositors' assessment of the volatility of their returns rises (the horizontal distance between the contours decreases – at a falling rate – moving to the right). Consequently, this premium changes more

[9] As the correlation between the returns on the two risky assets falls, banks tend to hold more nonproprietary assets in order to diversify their assets better. When the correlation is zero, nonproprietary assets represent about 37 percent, 22 percent, and 19 percent of banks' assets in columns 2, 3, and 4 as well as in columns 6, 7, and 8; the entries for the last three columns are 37 percent, 16 percent, and zero. If δ also were zero (as is the case with deposit insurance in Table 2), the penalty for banks' holding the nonproprietary asset would fall further. In this case, the entries in columns 8, and 12 would be 22 and 25 percent. With the addition of capital requirements, which increase the cost of deposits, banks' holding of nonproprietary assets falls in these cases.

rapidly when σ^d/σ^b increases than when it falls. This asymmetry is more pronounced at lower degrees of uncertainty. As depositors' uncertainty increases, banks' rents must rise at a decreasing rate in order to prevent the premium on loans from increasing (the positive slope of the contours decreases slightly as the rent increases), because banks hold a larger share of loans.

Deposit Insurance

With deposit insurance, depositors accept the risk-free rate of return on their accounts, because they lose no principal or interest if their bank becomes insolvent. When the insurance premium equals banks' assessment of the value of the shelter created by their limited liability, deposit insurance eliminates the excess risk premium that banks pay depositors, thereby reducing the effective cost of deposits to $r_1+\gamma$.[10] This lower cost of funds encourages banks to increase their leverage, thereby reducing the equilibrium risk premium for loans.

The following assumes that, from the banks' view, the insurance premium accurately reflects the risk in their portfolios. Although deposits can be insured by private entities, a government agency likely does so more efficiently. To eliminate depositors' excess risk premium (δ), insurers must be able, without restriction, to audit the quality of banks' proprietary information, and depositors must be certain that insurers will satisfy their obligations. The sharing of proprietary information with a private insurer poses risks for intermediaries, especially when

[10] This method of pricing insurance – deriving the premium from the distribution of capital that is induced by banks' leverage and the distribution of the returns on assets – produces a fair price from the banks' perspective (Chan et al. 1992). Banks in this case receive no subsidy for the option value created by their limited liability (Gennotte and Pyle 1991). Nonetheless, as discussed in conjunction with Table 3 below, the pricing of insurance might be less important than the provision of insurance for promoting more efficient capital markets.

the insurer might take a position in competing intermediaries (Bhattacharya and Chiesa 1995). Yet, an insurer that covers many intermediaries might provide insurance more efficiently, because of economies of scale in gathering information and to a better diversification of its own risks. A public agency might best realize these economies without creating a substantial conflict of interest, at least in the absence of a crisis (Kane 1989a,b).

The insurers are themselves intermediaries whose cost of funds and whose pricing of premiums depend on the public's view of their business, and the value of their guarantee depends on their proprietary information and capitalization. As an insurer's leverage rises, not only does its own cost of funds rise, but banks' cost of issuing deposits also rises as depositors recognize that the insurer's guarantee becomes less certain.[11] When insurers possess full information about the risk in banks' proprietary assets, private deposit insurance is functionally equivalent to banks' maintaining more capital (that provided by insurers) to protect their depositors' claims. In these circumstances, the excess risk premium that banks effectively pay their depositors would fall only as much as the extra capitalization permits. When insurers are no better informed than the public at large, private deposit insurance fails to reduce the excess risk premium that banks pay on their deposits – any reduction in depositors' excess risk premiums is offset by the excess premium banks must pay for their insurance.

For example, when banks issue subordinated debentures in some fixed proportion to their deposits, those who hold this debt provide a degree of insurance to depositors (Board of

[11] Extending this view of intermediaries as insurers, an enterprise that requires financing for capital investments can benefit from establishing a relationship with a reputable, well-capitalized intermediary (Haubrich 1989; Sharpe 1990; Rajan 1992; Slovin et al. 1993). The enterprise might issue senior obligations on better terms (Diamond 1984), and its line of credit with its intermediary can be more economical and secure.

Governors of the Federal Reserve System 1999). This insurance is limited to the value of the debentures, which in the depositors' view effectively provides more capital to protect their claims. If the holders of subordinated debt regard the potential returns of banks' assets no differently than depositors, this arrangement only reallocates a share of depositors' risk to bondholders without altering banks' effective cost of funds.[12] On the other hand, if subordinated creditors, unlike the public, could accurately assess the quality of banks' proprietary information, they still would require a premium to cover their own (opportunity) cost of funds, especially if they intend to trade these bonds in public markets. This premium likely would be greatest, and banks' cost of funds would approach that required by uninsured depositors, when the public is most wary of the returns on banks' assets, which often occurs during financial crises.

The following also assumes that banks pay a periodic premium for their deposit insurance. Insurers might assess each intermediary a periodic premium that reflects the risk in its balance sheet (pay-as-you-go) or might establish reserves which, in turn, could be held by the insurers (deposit insurance fund) or could be implicit and held by the intermediaries themselves (mutual guaranty). In competitive markets, the first two arrangements are equivalent provided intermediaries implicitly receive a risk-adjusted rate of return on their insurance reserve that reflects the return that they earn on their assets. When intermediaries earn rents, their diverting capital to an external reserve that earns no rent is more costly than their paying periodic premiums

[12] Intermediaries, like other corporations, currently issue subordinated debt in order to manage their cost of capital (Myers and Majluf 1984; Myers 1984; Harris and Raviv 1991; Bolton and Freixas 2000). Selling equity to investors who do not regard a bank's prospects as optimistically as existing shareholders entails losses for existing owners. When outsiders regard the bank's prospects differently, it can raise funds most economically through price discrimination: Issuing senior debt to the least optimistic, junior debt to those who regard its returns more favorably, subordinated debt and preferred stock to those who are nearly as optimistic as its existing owners. From this perspective,

or maintaining an implicit reserve. When reserves are implicit and guarantors draw capital from the survivors to pay the obligations of the insolvent, then intermediaries risk maintaining inadequate or excessive reserves because they cannot accurately assess the risks taken by others. In this case, capital requirements and other controls that limit the risks taken by intermediaries can serve the interests of the intermediaries themselves as well as those of their creditors.

Deposit insurance diminishes the risk premium for loans by reducing the cost of deposits, which fosters banks' demand for this asset (Table 2). When circumstances do not encourage banks to bear substantial risk by holding a very great share of loans (columns 1 and 2), the cost of deposits and the risk premium for loans fall comparatively little with the introduction of deposit insurance. When banks are less averse to risk and anticipate earning greater rents on their assets, the risk premiums on deposits and loans can fall substantially (columns 13 and 14). Although deposit insurance fosters leverage, thereby raising the insurance premium, both this premium and the banks' risk of losing their rent remain modest. Banks' leverage is limited entirely by the increasing volatility of their return on capital relative to their expected return on capital as their leverage rises and the yield on loans falls.

With deposit insurance, the premium on loans varies less with the degree of depositors' uncertainty about the return on loans than it does without insurance (Figure 2). This premium rises by a decreasing amount as depositors' uncertainty increases (the horizontal distance between contours is greater than in Figure 1, and the slope of the contours falls more rapidly moving to the right). Because the share of loans held by banks increases as the banks' rent or depositors'

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that intermediaries currently issue a variety of liabilities, including subordinated debt, suggests a disparity of information, a limit to the value of private insurance.

uncertainty increases, the premium depends less on depositors' view of their returns. Unlike the case without deposit insurance, the risk premiums respond asymmetrically to changes in depositors' uncertainty because premiums tend to change more rapidly when σ^d/σ^b falls than when it rises.

Capital Requirements

In principle, capital and solvency requirements promote safer banks by limiting their leverage and, therefore, the volatility of their return on capital (Sharpe 1978; Buser et al. 1981; Berger et al. 1995; Kane 1995; Diamond and Rajan 1999).[13] Banks reduce their leverage as their capital requirement increases, because the enforcement of a higher standard, other things equal, increases their risk of losing a share of their rent more than it reduces depositors' excess risk premium. The introduction of a requirement, therefore, initially raises $\delta+\gamma$ in equations (6), which reduces banks' margins on all assets.

Capital requirements also can induce banks to invest a greater share of their portfolios in assets that the public regards as especially risky (Koehn and Santomero 1980; Kim and Santomero 1988; Keeley and Furlong 1990). As banks reduce their leverage, the equilibrium return on loans and, therefore, their margin on loans rise more than those for other assets. The

[13] These requirements can reduce the premium for deposit insurance by diminishing the odds that a bank's losses exceed its capital (Allen and Saunders 1993). Requirements also can reduce agency costs and induce banks to recognize the cost of insuring deposits (e.g., Giammarino et al. 1993). These motives are not so important in this model because banks take little risk in the absence of a rent. With a rent, they internalize a substantial risk premium when they put that rent to risk (γ). For this reason, the capital ratios in Table 1 exceed requirements and increase as requirements rise. Also, as shown in the next section, even with deposit insurance, banks tend to shrink in order to control their risk and protect their remaining rent after they experience losses.

specific capital requirements that are applied to each asset might be restructured in order to encourage banks to reduce their holdings of loans and other assets by the same proportion as they shrink.[14] But, doing so would increase the equilibrium return on loans more than that on the nonproprietary asset when depositors are less certain of the return on loans or are more averse to risk than banks. If a change in requirements reduces banks' holdings of all assets by the same proportion, then from (6), (7), and the assumption of a fixed supply of assets:

$$\begin{aligned} \mathrm{d}\, s_i^b &= \nabla_{\mathbf{k}} s_i^b \cdot \mathrm{d}\,\mathbf{k} = -\alpha s_i^b \qquad && \alpha > 0 \qquad i = 2,3 \\ \mathrm{d}\, s_i^d &= -\,\mathrm{d}\, s_i^b \cdot \theta && \theta = W^b / W^d \end{aligned} \tag{8}$$

As banks shrink, their depositors must be willing to acquire the assets that they sell (as specified in (8)). Therefore, from (6):

$$\mathrm{d}\begin{pmatrix} \bar{r}_2 \\ \bar{r}_3 \end{pmatrix} = \theta\alpha(\Sigma^d \lambda^d)\begin{pmatrix} s_2^b \\ s_3^b \end{pmatrix}. \tag{9}$$

If the structures of Σ and s^d correspond with a return on loans that is greater than that on the other risky asset in the initial equilibrium, then the same conditions ordinarily imply that the return on loans increases more than that on the other asset, especially when banks invest a smaller share of their portfolio in nonproprietary assets than other savers do ($s_2^b / s_3^b < s_2^d / s_3^d$):

[14] Restrictions on permissible capital requirements – that they are not negative for any asset, for example – might make this goal unachievable. When banks hold only loans, as is the case in the examples below, any change in requirements meets this goal. An increase in the requirement also must increase the return on loans more than that on the other risky asset.

$$\mathrm{d}\begin{pmatrix}\bar{r}_2\\ \bar{r}_3\end{pmatrix} = \lambda^d\theta\alpha\begin{pmatrix}s_2^b\sigma_2^2 \ + \ s_3^b\rho\sigma_2\sigma_3\\ s_2^b\rho\sigma_2\sigma_3 \ + \ s_3^b\sigma_3^2\end{pmatrix}$$

(10)

$$\mathrm{d}(\bar{r}_3 - \bar{r}_2) = \lambda^d\theta\alpha\, s_3^b\, [\frac{s_2^b}{s_3^b}(\rho\sigma_2\sigma_3 - \sigma_2^2) \ + \ (\sigma_3^2 - \rho\sigma_2\sigma_3)].$$

Certainly, when depositors believe that σ_3 exceeds σ_2, the equilibrium return on loans increases more than that on the other risky asset. Conversely, a change in capital requirements that does not increase the premium on loans so greatly also induces banks to invest a greater share of their portfolio in loans.

The odds that banks will fail to meet their capital requirement increase as their requirement increases (Demsetz et al. 1996, Berger et al. 1995). In this model, banks' ratio of capital to assets does not rise as much as their requirement, because the higher return on loans that accompanies their lower leverage compensates them for bearing more risk of losing a share of their rent. When a change in capital requirements reduces banks' ratio of loans to capital, then (from (6)):

$$\mathrm{d}\begin{pmatrix}s_2^b\\ s_3^b\end{pmatrix} = (\Sigma^b\lambda^b)^{-1}\begin{pmatrix}\mathrm{d}(\bar{r}_2 - (\delta+\gamma))\\ \mathrm{d}(\bar{r}_3 - (\delta+\gamma))\end{pmatrix}$$

(11)

$$\mathrm{d}\, s_3^b = \frac{(\sigma_2^2\,\mathrm{d}\,\bar{r}_3 - \rho\sigma_3\sigma_2\,\mathrm{d}\,\bar{r}_2 - (\sigma_2^2 - \rho\sigma_3\sigma_2)\,\mathrm{d}(\delta+\gamma))}{\lambda^b\sigma_3^2\sigma_2^2(1-\rho^2)} < 0.$$

If depositors expect the return on loans to be lower or more volatile than banks expect, then the equilibrium return on loans rises more than that on the other risky asset. For the right side of (11) to be negative despite this greater relative return on loans and the accompanying drop in the depositors' excess risk premium (δ), banks must assume more risk of failing to meet their requirement (γ increases). The lower is banks' aversion to risk relative to that of their depositors, the more rapidly their odds of a deficiency increase with their capital requirement. With higher values of σ_3/σ_2 or ρ, the odds of a deficiency rise more slowly as the requirement increases.

In the following, the capital requirement equals one standard deviation of banks' return on assets. Because their risk of losing their rent is sufficiently great to induce them to hold only loans in the following, this requirement equals 10 percent of the value of their assets.[15] When banks are only half as averse to risk as their depositors, the requirement increases their effective cost of deposits only negligibly (Table 2, columns 3 versus 1, 7 versus 5). When they are more inclined to assume more risk and bid down the risk premium on loans, it increases their cost of deposits and the risk premium on loans more substantially (columns 11 versus 9, 15 versus 13).

Capital requirements raise the additional risk premium on loans most when the value of banks' proprietary information is greatest (Figure 3 compared to Figure 1). When banks' rents are low or banks are no more certain than depositors about the return on loans, then the premium on loans changes little with the introduction of a capital requirement. When banks maintain more leverage because of their ability to earn a rent or less volatile returns, then the introduction of requirements entails a larger premium. A greater rent typically allows banks to bid down the premium on loans for a given degree of depositors' uncertainty; yet, with capital requirements banks are less willing to assume sufficient leverage to reduce these premiums as aggressively as they do without these requirements (the contours in Figure 3 are steeper than those in Figure 1).

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[15] This requirement is greatest when banks hold only one risky asset. It is least, 8.1 percent when banks hold equal amounts of both risky assets, a more diversified portfolio.

Deposit insurance in conjunction with capital requirements can reduce the additional risk premium on the proprietary asset nearly as much as insurance alone when banks' rents are relatively low (Table 2 and Figure 4). But, even though deposit insurance eliminates depositors' excess risk premium, capital requirements increase the price of leverage, causing the premium on loans to rise with rents – especially for higher degrees of depositors' uncertainty – more than it would without capital requirements (the slopes of the contours in Figure 4 exceed those in Figure 2). Consequently, capital requirements diminish the capacity of insurance to insulate the risk premium on loans from changes in depositors' uncertainty.

III. Varying Assessments and Capital Losses

When the public's assessments of the return on proprietary assets change, savers require compensating changes in the returns on these assets and in the returns on the liabilities of financial intermediaries that hold these assets. Equilibrium returns also vary when capital losses diminish the value of assets, savers' wealth, and intermediaries' capacity for assuming risk. This section analyzes the response of returns and risk premiums in these circumstances both when banks can shrink without compromising their rent after they lose a portion of their capital and when banks earn their rent only as long as they maintain the size of their portfolios. This analysis also assesses the consequences of relaxing capital requirements during financial crises.

Deposit insurance helps to stabilize equilibrium returns as depositors' views of the return on loans vary. But, when the value of investments that back risky assets falls substantially, deposit insurance can hasten the resulting increase in returns for risky assets. Although capital requirements limit banks' leverage, thereby limiting their potential losses when the value of investments falls, these requirements also can hasten the increase in equilibrium returns by inducing banks to shrink more quickly after they lose capital. Following an unusually large loss of wealth, a flexible enforcement of capital requirements, which permits a degree of forbearance, reduces the odds of an abrupt increase in returns. But returns under capital requirements are more stable than they would be without these requirements only to the degree capital requirements limit banks' leverage in the steady state, thereby increasing average returns and risk premiums.

Equilibrium Returns

In the following analysis, all assets are one-period claims against their issuers. Assets offer a nominal dividend, which equals the constant return that issuers expect to earn on the investments that back their liabilities. Savers receive their dividends at the end of each period plus repayments of their assets' face value, which is normalized at one dollar. To simplify the following, any variation in an investment's repayment of principal is included in its dividend. The duration of all assets, consequently, is one period. The expected dividends for all assets equal their steady-state equilibrium returns, so their market prices equal their face values in the steady state.

At the beginning of each period, savers may exchange assets according to their market prices (v). Savers then advance to the issuers of their assets amounts equal to the market prices of those assets in anticipation of receiving dividends and payments of principal at the end of the period. An asset's actual payment in any period depends on the performance of its underlying investment in that period. Assets backed by very successful investments return more than their nominal dividend; sufficiently unsuccessful investments pay negative dividends. Because an investment's return in one period is independent of its returns in other periods, its dividends also are independent over time.

Depositors' assessments of the returns on loans can vary from period to period. A run of generous dividends, for example, could encourage depositors to expect greater or more secure returns from loans; a string of disappointments, lower or less secure returns. When depositors' assessments of the return on loans differ from their steady-state values, the equilibrium returns for both risky assets also tend to differ from their steady-state values. In these circumstances the market prices of risky assets can vary from their face values:

$$v_{i,t} = (1+\overline{div}_i)/(1+\bar{r}_{i,t}), \quad i = 2,3$$

$$W_t^j = W_{t-1}^j \cdot \mathbf{s}_{t-1}^{j\,\prime} \cdot \begin{pmatrix} 1 \\ v_{2,t}/v_{2,t-1} \\ v_{3,t}/v_{3,t-1} \end{pmatrix}, \quad j = b, d. \tag{12}$$

When depositors expect the dividends on loans to be more volatile, both the price of loans and the value of wealth tend to fall as the equilibrium rate of return on loans rises. The drop in the price of loans and in wealth is greater if depositors also expect dividends to fall.

Depositors' assessments of the return on loans, which reflect their judgments about the yield on the investments behind these assets, follow a random walk. Consequently, the expected values of equilibrium returns in the future equal current equilibrium returns, and the expected price of any asset in the future equals its current price. In these circumstances, an asset's expected holding-period return is defined by the first equation in (12), and the last expression in (1) describes savers' assessments of these returns. The equations of (6) and (7) combined with the definition of assets' prices and savers' wealth in (12) define equilibrium returns. As in the previous section, banks receive a 1-percentage-point rent from their loans, and the return on loans is less volatile for banks than it is for depositors. Banks also are less averse to risk.

Changes in Depositors' Assessments of Returns

Table 3 illustrates the response of risk premiums to changes in depositors' assessments of the return on loans. The first column shows the equilibrium without deposit insurance or capital requirements (from Table 2, column 13). Assets' dividend yields equal their steady-state equilibrium returns, so their market prices equal their face values, one dollar. In the second column, depositors' assessment of the return on loans improves sufficiently to reduce the equilibrium rate of return on loans by 1 percentage point. Depositors expect both a higher and less volatile dividend from loans.[16] In the third column, depositors' assessments deteriorate sufficiently to raise the equilibrium return on loans by 1 percentage point. Each subsequent set of three columns show first the initial equilibrium, then the consequences of the same shifts of assessments when deposit insurance or capital requirements are in force.

Deposit insurance reduces the volatility of the return on loans (columns 4, 5, and 6) significantly. When banks' aversion to risk is low, circumstances that could change this return by 1 percentage point without deposit insurance only raise it 0.14 of a percentage point or reduce it 0.32 of a percentage point with deposit insurance. Inasmuch as insurance insulates the cost of deposits from depositors' assessments of the return on loans, banks can vary their leverage

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[16] For the optimistic case, the depositors' assessments of the expected return and volatility of the return on loans move toward those of the banks, each closing the distance at the same proportionate rate, until the equilibrium return on loans falls 1 percentage point. For the pessimistic case, depositors' expected return and volatility move away from the values for the banks, the distance for each increasing at the same proportionate rate.

countercyclically, selling loans when their value is especially great to the public, buying loans when their value is especially low. The equilibrium return on loans also tends to be insulated from depositors' assessments because banks initially hold a larger share of its supply. The return on the other risky asset falls when that on loans rises, and conversely. Because the banks limit the drop in the return on loans when depositors assess its prospects more optimistically, the equilibrium return on the other risky asset tends to rise in order to attract sufficient demand. Finally, by reducing the volatility of the return on loans, deposit insurance also reduces the volatility of the market value of banks' capital (last line), which in turn reinforces banks' ability to counter shifts in depositors' assessments.

The provision of deposit insurance in these examples is more important than its pricing. For example, when the deposit insurance premium is fixed at zero (columns 7, 8, and 9), the results are very similar to those when the premium varies in accordance with banks' risks. This mispricing of insurance is not of great consequence in this case because a subsidy that is no greater than the comparatively modest deposit insurance premium (12 to 25 basis points) does not alter the balance between banks' expected return on capital and the volatility of this return very greatly in this model. Almost one-half of this subsidy is spent in reducing the equilibrium yield of the proprietary asset (columns 4 and 7) as banks' leverage increases. The remainder compensates banks for the greater volatility of their return on capital that accompanies this greater leverage.

Capital requirements, by themselves, alter the volatility of the return on loans only negligibly. The conditions that change the return on loans by 1 percentage point in the absence of capital requirements (the first three columns) also change this return nearly as much when these requirements are in force (last three columns). Just as these requirements do not alter very greatly the level of the excess risk premium on deposits in the initial equilibrium (columns 1 and 10), they do not alter this premium's response to changing conditions very greatly. Depositors' assessments of the return on loans govern banks' cost of funds, which in turn limits banks' capacity to counter changes in depositors' views.

Capital Losses

Although deposit insurance can stabilize returns when depositors' opinions change, it can aggravate the increase in equilibrium returns when the value of the investments that back financial assets falls too greatly. When a drop in the value of investments and financial assets reduces banks' capital very substantially, then the greater is the banking system's initial leverage, the more assets it must sell in order to achieve a optimal balance between the risk and return on its remaining capital. Moreover, banks' capital losses tend to increase with the volume of their sales of loans, because the transfer of loans from the portfolios of banks into the portfolios of depositors raises the equilibrium return on loans, thereby further depressing their value. Consequently, deposit insurance, which induces banks to assume more leverage in the steady state, can aggravate the response of financial markets to capital losses. By forcing banks to limit their leverage after they experience a loss, capital requirements also can amplify the increase in equilibrium yields and the accompanying drop in assets' values.

Starting from steady-state conditions described in the previous section (Table 2, columns 13 through 16), the following assumes that the aggregate values of both risky assets fall as a result of a change in economic conditions (Table 4 and Figure 5). For example, a share of the investments that back these assets might become redundant due to technical innovations, higher prices for materials, or a drop in demand for their output. Following these losses, depositors also expect the return on loans to become more volatile.[17]

Capital losses induce banks to sell a share of their loans to the public so that they maintain an optimal balance between their expected return on capital and the volatility of their return on capital. When the value of assets initially falls by 5 percent (about one standard deviation below their expected return), the value of loans falls by another 1.5 percent in order for depositors to place a greater share of their assets in loans (column 1). Although banks' capital falls nearly two-fifths in these circumstances, banks' holdings of loans fall almost one-fifth, as the rising interest rate on loans induces them to increase their leverage just over one-fifth. When initial capital losses increase, banks' loss of capital increases more rapidly, as the rising excess risk premium they must pay on their deposits diminishes their willingness to assume more leverage. Accordingly, when the value of assets initially falls 7 percent, the value of loans falls another 2.4 percent, and banks' capital falls by more than one-half (column 5). Banks' leverage rises only about one-quarter, while their holdings of loans fall almost one-third.

Although deposit insurance induces banks to increase their leverage when the value of wealth falls, it also induces banks to assume more leverage before the fact, thereby increasing their loss of capital and, very likely, the volume of loans that they sell (columns 2 and 6). When the value of assets falls 5 percent with deposit insurance, banks lose 50 percent of their capital. Although their leverage rises almost one-third, they still sell about one-fifth of their portfolio of loans, which in this case is about one-third larger than that in the first case, in order to optimize

[17] Expected volatility rises by one-half the initial capital loss. When the initial loss is 5 percent, for example, depositors expect the volatility of the return on loans to rise from 20 to 22.5 percent.

their risks and returns. As a result, the return on loans rises more with deposit insurance than it does without. After the value of assets initially falls by 7 percent, the equilibrium return on loans with deposit insurance exceeds that without insurance (Figure 5).

Although capital requirements limit banks' assumption of leverage, they also increase both the risk of banks' losing their capital and the odds of disintermediation. Capital requirements limit banks' assumption of more leverage following their initial loss of capital, thereby forcing them to sell more loans (columns 4 and 8). These sales then depress the value of loans and other risky assets further in order for depositors to be willing to acquire the loans that banks must sell (column 8), which costs banks a greater share of their capital. Capital requirements, consequently, can entail a comparatively large increase in the return on loans.

The risk of disintermediation increases with capital requirements (see also the discussion of (8)). In these examples, when the capital requirement rises from zero to 10 percent, the steady-state ratio of capital to assets rises only 1 percentage point. Consequently, the difference between banks' capital ratio and their capital requirement falls from 16 to 7 percentage points, thereby reducing their capacity for coping with losses. Capital ratios typically do not increase as much as capital requirements, because banks assume more risk as their expected return on capital increases with the equilibrium return on loans.

Deposit insurance offers the benefit of a lower cost of capital at the risk of increasing its volatility (Figures 5a and 5b). In the range of the least and most probable initial capital losses, the cost of capital remains lowest with deposit insurance. However, larger losses entail the highest cost of capital comparatively quickly with insurance, because these losses diminish banks' capital comparatively quickly as a result of their greater leverage. As noted above, capital requirements do not mitigate this consequence of deposit insurance; instead, capital requirements tend to increase interest rates even more quickly by causing banks to sell their loans sooner, thereby accelerating the decline in the value of loans and banks' capital. To maintain comparatively low and stable equilibrium returns on risky assets over time, macroeconomic policies that minimize, to the degree possible, the incidence of especially large drops in the prospective return on investments – a kind of implicit insurance – might complement the explicit insurance of depositors' accounts.

Fixed Scale of Intermediation

The previous analysis assumes that banks earn their full rent on their proprietary assets even when they shrink after they experience a loss of capital. For small changes, this assumption might be appropriate, but a bank that shrinks too greatly might sacrifice its franchise and its ability to earn rents on its remaining assets. In this case, a bank that loses a significant share of its capital must cope either by sacrificing its rent or by retaining its assets, thereby assuming more risk as it allows its leverage to increase. When banks' potential loss of rents is large compared to their loss of capital, the previous analysis understates the risk they assume by issuing deposits.

For the following, once banks establish their scale of operation, their rents depend on their ability to maintain their role. In this case, banks' cost of deposits depends not only on their risk of losing capital in the current period, but also on their risk of losses in the future. After a year of losses, the banks above sell loans in order to protect their remaining rent by maintaining an acceptable balance between their expected return on capital and the volatility of this return. When banks maintain their scale of operations, however, leverage rises after a year of losses, and they become more vulnerable to subsequent losses. Banks in these circumstances initially choose less leverage so that a sequence of losses is less likely to threaten their rent. Their expected loss of rents, formerly defined by (5), becomes:

$$\gamma \;=\; rent \sum_{t=0}^{\infty} \frac{\text{prob(capital becomes deficient in period } t\text{)}}{(1+\mathbf{r}'\mathbf{s}^{b}+(\delta+\gamma)s_{1}^{b}+\mu s_{3}^{b})^{t}} \;/\; D. \qquad (13)$$

With a fixed scale of operations, the provision of deposit insurance can reduce the cost of deposits by reducing γ as well as eliminating δ. Other things equal, deposit insurance increases the probability of a bank's recovery after it loses a share of its capital. Without insurance, losses that reduce its capital also increase the excess risk premium required by its depositors in following periods, which reduces the bank's subsequent expected return on capital and increases its risk of eventually having to shrink.

The excess risk premiums for deposits and the proprietary asset are higher when banks must maintain their scale of operations in order to retain their rent (Table 5, compared to Table 2). Even when banks do not assume much leverage (columns 1 through 4), their risk of losing their rent rises significantly. When banks' aversion to risk is lower, their leverage is greater, and their greater risk of losing their rent entails a significantly higher cost of funds, especially when banks are subject to capital requirements (columns 5 through 8). Consequently, banks that must maintain their scale of operations in order to retain their rent assume less leverage in the steady state than did banks in the previous analysis. The fair deposit insurance premium, from the point of view of the banks, therefore, is lower than in the previous examples.

Fixed Scale of Intermediation and the Loss of Wealth

When banks must maintain their scale of operations in order to retain their rent, the equilibrium return on assets varies less with the loss of wealth, provided the losses are not sufficiently great to force banks to shrink. Returns rise abruptly once the loss of wealth forces banks to sell their assets. Deposit insurance and capital requirements both tend to hasten this disintermediation as the initial loss of wealth rises.

Banks stabilize equilibrium returns and the value of assets when they tend to retain their loans after they suffer a loss of capital (Table 6 and Figures 6a and 6b). Without deposit insurance and capital requirements (columns 1 and 5), yields rise little compared with the previous results in which banks did not sacrifice their rent by shrinking (Table 4). After the value of assets initially falls 5 percent, the value of loans falls another 0.8 percent, and banks lose about 30 percent of their capital. The resulting increase in leverage increases both banks' expected cash flow on capital (defined as their return plus their implicit steady-state risk premium on deposits, γ) and the volatility of their cash flow. Because the depositors' risk premium rises substantially compared to the equilibrium return on loans (see Table 5), the expected rate of cash flow on capital increases comparatively little compared to its volatility. Consequently, the banks' probability of surviving another five years falls considerably when the value of assets declines as much as 5 percent.[18]

[18] When losses are sufficiently great, the banks' shareholders would achieve a better risk-adjusted return on capital by reducing their leverage, even though they sacrifice their rent. The managers of banks, however, who gain less and possibly sacrifice more by shrinking, can be more inclined to maintain high leverage. In this case, capital requirements can reduce the agency problems that arise between a bank's managers and its claimholders by allowing claimholders to intervene in management when the bank's leverage becomes too high (Dewatripont and Tirole 1993, 1994).

Deposit insurance reduces both equilibrium returns and the increase in returns following a loss of wealth, but diminishes banks' odds of survival (columns 2 and 6). When the value of assets falls 5 percent, the value of loans falls only another 0.5 percent. Although depositors believe the return on loans is more volatile, the price of loans falls comparatively little because loans account for a smaller share of depositors' portfolios. Even though the value of loans is more stable with insurance, banks lose more of their capital because they assume more leverage. Without deposit insurance, the value of assets must fall as much as 18 percent before banks' losses are sufficiently great to entail a sharp increase in equilibrium returns as they sell their loans; with insurance, values need fall only 15 percent. Although insurance allows banks to earn a higher rate of cash flow by preventing their cost of deposits from rising very greatly, the volatility of banks' cash flow increases with their leverage. Because the expected rate of cash flow does not increase sufficiently to offset the additional volatility of this flow, insurance further reduces banks' odds of surviving another five years after the value of assets declines.

Capital requirements improve banks' odds of surviving when their losses are small; yet, they also entail higher equilibrium rates and increase the odds of returns' rising abruptly (columns 3 and 7). When the value of assets falls 5 percent, the value of loans falls another 0.9 percent. The price of loans falls more than in the previous cases because loans account for a larger share of depositors' portfolios. Even though the value of loans drops the most in this case, banks' capital declines the least because their leverage is relatively low. Because this lower leverage limits the volatility of banks' cash flow, capital requirements significantly increase banks' odds of surviving another five years after the value of assets declines in these cases.

This benefit of capital requirements diminishes, however, as the magnitude of the initial loss of wealth increases, because capital requirements force banks to sell their loans sooner. When the value of assets initially falls only 13 percent, banks must shrink, thereby causing the price of loans to fall further which in turn forces banks to shrink further. The resulting disintermediation entails a sharp increase in equilibrium returns, which depresses the value of loans sufficiently to cost banks their capital.

This risk of disintermediation increases with capital requirements. Like the case with a flexible scale of operations, as banks reduce their leverage their greater risk of losing their rent is offset by their profit from the increasing return on loans. Because banks' steady-state capital ratio rises less than their capital requirement – in the current example, when the capital requirement rises 10 percentage points, the capital-asset ratio rises only 3 percentage points – greater capital requirements tend to reduce banks' capacity for coping with losses. With a 5-percent capital requirement, an initial 10-percent loss of wealth raises the additional risk premium on loans less than 3.5 percentage points (Figure 7). With a 10-percent requirement, the same initial loss would raise this additional risk premium to over 7 percentage points as banks sell their loans. Whereas initial losses must exceed 11 percent of wealth in order to precipitate disintermediation when requirements are 5 percent, losses need only exceed 7 percent of wealth when requirements are 10 percent.

The combination of capital requirements and deposit insurance makes the banking system most vulnerable (Table 6, columns 4 and 8). With insurance alone, banks could cope with a 10 percent loss of wealth by allowing their leverage to double (column 6), but capital requirements do not allow banks so much leeway (column 8). A 10 percent loss of wealth forces banks to sell assets, which ultimately depresses the price of loans another 5.7 percent and extinguishes the market value of banks' capital.

Flexible Capital Requirements

Although capital requirements are intended to promote sound banks and capital markets, the previous analysis indicates that fixed capital requirements can hasten disintermediation when macroeconomic events diminish very greatly the returns on the capital investments that back financial assets. In practice, however, the design and enforcement of capital requirements are more flexible than those examined above. When this flexibility allows banks to delay their sales of loans during crises, capital requirements can promote financial stability when savers experience a loss of wealth.

The design of capital requirements can limit banks' leverage without increasing so greatly the risk of disintermediation. Progressive capital requirements, which have been common in banking and insurance, impose several levels of "requirements" (Benston and Kaufman 1988; 1993; Kane 1989b; Webb and Lilly 1994; Spong 1994; Cummins et al. 1994).[19] The first is set sufficiently high to entail banks' maintaining relatively high capital ratios. Banks that violate this requirement incur the costs of closer supervision, costs resulting from understandings imposed by regulators or losses of credit ratings. As a bank's capital falls below progressively lower requirements, its regulators take greater control over its activities – suspending the payment of

[19] Before recent laws and regulations formalized progressive capital requirements, supervisory and regulatory actions effectively applied progressive requirements. The new regulations, to a degree, recognized and codified prevailing practice (Peek and Rosengren 1997; Berger et al. 2000).

dividends and fees, reviewing salaries and interest rates on deposits, and approving new issues of liabilities, allocations of assets, and the use of cash flow. Before its capital is exhausted, the regulators take full control and either sell or liquidate the bank. In this way, progressive capital requirements can entail leverage that is nearly as conservative as that resulting from fixed capital requirements, without forcing banks to maintain that leverage during a crisis.[20]

Regulators also can enforce capital requirements in a more flexible manner. For example, they might not recognize banks' full losses on at least a portion of their assets. By measuring capital in this way, regulators essentially reduce banks' nominal capital requirements. If banks received this leeway only during sufficiently severe financial crises, then this enforcement would not diminish very greatly capital requirements' influence on banks' leverage at other times.[21] Although a bank must shrink when its particular fortunes diminish its capital too greatly, the adjustment of the banking system may be postponed when the economy's fortunes deteriorate too greatly.

Compared to having no capital requirements, flexible capital requirements raise average risk premiums without making returns very much more stable. While flexible capital requirements can raise average risk premiums on assets nearly as much as fixed requirements in the steady state, returns are nearly as stable with flexible requirements as they are without capital requirements

[20] This approach also raises agency problems. The incentives of regulators, especially in crises, can coincide more closely with those of banks' managers than those of depositors (Kane 1989a,b). It also increases the effective premium for deposit insurance (Allen and Saunders 1993).

[21] Forbearance during a crisis does not encourage a bank to assume very much more risk if aggregate crises occur much less frequently than the bank's own potential crises. If the bank cannot expect forbearance very often when it experiences difficulties, it will tend to respect the letter of stated capital requirements.

during crises. Suppose regulators relax the 10-percent requirement so banks need not shrink until their capital-asset ratio falls to 3 percent when wealth falls significantly (Figure 8). Without deposit insurance, this leeway postpones disintermediation: Wealth must fall 18 percent initially with flexible requirements, instead of 17 percent in the absence of requirements. With insurance, returns rise abruptly when initial losses exceed 12 percent of wealth whether banks are subject to flexible requirements or to no requirements. Flexible requirements would raise premiums less if banks possessed less proprietary information or were more averse to risk. In this case, capital requirements would not reduce banks' leverage so greatly in the steady state, and any reduction in their leverage would not raise equilibrium returns so greatly. On the other hand, the abrupt increase in returns would be delayed longer if the minimum effective capital requirement were smaller.

IV. Summary and Conclusion

When the public is especially wary of the potential returns on investments, intermediaries can profit by issuing their own liabilities to the public in order to convey funds to investors on better terms. The potential volume of this intermediation increases with the difference between intermediaries' perception of risk-adjusted returns on investments and that of the public. Yet, a substantial difference in perceptions also limits intermediaries' capacity to fulfill this potential. When the public is relatively wary of the returns on intermediaries' assets, it requires a risk premium for holding their liabilities, a premium that is excessive from the intermediaries' point of view and that rises with their leverage. Intermediaries also incur an implicit risk premium by issuing liabilities: Their odds of losing a share of their capital and a share of their economic rent rise with their leverage. Together, these premiums ultimately arrest intermediation by diminishing margins for profit.

Insurance can foster intermediation, thereby reducing the cost of funds for investors, by eliminating the excess risk premium that intermedaries pay to obtain funds from the public. Although the model in this paper assumes that insurers can verify intermediaries' assessments of the returns on their assets, it also suggests that the consequences can be small when insurers assess intermediaries a premium that is too low, particularly if the government backs the insurers. Even when intermediaries are not very averse to risk and their assets offer substantial excess returns, their fair insurance premiums remain relatively low in this model because their declining risk-adjusted return on capital and their increasing risk of losing a share of their rent constrain their leverage. Consequently, cheap insurance is not a sufficient subsidy to encourage intermediaries to assume substantially more leverage and risk.

Although insurance generally reduces the returns required of assets and diminishes the volatility of these returns, insurance also increases an economy's odds of experiencing a financial crisis. When the public's assessment of assets shifts, insurance tends to stabilize equilibrium returns by stabilizing intermediaries' cost of funds, provided that the aggregate value of wealth does not fall too greatly at these times. By reducing the volatility of equilibrium returns, insurance also reduces the volatility of the market value of intermediaries' capital, which reinforces their ability to stabilize capital markets. However, with insurance the values of assets in credit markets need not fall so greatly before they cost intermediaries a large share of their capital, thereby inducing them to shrink abruptly. The greater incidence of crises in this model arises not from intermediaries' taking excessive risk, but instead from their avoiding excessive risk – their attempt to maintain an optimal risk-adjusted return on capital and protect their rents by shrinking, which can threaten their solvency. Just as intermediation can reduce the cost of capital significantly, disintermediation can raise it substantially as the public's assessments displace those of intermediaries in pricing assets.

Capital requirements generally increase intermediaries' effective cost of funds, raise equilibrium returns, diminish intermediaries' capacity for stabilizing returns, and increase the odds of a financial crisis when intermediaries must maintain their scale of operations in order to earn their rent. As capital requirements induce intermediaries to reduce their leverage, they also induce intermediaries to accept more risk of failing to satisfy their requirement, thereby diminishing their leeway for managing their leverage, reducing their capacity to cope with losses, and exposing their capital to greater risk. Consequently, intermediaries shrink more readily and returns can rise more abruptly when the value of the investments backing their assets falls. This risk of disintermediation increases with the magnitude of capital requirements. It also increases when insurance is combined with capital requirements.

In at least two important respects the results in this paper understate the potential frequency and magnitude of financial crises. First, the model assumes that intermediaries are competitive institutions for which marginal net returns equal average net returns. When intermediaries are larger and more influential and they recognize that their cost of funds and their return on assets vary with the volume of their activity, then they will tend to assume less leverage on average, and smaller shifts in public assessments can precipitate larger changes in their marginal risk-adjusted return on capital. In this case, intermediaries might reduce their leverage more quickly when the public becomes more wary of the return on investments. Second, the results assume that neither the public's nor the intermediaries' assessments of the returns on assets deteriorate as their prices fall. Consequently, disintermediation entails no increase in the cost of capital beyond that which occurs as assets are priced to shift from the portfolios of intermediaries to the portfolios of the public.

Despite their risks, insurance and capital requirements have become common features of regulatory policy. When the public's knowledge of investments is sufficiently shallow or volatile, insurance promises a lower cost of funds for intermediaries and a lower cost of capital for investors when returns on investments generally fulfill expectations. Capital requirements also can protect intermediaries by limiting the types of investment that each might make. This limitation is especially important for regulators when at least some intermediaries' assessments of investments are themselves too shallow or volatile. These requirements also protect intermediaries when their competition might make investments that seem ill-advised or excessive according to their industry's norms. Moreover, capital requirements can benefit intermediaries' shareholders by limiting their agency risks: After experiencing substantial losses, shareholders eventually would prefer their intermediary to shrink rather than expose their remaining capital to excessive risk, while managers would be more inclined to maintain their operations as long as possible rather than lose their positions, reputation, and influence.

A flexible design or enforcement of capital requirements can help stabilize capital markets, but, compared to having no requirements, flexible requirements raise the average cost of capital without diminishing its volatility very greatly. When few intermediaries suffer substantial losses, regulators may enforce stringent standards. During severe recessions, however, when substantial losses are the norm, regulators may relax these standards. That forbearance might encourage intermediaries to assume more risk is not a very great concern when intermediaries are small competitors, but this concern grows as they become more influential and their economy's well-being depends too greatly on the health of each. In this last case, when intermediaries identify their economy's fortunes too closely with their own, the stability of their economy's financial markets depends more strongly on its ability and the ability of its trading partners to support the return on its investments.

When capital markets are not complete, the boundary between regulatory policy and macroeconomic policy is not very sharp. The level and cyclical behavior of the cost of capital depend on the regulations that govern intermediaries' capacity to manage their risks. Insurance and capital requirements ordinarily diminish the volatility of returns; yet, with broader effective insurance coverage and higher capital requirements for intermediaries, returns also are more likely to jump in response to smaller macroeconomic disturbances. Consequently, the stability of intermediaries and of returns on financial assets ultimately depends on the stability of returns on investments as achieved by monetary and fiscal policies. Macroeconomic policy essentially underwrites the lower cost of capital promised by insurance and the security promised by capital requirements. The dependence is mutual (Eccles 1951, pp. 266-67):

> . . . Clearly, if the [Federal Reserve] System is committed to a policy of monetary ease in times of depression, then bank-examination policies should follow a similar commitment. Or if the System is committed to a policy of credit stringency in order to curb an imminent inflation, then bank-examination policy should be brought in line with that same intention. Neither action was possible, however, so long as examinations were also devised by the FDIC and the Comptroller, whose personnel were disposed to follow the same policies regardless of prevailing economic conditions.

At times of incipient crises, even the distinction between macroeconomic policy and regulatory policy can become moot. When markets are not complete, the governments and central banks of large, diversified economies essentially become their ultimate intermediaries. Once the capacity of private intermediaries is strained, their attempts to manage their risks prudently can precipitate disintermediation and their insolvency. At these times, either by supporting the value of intermediaries' liabilities through contributions of equity or loans or by directly supporting the value of assets, these intermediaries of last resort can mitigate systemic threats and support the solvency of private intermediaries by preventing a substantial transfer of risky assets from their portfolios to the public (Thornton 1802, ch. 3, 4, 6, 7 and pp. 283-94, 303-10; Goodhart 1987, 1995; Humphrey 1986; Goodfriend and King 1988). These governments' considerable capital – their potential claim on their countries' current and future income – allows them to act as the ultimate lenders of last resort and insurers of assets' values. Governments and central banks in smaller, less diversified economies, especially those with relatively volatile returns on their capital assets, have less capacity to support the return on investment or their intermediaries. Consequently, the insurance and capital requirements that might normally allow their intermediaries to attract funds on favorable terms also can precipitate financial crises more readily when assessments of the returns on their investments deteriorate.

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Table 1a
Steady-State Portfolio Allocations and Returns
(percent of assets)

	$\lambda_b = 3$ $\lambda_d = 3$				$\lambda_b = 1.5$ $\lambda_d = 3$				$\lambda_b = .5$ $\lambda_d = 3$			
	$\sigma_{3,d}/\sigma_{3,b} = 1$		$\sigma_{3,d}/\sigma_{3,b} = 2$		$\sigma_{3,d}/\sigma_{3,b} = 1$		$\sigma_{3,d}/\sigma_{3,b} = 2$		$\sigma_{3,d}/\sigma_{3,b} = 1$		$\sigma_{3,d}/\sigma_{3,b} = 2$	
	μ=0%	μ=1%	μ=0%	μ=1%	μ=0%	μ=1%	μ=0%	μ=1%	μ=0%	μ=1%	μ=0%	μ=1%
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	------------------------------ in percentage points ------------------------------											
<u>Depositors</u>:												
Portfolio Shares												
Risk-free Asset & Deposits	5.0	6.0	11.2	12.6	9.5	11.5	18.1	20.2	24.0	27.9	29.1	31.9
Nonproprietary Risky Asset	47.5	49.1	50.0	50.0	45.2	48.2	50.0	50.0	38.0	46.1	50.0	50.0
Proprietary Risky Asset	47.5	44.9	38.8	37.4	45.2	40.3	31.9	29.9	38.0	26.0	20.9	18.1
Expected Return on Assets	3.2	3.1	4.9	4.8	3.0	2.9	4.1	3.9	2.4	2.3	3.0	2.8
Volatility of Ret. on Assets	8.5	8.4	11.5	11.2	8.1	7.9	10.2	9.8	6.8	6.5	8.2	7.7
<u>Banks</u>:												
Portfolio Shares:												
Risk-free Asset & Deposits	5.0	-12.9	-53.2	-58.3	-44.7	-54.2	-71.0	-73.9	-78.1	-81.2	-81.9	-83.5
Nonproprietary Risky Asset	47.5	15.5	0	0	50.0	15.5	0	0	50.0	14.3	0	0
Proprietary Risky Asset	47.5	84.5	100	100	50.0	84.5	100	100	50.0	85.7	100	100
Capital/Assets	100	87.1	46.8	41.7	55.3	45.8	29.0	26.1	21.9	18.8	18.1	16.5
Expected Return on Capital	3.2	4.5	14.7	18.4	4.9	7.4	19.3	23.6	9.3	13.8	17.9	21.3
Volatility of Ret. on Capital	8.5	10.9	21.4	24.0	16.2	20.7	34.4	38.2	40.8	50.4	55.4	60.6

Table 1b
Steady-State Yields

	$\lambda_b = 3$ $\lambda_d = 3$				$\lambda_b = 1.5$ $\lambda_d = 3$				$\lambda_b = .5$ $\lambda_d = 3$			
	$\sigma_{3,d}/\sigma_{3,b} = 1$		$\sigma_{3,d}/\sigma_{3,b} = 2$		$\sigma_{3,d}/\sigma_{3,b} = 1$		$\sigma_{3,d}/\sigma_{3,b} = 2$		$\sigma_{3,d}/\sigma_{3,b} = 1$		$\sigma_{3,d}/\sigma_{3,b} = 2$	
	μ=0%	μ=1%	μ=0%	μ=1%	μ=0%	μ=1%	μ=0%	μ=1%	μ=0%	μ=1%	μ=0%	μ=1%
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	---------- in percentage points ----------											
Risk-free Asset	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Nonproprietary Asset	3.28	3.28	3.90	3.84	3.17	3.17	3.65	3.57	2.82	2.85	3.25	3.15
Proprietary Asset	3.28	3.23	7.45	7.28	3.17	3.08	6.62	6.38	2.82	2.61	5.30	4.97
Effective Cost of Deposits ($r_1+\delta+\gamma$)	na	1.00	1.04	1.09	1.00	1.00	1.46	1.64	1.01	1.10	2.54	2.94
Hypothetical Deposit Insurance Prem. (p^b)	0	0	0	0	0	0	0	0	0.01	0.05	0.05	0.07
Excess Deposit Premium	0	0	0.04	0.09	0	0	0.46	0.64	0	0.10	1.54	1.94
Depositors' Risk (δ)	0	0	0.04	0.09	0	0	0.46	0.64	0	0.01	1.54	1.81
Banks' Risk (γ)	0	0	0	0	0	0	0	0	0	0.09	0	0.13

Table 2

Effects of Deposit Insurance and Capital Requirements

	$\lambda_b = 1.5,\ \lambda_d = 3\quad \sigma_{3,d}/\sigma_{3,b} = 2$								$\lambda_b = .5,\ \lambda_d = 3\quad \sigma_{3,d}/\sigma_{3,b} = 2$							
	μ = 0.5%				μ= 1%				μ= 0.5%				μ= 1%			
	no cap req		cap req		no cap req		cap req		no cap req		cap req		no cap req		cap req	
	no DI	DI	no DI	DI	no DI	DI	no DI	DI	no DI	DI	no DI	DI	no DI	DI	no DI	DI
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
	------ in percentage points ------															
r_2	3.61	3.56	3.61	3.56	3.58	3.52	3.58	3.52	3.20	2.92	3.22	2.95	3.15	2.85	3.18	2.90
r_3	6.50	6.34	6.51	6.35	6.38	6.19	6.39	6.20	5.14	4.21	5.19	4.30	4.97	3.98	5.07	4.14
Effective Cost of Deposits ($r_1+\gamma+\delta$)	1.55	1.00	1.56	1.01	1.64	1.01	1.66	1.03	2.74	1.09	2.83	1.24	2.94	1.17	3.12	1.45
Deposit Ins. Prem. (p^b)	(0)	0	(0)	0	(0)	0	(0)	0	(0.06)	0.18	(0.05)	0.17	(0.07)	0.20	(0.06)	0.17
Excess Deposit Premium	0.55	0	0.56	0.01	0.64	0.01	0.66	0.03	1.74	0.09	1.83	0.24	1.94	0.17	2.12	0.45
Depositors' Risk (δ)	0.55	0	0.55	0	0.64	0	0.64	0	1.68	0	1.63	0	1.81	0	1.73	0
Banks' Risk (γ)	0	0	0.01	0.01	0	0.01	0.02	0.03	0.06	0.09	0.20	0.24	0.13	0.17	0.39	0.45
Return on Capital	21	24	21	24	24	27	24	26	20	27	19	27	21	30	20	29
Volatility of RoC	36	39	36	39	38	41	38	41	58	73	57	71	61	76	59	74
Capital/Assets	28	26	28	26	26	24	26	24	17	14	17	14	16	13	17	14

Table 3
Consequences of Changes in Depositors' Assessments of the Return on Loans
When Banks' Aversion to Risk Is Low

	No Deposit Insurance No Capital Requirements			Deposit Insurance Variable Premium			Deposit Insurance Zero Premium			Capital Requirements			Capital Requirements & Deposit Insurance		
	Steady State	Optim	Pessim	Steady State	Optim	Pessim	Steady State	Optim	Pessim	Steady State	Optim	Pessim	Steady State	Optim	Pessim
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
	---------------------------- --- in percentage points ---														
r_2	3.15	-0.08	+0.08	2.86	+0.10	-0.09	2.86	+0.10	-0.09	3.18	-0.08	+0.08	2.90	+0.10	-0.10
r_3	4.97	-1.00	+1.00	3.98	-0.32	+0.14	3.89	-0.29	+0.12	5.07	-1.02	+1.01	4.14	-0.36	+0.16
Deposit Ins. Prem.(p^b)	(0.07)	(-0.01)	(0)	0.20	-0.08	+0.05	(0.22)	(-0.09)	(+0.05)	(0.06)	(-0.01)	(0)	0.17	-0.08	+0.05
Excess Deposit Premium	1.94	-1.08	+1.09	0.17	-0.03	+0.01	-0.05	+0.06	-0.04	2.12	-1.09	+1.10	0.45	-0.05	0
Depositors' Risk (δ)	1.81	-1.06	+1.08	0	0	0	-0.22	+0.09	-0.05	1.73	-1.04	+1.07	0	0	0
Banks' Risk (γ)	0.13	-0.02	+0.01	0.17	-0.03	+0.01	0.17	-0.03	+0.01	0.39	-0.05	+0.03	0.45	-0.05	0
Capital/Assets	16.5	+2.0	-1.3	13.1	+2.9	-1.5	12.9	+2.8	-1.4	16.9	+2.1	-1.4	13.6	+3.2	-1.6
Change in Capital		+8	-8		+5	-4		+5	-4		+8	-8		+5	-4

Table 4
Variable Scale of Intermediation -- Consequences of a Loss of Wealth

	The Value of Wealth Initially Falls by:							
	5 percent				7 percent			
	No Capital Requirements		Capital Requirements		No Capital Requirements		Capital Requirements	
	No Deposit Insurance	Deposit Insurance	No Deposit Insurance	Deposit Insurance	No Deposit Insurance	Deposit Insurance	No Deposit Insurance	Deposit Insurance
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	---------- in percentage points ----------							
Before the Loss of Wealth:								
r_2	3.15	2.85	3.18	2.90	3.15	2.85	3.18	2.90
r_3	4.97	3.98	5.07	4.14	4.97	3.98	5.07	4.14
Capital/Assets	16	13	17	14	16	13	17	14
Immediately After the Loss of Wealth:								
Additional Change in Value of Proprietary Asset	-1.5	-1.6	-1.5	-2.0	-2.4	-3.6	-2.3	-4.8
Loss of Capital	-39	-50	-38	-51	-56	-78	-54	-84
r_2	3.44	3.19	3.45	3.33	3.61	3.67	3.61	4.07
r_3	6.61	5.70	6.66	6.22	7.56	7.82	7.55	9.37
Deposit Insurance Premium (p^b)	(0.09)	0.34	(0.08)	0.24	(0.11)	0.36	(0.10)	0.11
Depositors' Risk Premium (p^d)	2.85	0.34	2.75	0.24	3.30	0.36	3.20	0.11
Banks' Risk Premium (γ)	0.14	0.13	0.39	0.26	0.14	0.07	0.37	0.10
Capital/Assets	13	9	14	10	12	6	12	10
Expected Return on Capital	32	63	30	61	41	122	38	94
Volatility of Return on Capital	75	112	72	100	85	156	82	100

Table 5

Fixed Scale of Operation -- Effects of Deposit Insurance and Capital Requirements

	$\lambda_b = 1.5,\ \lambda_d = 3 \quad \sigma_{3,d}/\sigma_{3,b} = 2$				$\lambda_b = 0.5,\ \lambda_d = 3 \quad \sigma_{3,d}/\sigma_{3,b} = 2$			
	no cap req		cap req		no cap req		cap req	
	No Insurance	Deposit Insurance	No Insurance	Deposit Insurance	No Insurance	Deposit Insurance	No Insurance	Deposit Insurance
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	---------- in percentage points ----------							
r_2	3.59	3.54	3.61	3.56	3.31	3.00	3.45	3.26
r_3	6.43	6.24	6.50	6.33	5.48	4.46	5.94	5.33
Effective Cost of Deposits $(r_1+\gamma+\delta)$	1.81	1.13	2.07	1.49	3.85	2.01	4.68	3.61
Deposit Insurance Premium (p^b)	(0)	0	(0)	0	(0.03)	0.13	(0.01)	0.03
Excess Deposit Premium	0.81	0.13	1.07	0.49	2.85	2.01	3.68	2.61
Depositors' Risk (δ)	0.61	0	0.54	0	1.39	0	1.01	0
Banks' Risk (γ)	0.20	0.13	0.53	0.49	1.46	2.01	2.67	2.61
Return on Capital	23	26	22	24	18	26	15	18
Volatility of RoC	38	41	36	38	53	69	45	54
Capital/Assets	27	25	28	26	19	15	22	18

Table 6
Fixed Scale of Intermediation -- Consequences of a Loss of Wealth

	The Value of Wealth Initially Falls by:							
	5 percent				10 percent			
	No Capital Requirements		Capital Requirements		No Capital Requirements		Capital Requirements	
	No Deposit Insurance	Deposit Insurance	No Deposit Insurance	Deposit Insurance	No Deposit Insurance	Deposit Insurance	No Deposit Insurance	Deposit Insurance
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	---------- in percentage points ----------							
Before the Loss of Wealth:								
r_2	3.31	3.00	3.45	3.26	3.31	3.00	3.45	3.26
r_3	5.48	4.46	5.94	5.33	5.48	4.46	5.94	5.33
Capital/Assets	19	15	22	18	19	15	22	18
Immediately After the Loss of Wealth:								
Additional Change in Value of Proprietary Asset	-0.8	-0.5	-0.9	-0.8	-1.1	-0.8	-1.8	-5.7
Loss of Capital	-30	-38	-26	-31	-42	-53	-53	-100
r_2	3.36	3.01	3.54	3.31	3.40	3.03	3.61	4.51
r_3	6.32	5.04	6.91	6.13	6.67	5.28	7.92	11.75
Deposit Insurance Premium (p^b)	(0.09)	0.35	(0.02)	0.11	(0.13)	0.52	(0.10)	na
Depositors' Risk Premium (p^d)	2.70	0.35	2.08	0.11	3.34	0.52	3.59	na
Capital/Assets	14	9	17	13	12	7	11	na
Expected Cash Flow on Capital	29	54	31	47	32	73	41	na
Volatility of Cash Flow on Capital	71	105	58	74	84	136	84	na
Probability of Insolvency in:								
One year	4	8	1	3	6	12	5	na
Five years	32	42	17	20	41	51	34	na

Figure 1:
Additional Risk Premium for Loans ($r_3 - r_2$)
(contour map)

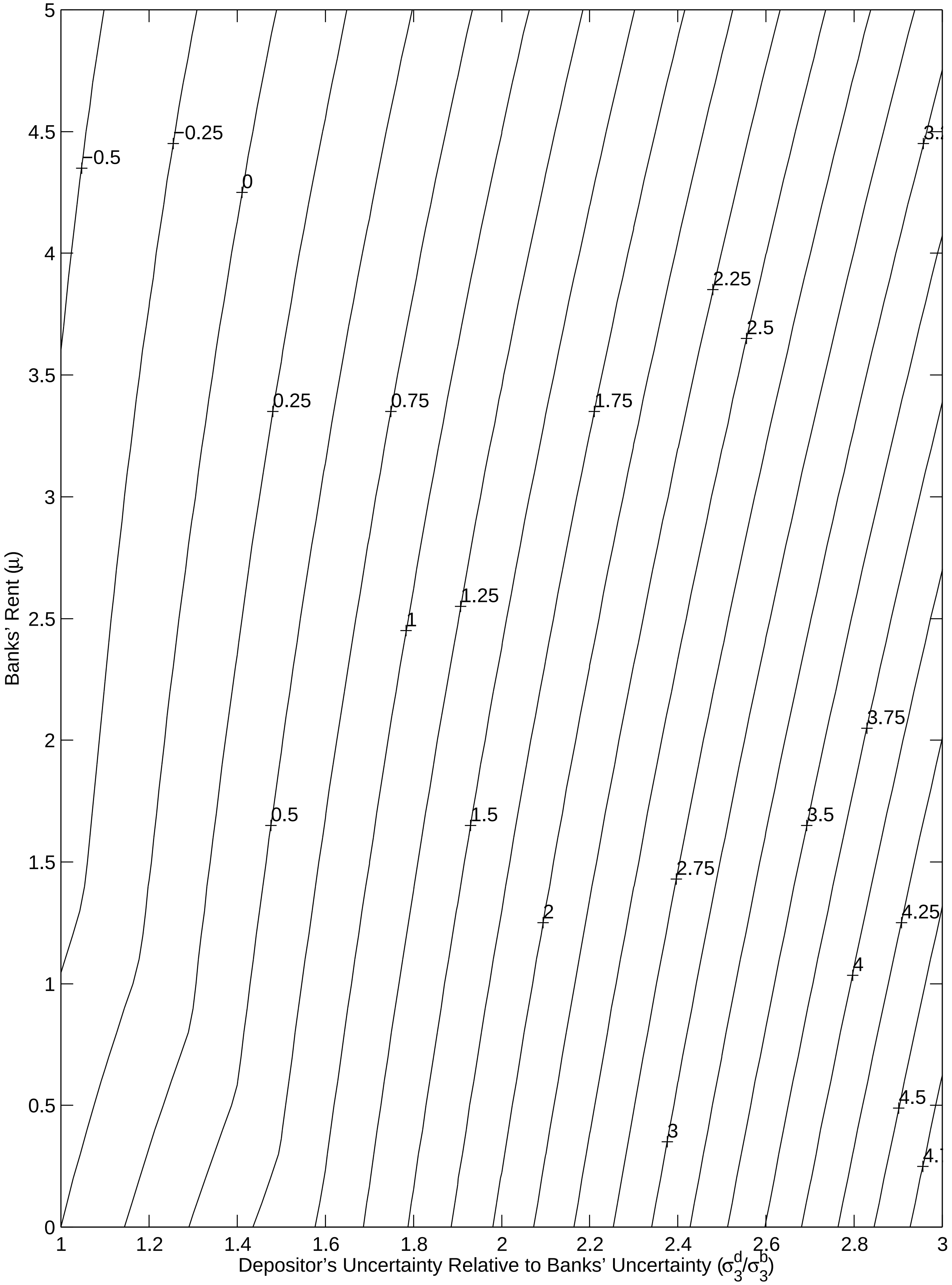

Figure 2:
Additional Risk Premium for Loans with Deposit Insurance ($r_3 - r_2$)
(contour map)

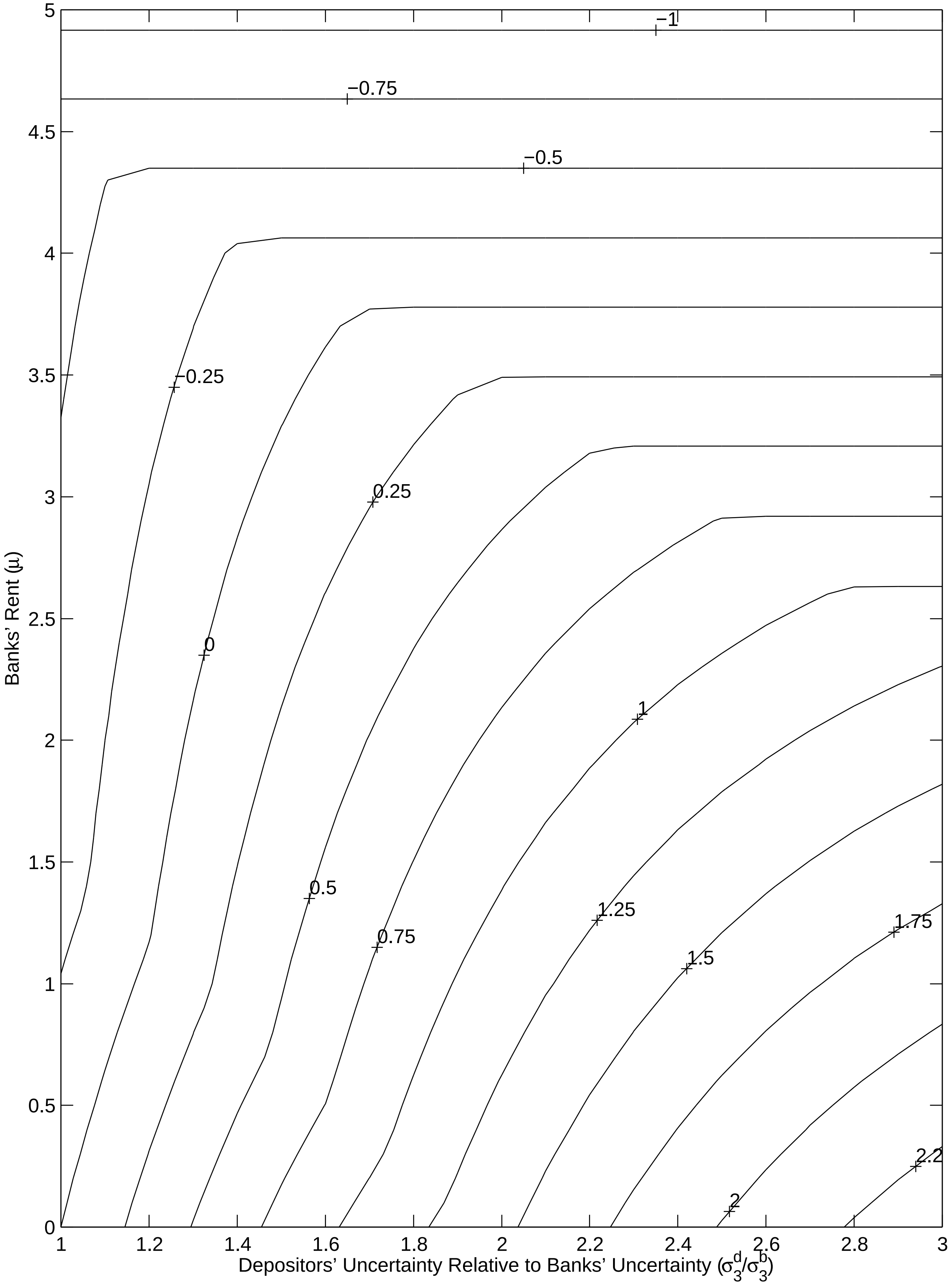

Figure 3:
Additional Risk Premium for Loans with Capital Requirements ($r_3 - r_2$)
(contour map)

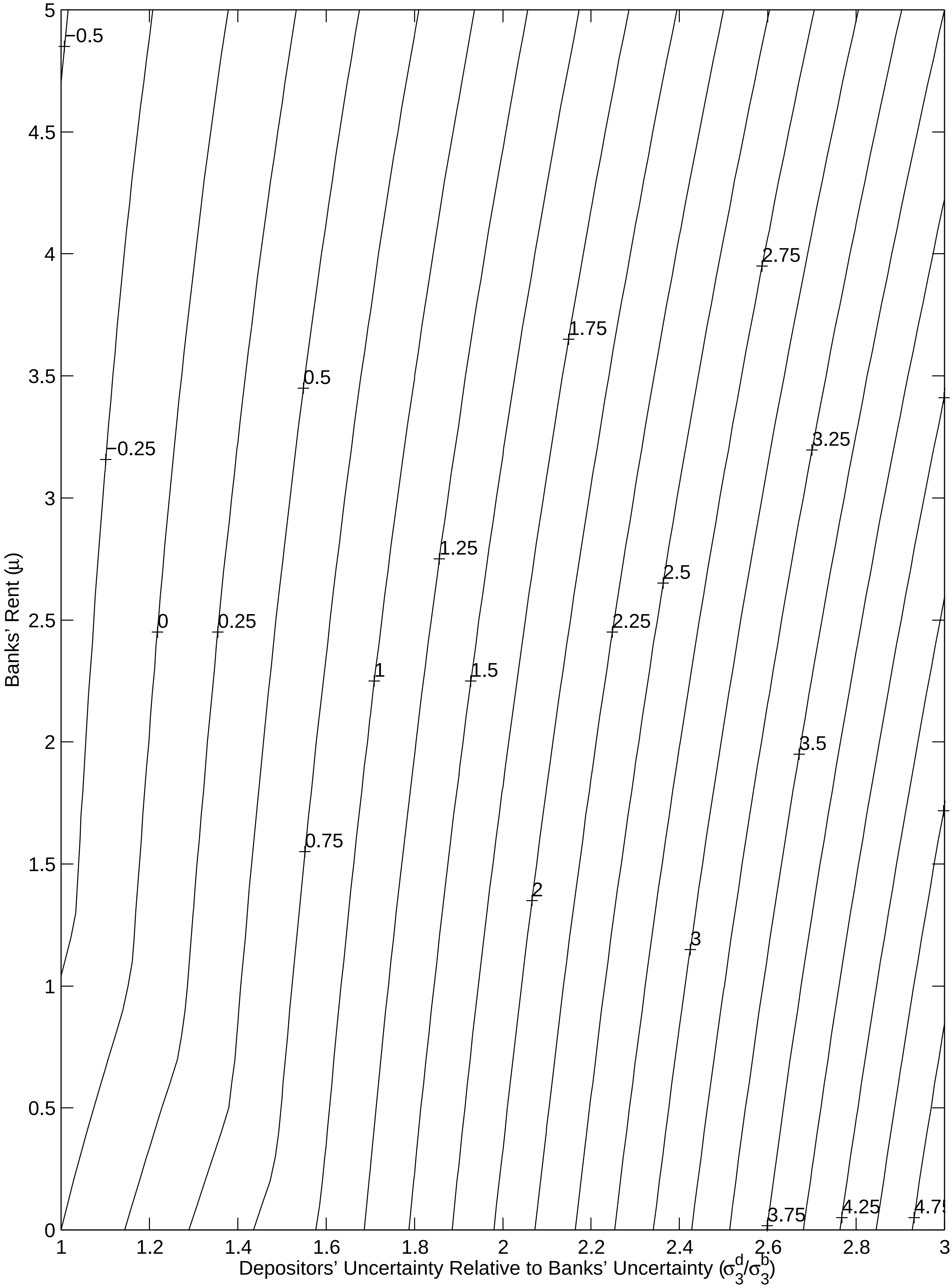

Figure 4:
Additional Risk Premium for Loans with Deposit Insurance and Capital Requirements (r_3−r_2)
(contour map)

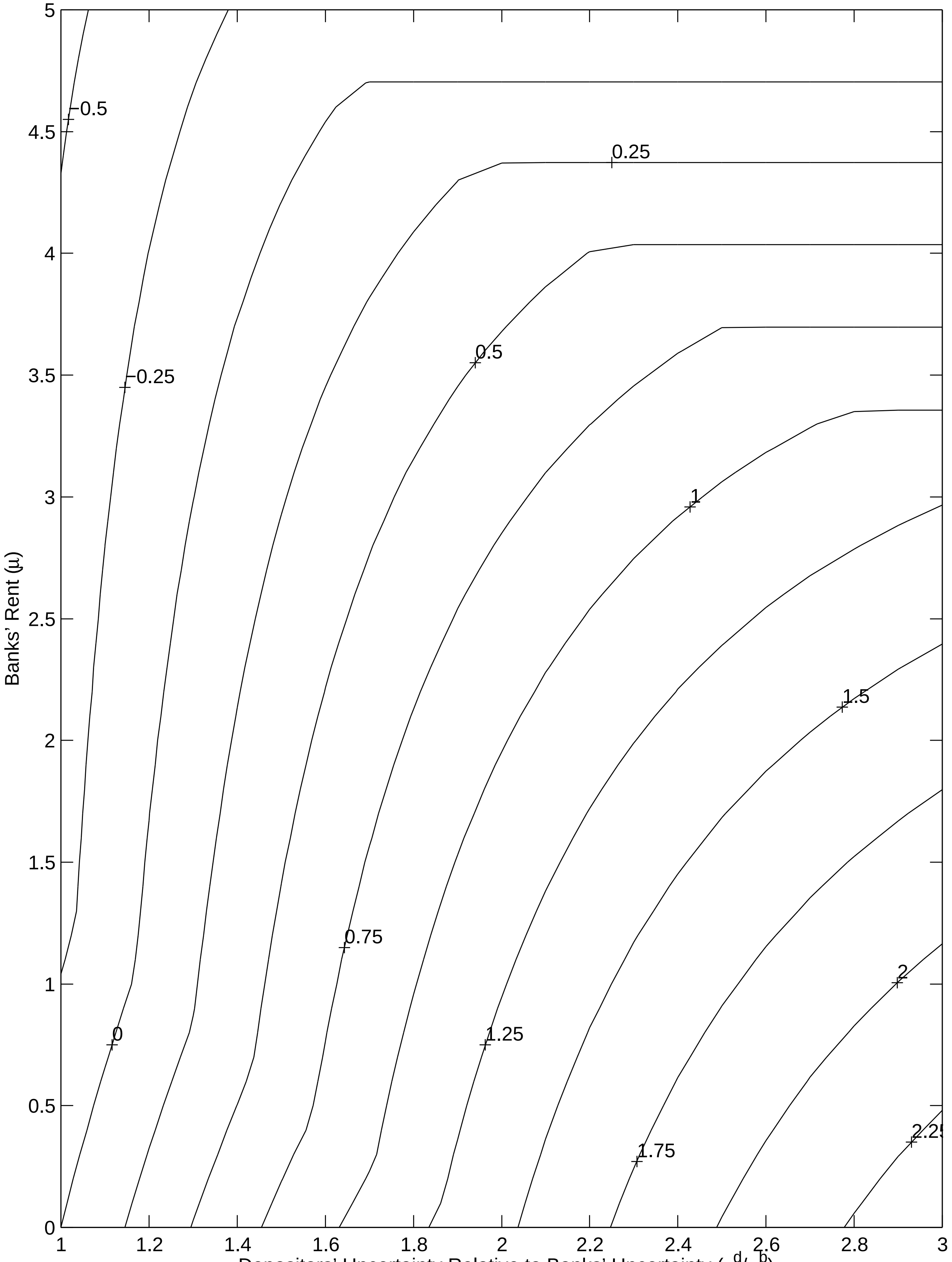

Figure 5a:
Flexible Scale: Risk Premium on Nonproprietary Assets ($r_2 - r_1$)
(λ_b=0.5 and λ_d=3)

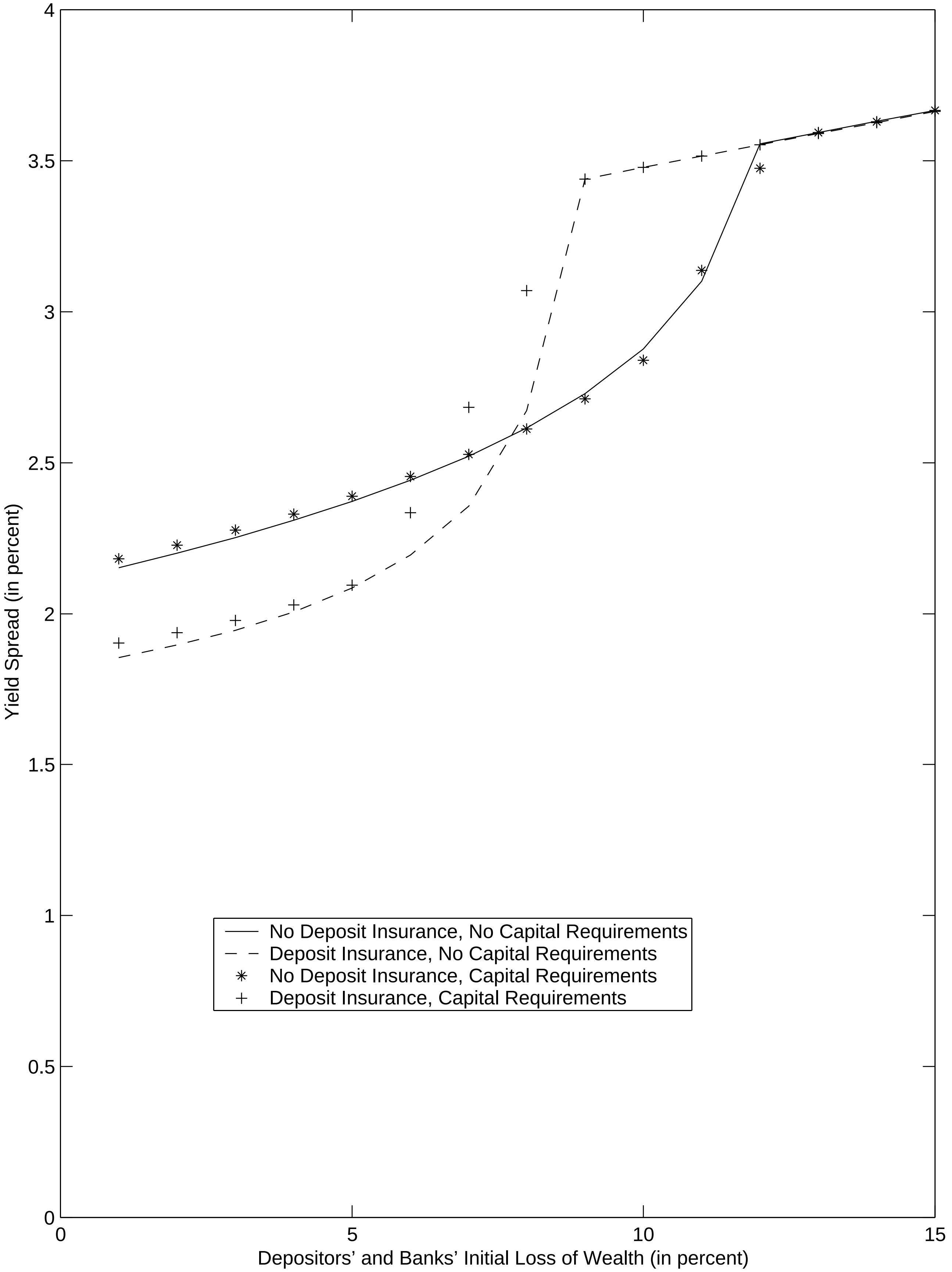

Figure 5b:
Flexible Scale: Risk Premium on Proprietary Assets (r_3-r_2)
(λ_b=0.5 and λ_d=3)

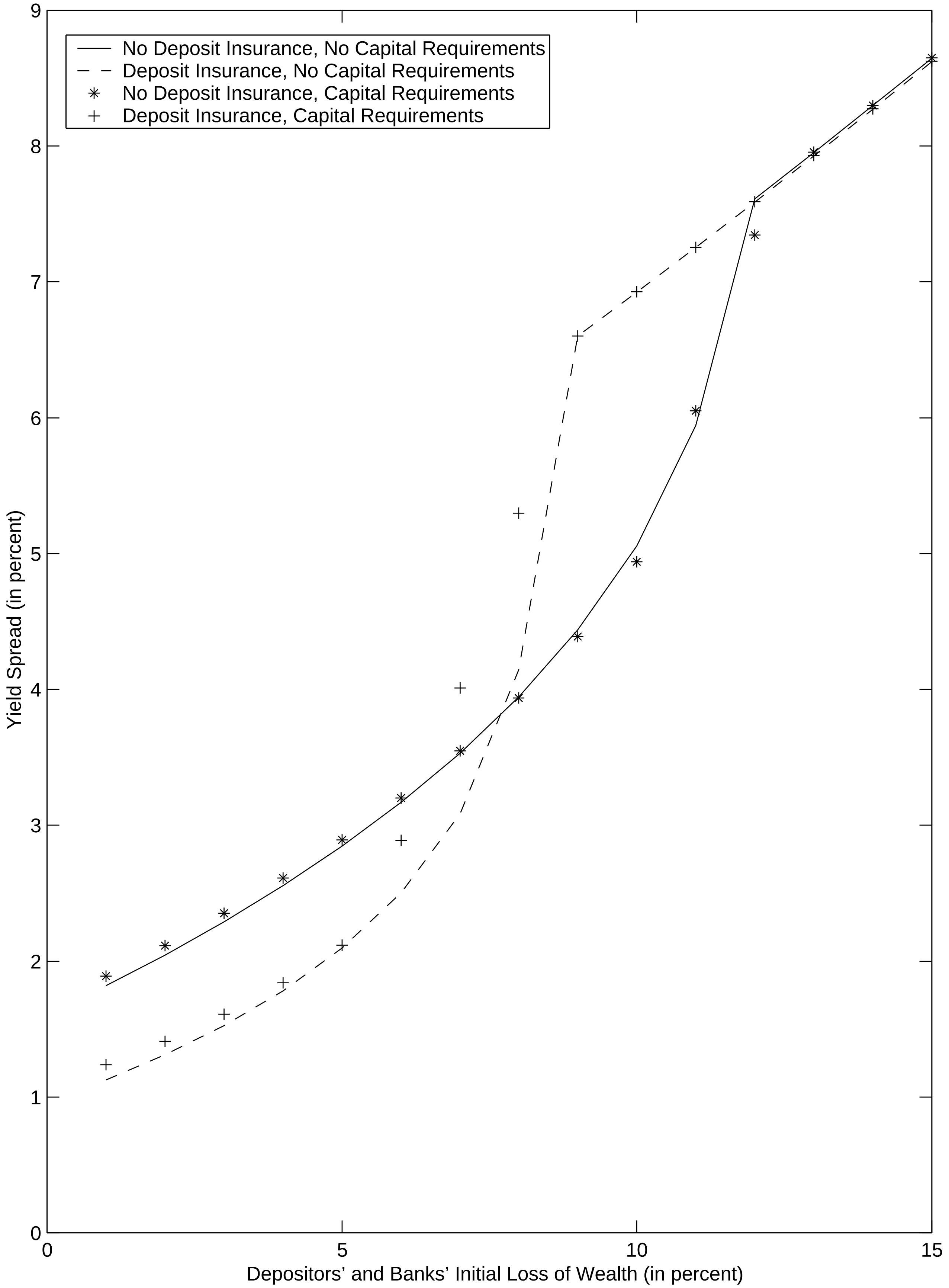

Figure 6a:
Fixed Scale: Risk Premium on Nonproprietary Assets ($r_2 - r_1$)

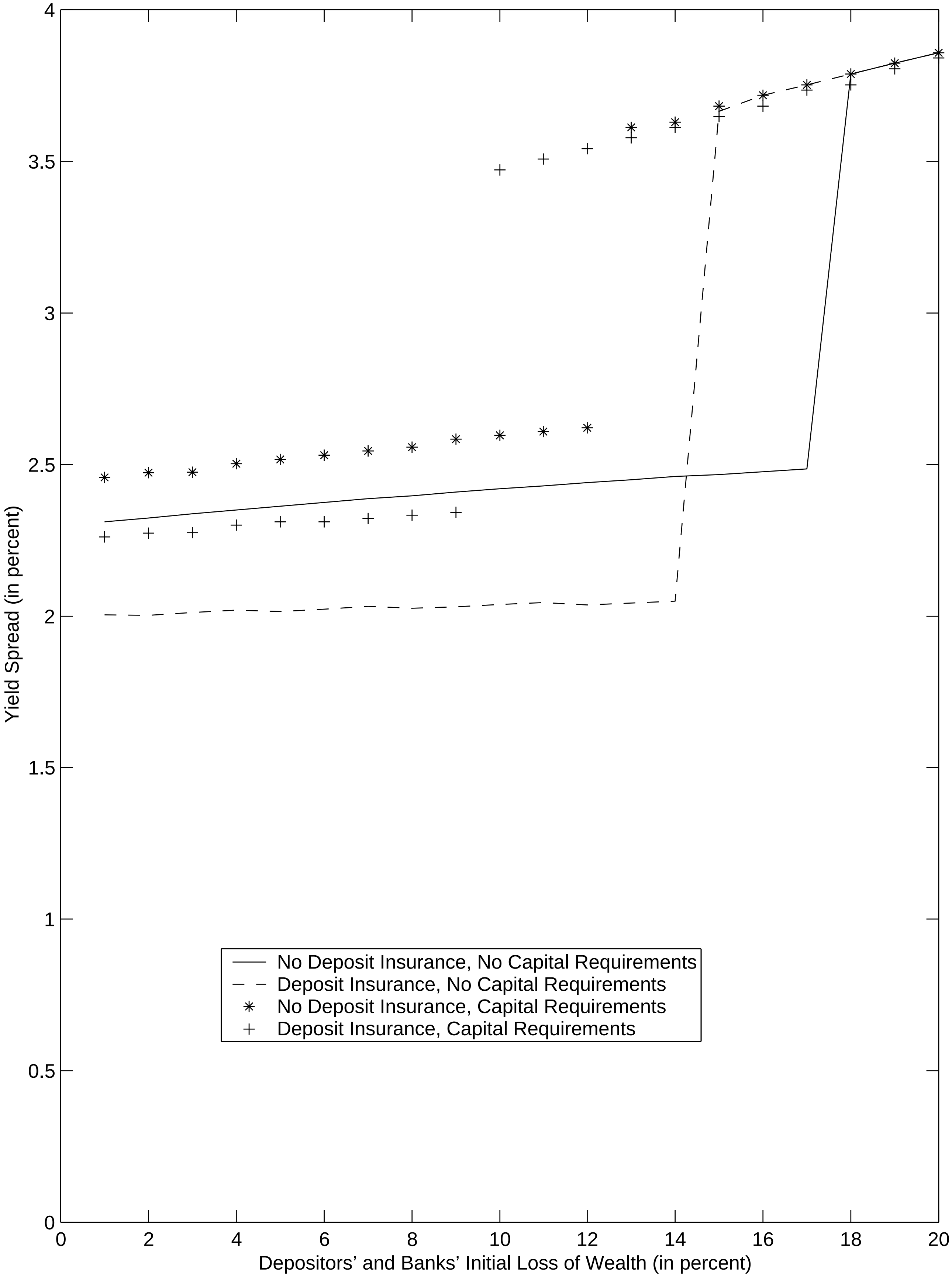

Figure 6b:
Fixed Scale: Additional Risk Premium on Proprietary Assets ($r_3 - r_2$)

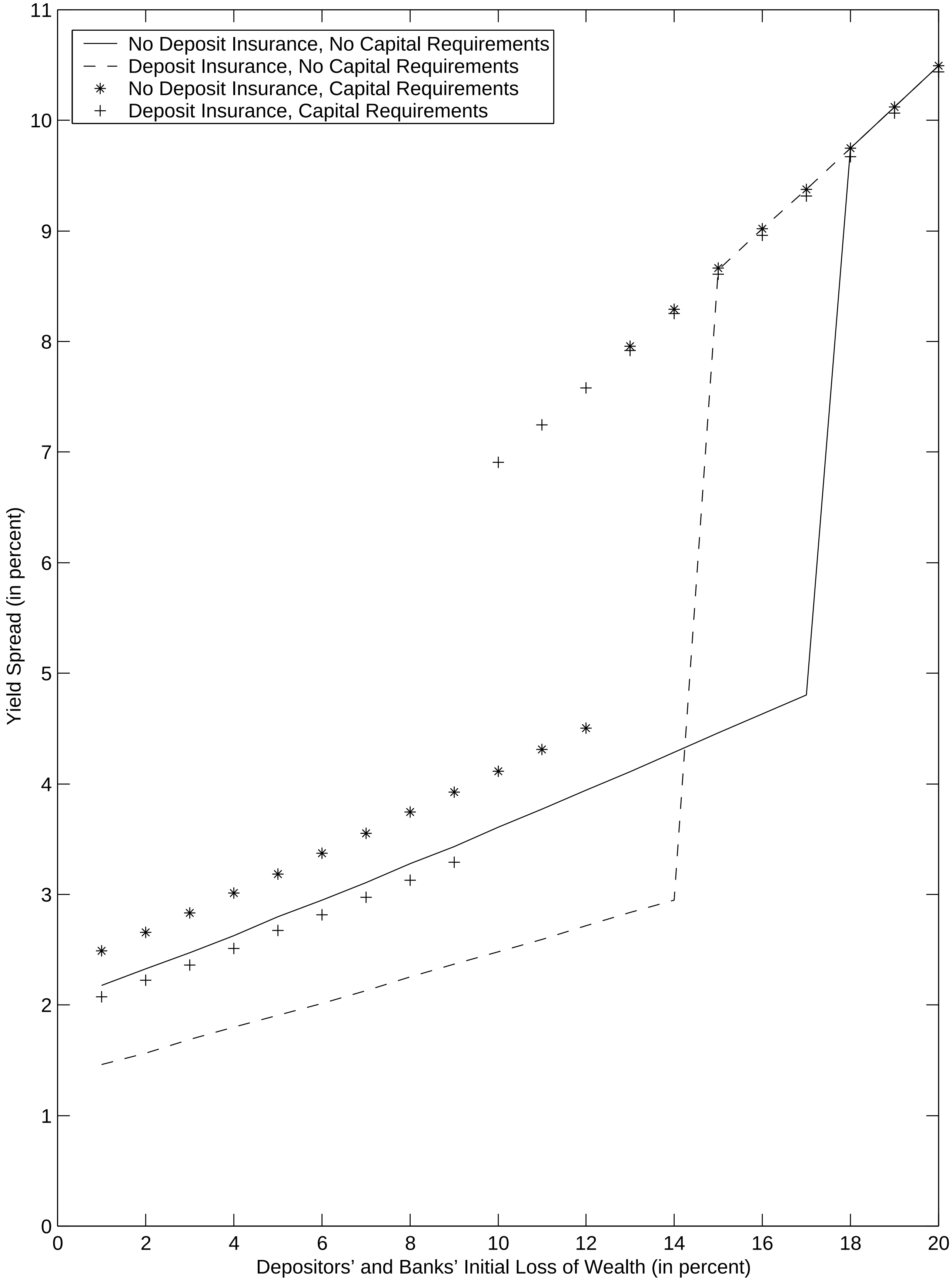

Figure 7
Fixed Scale − Additional Risk Premium on Proprietary Assets ($r_3 - r_2$)
(contour map)

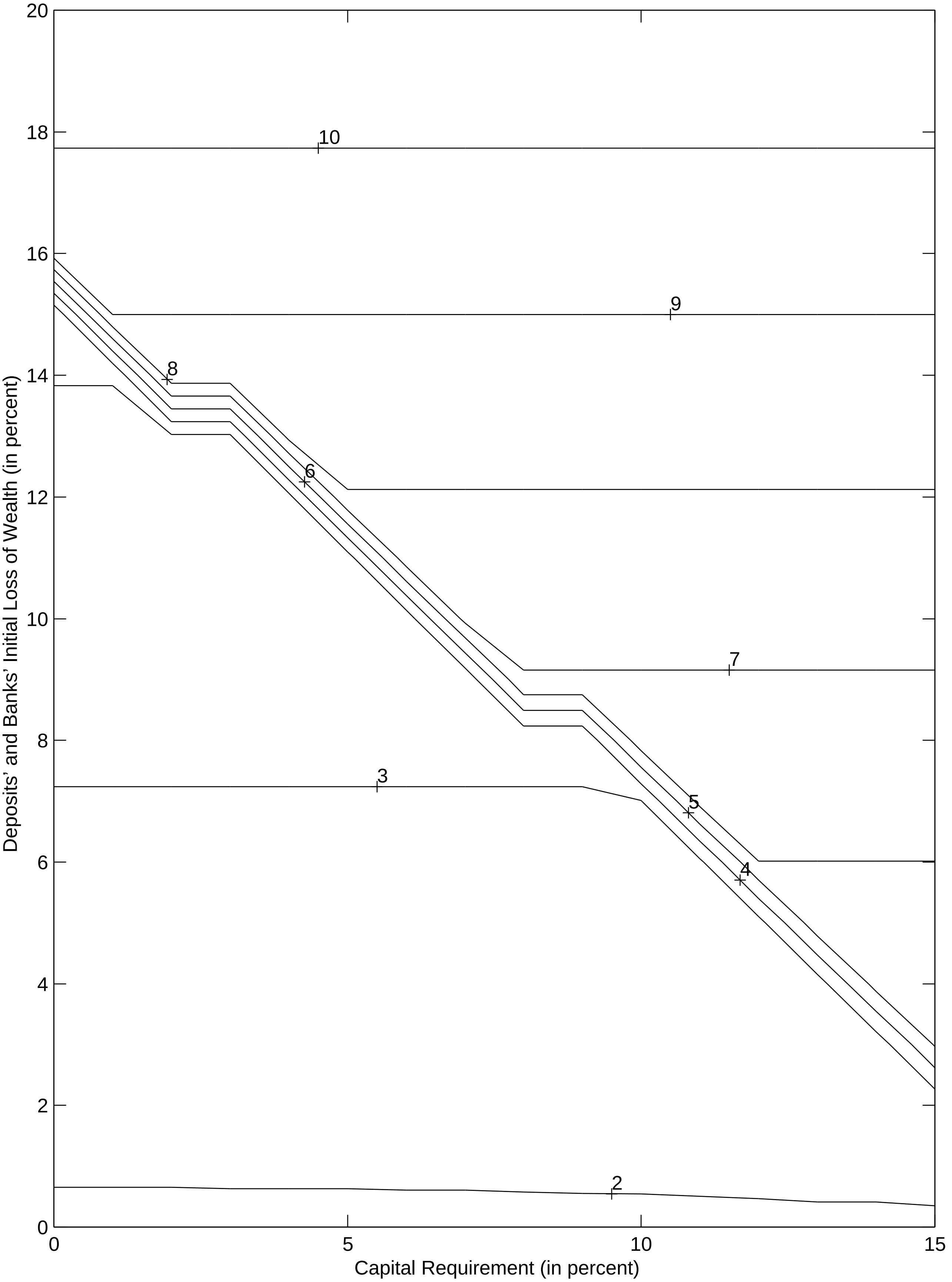

Figure 8:
Fixed Scale & Forbearance − Additonal Risk Premium on Proprietary Assets ($r_3 - r_2$)