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Deposit insurance and the risk premium in bank deposit rates

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Abstract

By placing a ceiling on the amount of possible depositor loss, deposit insurance should result in a lower deposit risk premium. However, this effect may be modified if either the insurance promise has low credibility or the moral hazard incentives generated by deposit insurance result in a greater probability of bank default. Using financial and institutional panel data from thirteen countries, we find that the risk premium is over 40 basis points higher on average in uninsured countries than in countries that offer insurance up to some pre-specified maximum. However, the risk premium has a non-linear relationship with the level of maximum insurance coverage, suggesting that the market recognizes the moral hazard potential. Moreover, the effect of deposit insurance on the risk premium is weaker in countries with strong creditor rights, consistent with the view that investors view the latter as a substitute for explicit deposit insurance.

JEL classification: G12; G21; G28; E43; E58
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1. Introduction

What effect does the provision of deposit insurance have on the risk premium required by holders of bank deposits? At first glance, the answer seems obvious: by

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eliminating the possibility of loss, deposit insurance provides protection to depositors and thereby induces a lower risk premium. However, there are at least two modifying influences on this relationship. First, the promise to insure depositors may have imperfect credibility, thereby negating the offered protection and curbing the fall in the risk premium. Second, even if the promise to pay is fully credible, the moral hazard incentives created by fixed rate deposit insurance may increase the probability of bank default. For deposits which are only partially insured (e.g., because of an upper limit on the size of insured deposits), this increases the probability of receiving a lower-than-expected payout and therefore raises the risk premium on these deposits.

A number of other authors have examined one or other of these issues in isolation. Consistent with the notion that the deposit risk premium reflects insurer credibility, Cook and Spellman (1996) analyze 233 US thrifts during 1987 and 1988 and conclude that most of the elevation in risk premia during that period was due to increases in guarantor risk. Similarly, Flannery and Sorescu (1996) examine 422 issues of subordinated notes and debentures by US institutions between 1983 and 1991 and find that yields on these securities changed in line with variations in the perceived strength of the insurance guarantee. With regard to the moral hazard effect, Grossman (1992), Kane (1989), Keeley (1990) and White (1991), among others, attribute periods of high bank failure rates to this problem. Moreover, Brewer and Mondschean (1994) conclude that depositors in US savings and loan associations during the 1980s required higher deposit rates from institutions with strong moral hazard characteristics, while Shoven et al. (1992) argue that high treasury bill yields during the same period reflected the need for these securities to remain competitive with the CD rates offered by high-risk, but insured, institutions. Thus, these groups of authors emphasize the importance of both insurer credibility and moral hazard incentives for the setting of risk premia on deposits. However, their data come from a single insurance system with a single insurer, so they are unable to address the extent to which these effects are reflected in risk premia on deposits with different levels of insurance coverage and different insurers. Moreover, they typically focus on the implications of either imperfect credibility or moral hazard incentives; they do not explicitly examine the extent to which both of these factors affect deposit risk premia.

In this paper, we examine the extent to which insurer credibility and moral hazard effects are simultaneously present in interest rate data from thirteen countries that differ in the amount of formal depositor protection that they offer. We find that the risk premium is, on average, significantly higher on deposits in countries that do not offer explicit insurance than it is on deposits in countries that provide insurance up to some maximum level, consistent with deposit insurance schemes having high credibility. However, we also find some weak evidence that the marginal impact of insurance on the risk premium becomes smaller as the maximum insurance coverage increases, consistent with the view that generous insurance schemes encourage morally hazardous behavior.

We also consider other determinants of the deposit risk premium. Most of the single-country studies cited above recognize that the risk premium depends not only on the level of insurance coverage, but also on the risk characteristics of the offering bank. Thus, the standard approach (see, for example, Flannery and Sorescu, 1996; Park and Peristiani, 1998) in these studies relates bank deposit premia to a vector of financial variables that proxy for bank financial health. In a parallel manner, we examine the relationship between a country's deposit premium and a set of variables that potentially affect the soundness of its banking system and the protection afforded to depositors. We focus in particular on regulations that restrict the abilities of banks to engage in non-bank activities and on depositor rights in the event of bank default. We find that the risk premium is, on average, lower in countries that (i) place restrictions on bank participation in non-bank activities and (ii) provide greater creditor rights. Moreover, the provision of deposit insurance has a weaker impact on the risk premium when creditor rights are strong.

In the next section, we develop a simple model that illustrates the complex relationship between, on the one hand, the deposit risk premium and, on the other hand, deposit insurance policies, insurer credibility, and moral hazard incentives. Section 3 provides a discussion of the regulatory and legal determinants of the risk premium. In Section 4, we describe our data and present some preliminary statistics. Section 5 contains the core of our empirical analysis. Section 6 summarizes our findings and provides some concluding remarks.

2. The relationship between deposit insurance and the risk premium: A motivation

By promising to protect depositors from loss in the event of bank default, deposit insurance should have a moderating effect on the deposit risk premium. However, deposit insurance may also create moral hazard incentives that increase the likelihood of bank default, thereby increasing the expected losses to holders of deposits that are larger than the maximum insurance coverage. These deposits would therefore require a higher premium as compensation for the greater risk.

To demonstrate in a more formal manner our conjectures about the ambiguous effect of deposit insurance on deposit risk premia, we present in this section a simple arbitrage model of deposit rate setting, similar to that used by Cook and Spellman (1996). We assume that markets are sufficiently complete so that pricing follows a unique risk-neutral probability measure. [1] That is, the one-period random rate of return k on any asset satisfies

$$E^*[1+k] = 1+r \tag{1}$$

where $E^*[\cdot]$ denotes expectations with respect to the risk-neutral distribution and r is the one-period riskless return. All probability values used in our subsequent analysis come from this risk-neutral distribution.

The generic structure of our model is as follows. There are two dates. At date 0, the bank accepts deposits on which it offers a rate of return i to be paid at date 1.

[1] Alternatively, we could assume, as do Cook and Spellman (1996), that investors are risk neutral, or that uninsured deposits have the same systematic risk as otherwise-equivalent insured deposits. For details on pricing by the risk neutral probability measure, see Pliska (1997).

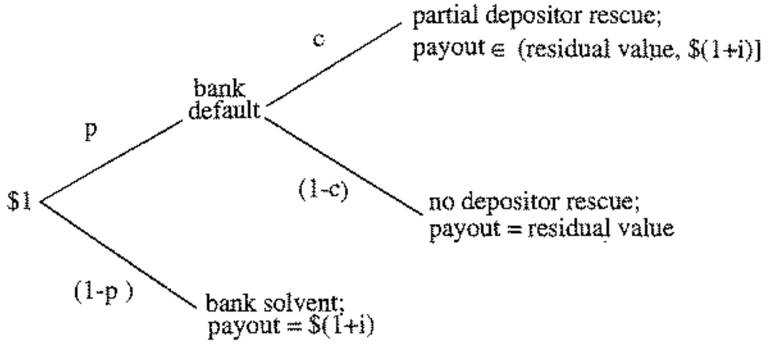

Fig. 1. Generic structure of two-period model of bank deposits and returns. This figure presents the basic random structure of depositor payouts in the various states of the world.

With probability p, the bank defaults at date 1. If default occurs, then with probability c the regulatory authority "rescues" depositors with a payout that is greater than the residual bank value; otherwise depositors receive the residual bank value.[2] This structure is illustrated in Fig. 1.

We use this structure to calculate the deposit risk premium in both insured and uninsured systems; the probabilities of default and rescue (p and c) may vary across these two systems, taking the values (p_U, p_I) and (c_U, c_I) respectively. Consider first a bank deposit in a system where deposits are formally and costlessly insured up to some maximum level. This deposit offers a return of $1 + i_I$ dollars next period and this return is insured up to a maximum of $\gamma(1 + i_I)$ dollars for some $\gamma < 1$.[3] With probability $(1 - p_I)$ this deposit pays the promised return; with probability p_I the bank defaults. If the presence of deposit insurance induces moral hazard by encouraging banks to undertake excessively risky investments, then p_I is an increasing function of γ for at least some values of γ.

If default occurs, then with probability c_I the bank regulatory authority honors its insurance commitment and depositors receive the return $\gamma(1 + i_I)$; with probability $(1 - c_I)$ the insurance promise turns out to be worthless and depositors receive the residual bank value, which we express as a fraction R of the promised return, where $R < \gamma$.[4] Eq. (1) then implies that the deposit rate i_I satisfies:

[2] Note that the residual value could be zero, or indeed even negative to the extent that depositors also lose an intangible asset corresponding to the value of the relationship they have built up with the bank.

[3] In practice, insurance systems tend to specify a maximum dollar payout rather than a maximum return payout. Introducing this feature into our model would make the risk premium dependent on the size of the deposit, so our approach represents a simplified attempt to capture the broad spirit of a system that specifies an upper limit on insurance coverage.

[4] On the one hand, it might be argued that c_I is a decreasing function of γ since the incentive to default on any insurance commitment is greater for high insurance coverage levels. On the other hand, higher coverage levels may be offered precisely because of stronger insurer finances and therefore a greater probability of honoring insurance commitments. In the absence of any compelling theoretical or empirical reason for favoring one argument over the other, we assume that c_I is determined by factors exogenous to the model.

$$(1 - p_{\mathrm{I}})(1 + i_{\mathrm{I}}) + p_{\mathrm{I}} c_{\mathrm{I}} \gamma (1 + i_{\mathrm{I}}) + p_{\mathrm{I}}(1 - c_{\mathrm{I}}) R (1 + i_{\mathrm{I}}) = 1 + r.$$

Collecting terms in $(1 + i_{\mathrm{I}})$ and p_{I}, and using the approximation $(1 + x)(1 + y) = 1 + x + y$ for small x and y, we obtain

$$\pi_{\mathrm{I}} \equiv i_{\mathrm{I}} - r = p_{\mathrm{I}}\{1 - \gamma c_{\mathrm{I}} - R(1 - c_{\mathrm{I}})\}. \tag{2}$$

Eq. (2) states that the credit spread π_{I} equals the (risk-neutral) expected return loss due to bank default. As intuition suggests, this is increasing in the probability of bank default, but decreasing in the residual value and in the probability and level of depositor rescue.

Now consider the same bank deposit in a system where deposits are uninsured. This deposit offers a return of $1 + i_{\mathrm{U}}$ dollars next period. With probability $(1 - p_{\mathrm{U}})$ this deposit pays the promised return; with probability p_{U} the bank defaults. If default occurs, then with probability $(1 - c_{\mathrm{U}})$ the regulatory authority follows its announced "no-rescue" policy and depositors receive the residual bank value. However, political factors (e.g., the too-big-to-fail doctrine) may make bank failure impossible; that is, with probability c_{U} the authority acts as if the deposits are insured and pays depositors the return $\gamma(1 + i_{\mathrm{U}})$. Eq. (1) then implies that i_{U} satisfies

$$(1 - p_{\mathrm{U}})(1 + i_{\mathrm{U}}) + p_{\mathrm{U}} c_{\mathrm{U}} \gamma (1 + i_{\mathrm{U}}) + p_{\mathrm{U}}(1 - c_{\mathrm{U}}) R (1 + i_{\mathrm{U}}) = 1 + r.$$

Collecting terms in $(1 + i_{\mathrm{U}})$ and p_{U} and again ignoring the cross-product term, we obtain

$$\pi_{\mathrm{U}} \equiv i_{\mathrm{U}} - r = p_{\mathrm{U}}\{1 - \gamma c_{\mathrm{U}} - R(1 - c_{\mathrm{U}})\} \tag{3}$$

which has the same interpretation as Eq. (2).

Eqs. (2) and (3) can be used to illustrate the complex nature of the relationship between deposit insurance and the risk premium. It is helpful to focus on two special cases. First, suppose that the promises to insure and not insure are both perfectly credible, i.e., $c_{\mathrm{I}} = (1 - c_{\mathrm{U}}) = 1$. Then subtracting Eq. (2) from Eq. (3) yields the risk premium difference $\Pi \equiv \pi_{\mathrm{U}} - \pi_{\mathrm{I}}$

$$\Pi = (p_{\mathrm{U}} - p_{\mathrm{I}})(1 - \gamma)$$

which has the sign of $(p_{\mathrm{U}} - p_{\mathrm{I}})$, the difference in the probability of bank default between insured and uninsured systems. Ignoring for the moment other possible determinants of this probability difference, if the presence of deposit insurance encourages banks to undertake excessively risky investments (the moral hazard effect), then $(p_{\mathrm{U}} - p_{\mathrm{I}})$ is negative.

Second, suppose that there is no moral hazard effect, i.e., $p_{\mathrm{U}} = p_{\mathrm{I}} \equiv p$. Then we have

$$\Pi = p(\gamma - R)[c_{\mathrm{I}} + (1 - c_{\mathrm{U}}) - 1]$$

which is positive if and only if the average probability of behaving as promised exceeds 0.5. More generally, if the credibility of the announced policies (to insure or not to insure) is sufficiently high, then this term is positive.

In general, the risk premium difference can be positive or negative depending on the magnitude of the moral hazard effect relative to the credibility of the announced policies. In subsequent sections, we consider the empirical importance of these two effects by examining international differences in deposit risk premia.

3. Bank regulation and the deposit risk premium

Deposit insurance is only one mechanism for achieving depositor protection. In general, banking system regulators prefer to make insurance payouts only when absolutely necessary, focusing instead on policies that are designed to enhance banking system stability and alleviate the need to resort to direct depositor rescue. Bank regulators frequently attempt to foster bank soundness (i.e., minimize the probability of bank default p in the model of Section 2) by imposing restrictions on the activities in which banks can participate. The most common of these regulations restrict the ability of banks to hold the equity of other firms (particularly loan clients), offer and underwrite insurance products, engage in securities dealing, brokering and underwriting, and undertake real estate investment and management.

The principal motivation for these restrictions is based on the potential they provide for conflicts of interest between banks and depositors and consequent bank failure. For example, allowing banks to invest in the equity of other firms provides them with the temptation to take financial risks for the firms in which the equity is held, i.e., banks may "throw good money after bad" in an attempt to protect their equity investment. Similarly, as noted by Pecchioli (1987, p. 58), "... the wish to preserve customer relationships might induce banks to underwrite and distribute low quality stocks, or to overlend to underwriting clients, thereby impairing the safety of the underwriting institution." According to this view, restricting banks from participating in non-bank activities protects depositors by fostering bank soundness and should result in a lower deposit risk premium. However, another view holds that preventing banks from engaging in such activities has significant diversification costs and thereby increases bank risk. Thus, the effect of these types of activities on the risk premium is ambiguous. One aim of this paper is to shed some light on this issue.

Table 1 summarizes the regulatory positions adopted by 13 OECD countries between 1985 and 1990. [5] Data were obtained primarily from Pecchioli (1987), supple-

[5] Our choices of countries and sample period were dictated largely by the availability of usable data. One constraint was that many Asian countries, which might otherwise have been included in the sample, had significant regulations on capital flows during the period. Moreover, other countries without deposit insurance during the period of our study were predominantly former Soviet bloc countries or countries in Africa and Asia for which the necessary data were unavailable. For example, we obtained interest rate data from South Korea for that period, but not only were these data quarterly but also there were considerable missing data and no reported government securities with maturities of ninety days. Another difficulty we encountered was classifying the regulatory positions of the various countries. As the Pecchioli (1987), United States House of Representatives (1990) and OECD (1992) studies provided a continuous, consistent and reliable source of information up to 1990, we therefore terminated our sample period at December of that year.

Table 1
Banking system regulatory characteristics

	Hold equity in other firms	Securities activities	Insurance activities	Real estate activities
Australia	Restricted	Restricted	Allowed	Restricted
Belgium	Restricted	Allowed	Allowed	Restricted
Canada	Restricted	Restricted	Restricted	Allowed
Denmark	Restricted	Allowed	Allowed	Allowed
France	Restricted	Allowed	Allowed	Allowed
Germany	Allowed	Allowed	Allowed	Allowed
Italy	Restricted	Restricted	Allowed	Restricted
Japan	Allowed	Restricted	Restricted	Restricted
Netherlands	Allowed	Allowed	Allowed	Allowed
New Zealand	Allowed	Allowed	Allowed	Allowed
Sweden	Restricted	Restricted	Restricted	Restricted
UK	Allowed	Allowed	Allowed	Allowed
USA	Restricted	Restricted	Restricted	Restricted

Regulations on non-banking activities for 13 OECD countries during 1985–1990. For each activity, a country's position is classified as follows. Allowed: generally permitted, although may be subject to some constraints on nature and extent of activity. Restricted: either prohibited, or approval required, or subject to other significant restrictions.
Sources: Dale (1986), Pecchioli (1987), OECD (1992), United States House of Representatives (1990), Saunders (1997).

mented by the updated material in in United States House of Representatives (1990), OECD (1992) and, where necessary, the description of earlier conditions in Dale (1986) and the more recent classification of Saunders (1997). All but five of the countries listed either prohibited their banks from purchasing the equity of other firms or placed severe restrictions on such activity. By contrast, most countries permitted banks to offer insurance services. Finally, about half of the countries listed allowed banks to offer securities services and engage in real estate investment and management. [6]

Another factor that may affect the size of a country's deposit risk premium is the extent of legal protection given to depositors in the event of bank liquidation. For deposits that are fully insured, bankruptcy laws are irrelevant since depositors endure no loss in the event of default (so long as the insurance promise is fulfilled), but they may be important for deposits that are either uninsured or only insured up to some maximum level. For example, legal systems that encourage liquidation rather than reorganization and give depositors high priority in the event of liquidation provide greater protection to investors that have uninsured or partially insured

[6] This delineation exercises some judgement. For example, in 1988 the US Supreme Court gave commercial banks authority to underwrite commercial paper, mortgage-backed securities and municipal revenue bonds, although their ability to generate income from these sources was restricted to 5% of gross revenues. In 1989, the Federal Reserve Board permitted six large banks to underwrite corporate debt while in 1990 it permitted J.P. Morgan to underwrite equity offerings. Nevertheless, no changes of any substance occurred until after 1990, so we include the US in the "restricted" group.

deposits. Thus, all else equal, a country's deposit risk premium should be a decreasing function of creditor rights. In this study, we use the index of La Porta et al. (1997) which assigns countries a score between zero and four depending on the extent of legal protection they offer to creditors. [7] Although this index applies to conditions existing slightly after the end of our sample period, it seems reasonable to assume that any errors due to this mis-match are minor.

4. Interest rate data and preliminary statistics

To address the relationship between international deposit risk premia and systemic differences in deposit insurance coverage, banking regulation policy, and legal protection, we collected monthly interest rate data for the period January 1985–December 1990. All countries in our sample other than Australia, New Zealand, Sweden, Singapore, Italy and Denmark operated formal deposit insurance schemes throughout this period; Italy and Denmark implemented such schemes in June 1987 and March 1988 respectively.

In order to calculate risk premia, we require proxies for the deposit and riskless rates in each country. For deposit rates, we collected monthly observations of three-month CD rates from *The Economist*. [8] For some countries, these rates come from an individual bank; in other countries they represent averages of the rates offered by several banks. In either case, we assume that they are representative of those on offer in the corresponding country. We use these data because they represent the rates offered on deposits that are large and tradeable, features that are important for the following reasons. First, recall our hypothesis that the moral hazard incentives of deposit insurance may moderate the beneficial effect of insurance on the risk premium. Such an effect can apply only to deposits that are larger than the maximum insurance coverage; for small deposits, any increase in the probability of bank default induced by morally hazardous behavior is immaterial since these deposits are completely insured and all that matters is the solvency of the insurer. For large deposits, by contrast, any investment over and above the maximum insurance coverage is at risk. Since we are interested in the extent to which moral hazard effects are incorporated in deposit rates, it is therefore necessary that we use large deposits. Second, if investors are unable to liquidate deposits without penalty prior to maturity, then risk premium differences between insured and uninsured countries will partly reflect differences in withdrawal penalties. Since we do not have any information on withdrawal penalties, this creates a potential bias in our empirical analysis. However, by using tradeable deposits, such a problem does not arise.

[7] This index is increasing in the extent to which creditors can retain or regain control of their securities in the event of the borrowing firm seeking re-organization or bankruptcy. For details, see Tables I and II of La Porta et al. (1997).

[8] Exceptions were West Germany (supplied by the Bundesbank), Denmark (Danmarks National Bank) and New Zealand (CS First Boston).

Table 2
Summary statistics for risk premia

	Uninsured	Insured	Difference t-statistic
January 1985–December 1990 ($n = 72$)	0.196 (0.28)	0.045 (0.11)	4.21
January 1985–June 1987 ($n = 30$)	0.232 (0.30)	0.085 (0.07)	2.51
July 1987–February 1988 ($n = 8$)	0.196 (0.29)	0.002 (0.15)	2.25
March 1988–December 1990 ($n = 34$)	0.165 (0.26)	0.020 (0.12)	2.72

Mean deposit premia for 1985–1990 period and various subperiods, estimated from monthly observations of annualized yields and expressed in percentage points. Standard deviations are in parentheses. Italy implemented a formal deposit insurance scheme in June 1987 and so moves from the uninsured group to the insured group at that time. Similar comments apply to Denmark in March 1988. The risk premium is the difference between the rate offered on a large three-month certificate of deposit and the corresponding three-month treasury bill rate.

As a proxy for the riskless rate of each country, we use monthly observations of three-month T-Bill yields provided by the OECD.[9,10] To the extent that we were able to definitively identify the basis on which interest rates were quoted, all CD and T-Bill rates are converted to annual yields to ensure comparability. Summary means and standard deviations for the deposit risk premia implied by our interest rate data appear in Table 2. For the entire period of our sample, the mean annual risk premium on uninsured deposits is 19.6 basis points while that on insured deposits is 4.5 basis points; the 15.1 basis point difference has a t-statistic of 4.21. Moreover, the mean difference between the uninsured and insured risk premia for each of the sub-periods is similar in magnitude and statistical significance to the sample period as a whole.

Further preliminary analysis is provided by Table 3 where we show the correlations between the variables used in this study. We distinguish between insured and uninsured deposits by assigning a value of one to countries that provide explicit insurance coverage and zero otherwise. Similarly, for each restriction on non-bank activity, every observation from a country is given a value of one if that country is listed as "allowed" in Table 1 and zero otherwise.

Table 3 confirms the strong negative correlation between the risk premium and the provision of deposit insurance. Moreover, the risk premium is also negatively correlated with restrictions on bank equity purchases and with the level of creditor rights. However, the provision of deposit insurance is positively correlated with the ability of banks to offer securities services which in turn is negatively correlated with the risk premium. Similarly, the provision of deposit insurance is negatively correlated with the ability of banks to offer insurance services which in turn is positively correlated with the risk premium. Thus, although Tables 2 and 3 are consistent with

[9] Exceptions are France (PIBOR rate for 1985–1986), Japan (Gensaki rate), Denmark (estimates inferred from a zero coupon yield curve) and Netherlands (for 1985–1987, estimates inferred from Interbank rate). A full listing of interest rate data sources is available upon request from the authors.

[10] In order to allow for taxation differences across countries, we also used statutory corporate tax rates to calculate after-tax deposit premia. However, this made no difference to the results so before-tax premia are used throughout the paper.

Table 3
Correlation structure for variables used in this study

	Deposit risk premium	Deposit insurance provided	Equity in other firms allowed	Securities services allowed	Insurance services allowed	Creditor rights index
Deposit risk premium	1.00	−0.15**	0.12**	−0.04	0.05	−0.08**
Deposit insurance provided	−0.15**	1.00	0.18**	0.20**	−0.08*	−0.11**
Equity in other firms allowed	0.12**	0.18**	1.00	0.41**	0.18**	0.60**
Securities activities allowed	−0.04	0.20**	0.41**	1.00	0.72**	0.59**
Insurance activities allowed	0.05**	−0.08*	0.18**	0.72**	1.00	0.21**
Real estate activities allowed	−0.03	0.20**	0.41**	0.69**	0.39**	0.39**
Creditor rights index	−0.08*	−0.11**	0.60**	0.59**	0.21**	1.00

This table presents Pearson correlation coefficients for some of the critical variables in our study. The deposit risk premium is the difference between a large deposit rate offered by a representative bank or banks of a country and the country's T-Bill rate. The deposit insurance variable equals one if a country has an explicit insurance system and zero otherwise. The bank regulation variables equal one if a country is listed as "Allowed" in Table 1 and zero otherwise. The creditor rights index is taken from La Porta et al. (1997)

*Significant at the 5% level.

**Significant at the 1% level.

the view that the deposit risk premium is lower in countries that provide deposit insurance, have strong creditor rights, and place restrictions on at least some non-banking activities, there are enough interdependencies between these variables to suggest that we should employ a multiple regression approach that allows us to disentangle the various relationships. This is the subject of the next section.

5. Regression analysis

5.1. Insured vs uninsured

For each of the thirteen countries, we have 72 months of data. We pool these data and regress the risk premium series on the insurance, regulatory, and creditor rights variables, and on the T-Bill rate. We include the latter because Longstaff and Schwartz (1995) show, and verify empirically, that credit spreads are a decreasing function of the riskless interest rate.[11]

We first estimate this model using OLS and apply a number of specifications tests to the results. In particular, we test for omitted variables (RESET tests), parameter

[11] Our risk premium data may also reflect additional risks associated with the specific banks from which these data are obtained, although these seem likely to be small compared with the premia associated with countries. Nevertheless, we experimented with two measures of individual bank risk. First, we calculated the conditional standard deviation of a GARCH (1,1) process fitted to each country's risk premium series, on the grounds that greater variation in expected returns translate into greater price variation and hence greater risk. Second, we calculated the mean ratio of book equity to total assets for a representative sample of large banks in each country. However, after controlling for the differences in insurance and regulation, these variables proved to be unrelated to the risk premium.

stability, heteroscedasticity and autocorrelation. These tests reveal some problems, primarily with the latter two phenomena. First, the error term is correlated across countries, presumably due to common international shocks. Second, the variance of the error term differs across countries. Third, there is serial correlation in the error term. To correct for these problems, we use a SUR approach to re-estimate the model with the following properties in the error term ε:

(i) $E[\varepsilon_{it}^2] = \sigma_{\varepsilon i}^2$ where $\sigma_{\varepsilon i}^2$ is the constant error variance for country i.
(ii) $E[\varepsilon_{it}\varepsilon_{jt}] = \sigma_{\varepsilon ij}$ where σ_{ij} is the constant error covariance between country i and country j.
(iii) $\varepsilon_{it} = \rho_i \varepsilon_{it-1} + \eta_{it}$ where η_i is a zero-mean, serially-uncorrelated variable with constant variance $\sigma_{\eta i}^2$ and which is independent of $\eta_j \forall j$.

Modification (i) adjusts our estimation procedure so as to allow for heteroscedasticity across countries; (ii) admits error term correlation across countries; (iii) permits first-order serial correlation in the error term. The AR(1) structure of the final adjustment uses up one month of data, leaving us with 71 months or 923 observations. Interpretation of standard goodness-of-fit measures is problematic with such an estimation procedure, so we report adjusted-R^2 values from corresponding OLS regressions.

The results of our SUR regressions appear in Table 4; the base model results are in column (1). For our purposes, the most important finding is that the risk premium on insured deposits averages 43 basis points lower than the premium on uninsured deposits and that this reduction is statistically significant at the 1% level. Thus, the perceived credibility of announced depositor protection policies appears to be sufficiently high to outweigh any moral hazard effect.

Column (1) of Table 4 also shows that prohibiting banks from holding equity in other firms decreases the risk premium by 47 basis points while a similar embargo on insurance activities results in a 25 basis point decrease in the premium. As these differences are significant at the 1% and 5% levels respectively, this lends some support to the view that non-bank operations have the potential to undermine bank soundness. However, restrictions on securities and real estate activities have no significant effect on the risk premium. The extent of legal protection offered to depositors also seems to be an important determinant of CD risk premia as each step up on the La Porta et al. (1997) creditor rights index reduces the risk premium by 20 basis points on average. Finally, the premium is negatively related to the T-Bill rate, consistent with the findings of Duffee (1998) and Longstaff and Schwartz (1995).

The adjusted R^2 value for this model is quite low at only 13%. However, since our explanatory variables (other than the T-Bill rate) do not vary through time, our model is essentially attempting to explain the risk premium variation that is due to cross-country differences. The maximum amount of premium variation that can be "explained" by cross-country differences can be estimated by regressing the risk premium on 12 country dummy variables. Estimation of such an equation yields an adjusted R^2 of about 20%, so our base model explains about 65% of the cross-country variation in the risk premium.

Table 4
Risk premium regressions

Independent variable	(1)	(2)	(3)	(4)	(5)
Intercept	0.35 (3.6)**	0.37 (3.9)**	0.38 (4.0)**	0.35 (4.1)**	−0.34 (3.3)**
Deposit insurance provided	−0.43 (5.3)**	−0.56 (6.4)**	−0.50 (6.1)**	−0.53 (6.7)**	
Equity in other firms allowed	0.47 (5.5)**	0.41 (5.1)**	0.29 (4.0)**	0.28 (4.0)**	0.29 (3.9)**
Securities activities allowed	−0.12 (0.9)	0.10 (0.7)	−0.55 (3.2)**	−0.29 (1.5)	−0.34 (2.2)*
Insurance activities allowed	0.25 (2.5)*	−0.01 (0.1)	0.32 (3.1)**	0.09 (0.7)	0.31 (2.6)*
Real estate activities allowed	0.01 (0.2)	0.12 (1.6)	0.17 (2.4)*	0.21 (3.2)**	0.01 (0.1)
Creditor rights index	−0.20 (4.4)**	−0.49 (4.5)**	−0.11 (2.4)*	−0.38 (3.4)**	−0.13 (3.2)**
T-Bill rate	−0.02 (3.0)**	−0.02 (2.9)**	−0.03 (3.2)**	−0.02 (2.9)**	−0.02 (2.7)**
Deposit insurance provided × Creditor rights index		0.34 (3.1)**		0.30 (2.7)**	
Depositor loss history			0.36 (3.7)**	0.31 (3.2)**	
Maximum USD coverage					−0.33 (3.2)**
Square of maximum USD coverage					0.03 (2.1)*
Adjusted R^2	0.13	0.14	0.14	0.15	0.10
Number of observations	923	923	923	923	923

These regressions use pooled monthly data from 13 OECD countries for the 1985–1990 period. Estimation is by SUR, allowing for heteroscedasticity and error term correlation across countries and for first-order serial correlation in the error term. The dependent variable is the deposit risk premium for each country, defined as the difference between a large deposit rate offered by a representative bank or banks and the country's T-Bill rate. Deposit insurance provided equals one if a country has an explicit insurance system and zero otherwise. The bank regulation variables equal 1 if a country is listed as "Allowed" in Table 1 and zero otherwise. The creditor rights index is taken from La Porta et al. (1997). Depositor loss history equals one if depositors of the corresponding country ever lost money in a bank failure between 1970 and 1993 and zero otherwise. Maximum USD coverage equals the US dollar value of the maximum insurance coverage available on each deposit. Absolute values of t-statistics are in parentheses.

* Significant at the 5% level.

** Significant at the 1% level.

Our base model assumes that the various methods of depositor protection are independent of each other, but this may not be the case. For example, the provision of deposit insurance may not be as crucial when significant creditor rights exist, and vice versa. We therefore examine the interaction between deposit insurance and other direct depositor protection by creating a new variable equal to the product of the deposit insurance dummy and the creditor rights index. [12] In column (2) of Table 4, we see that this variable has a positive and significant association with the risk premium. Moreover, its inclusion in our model raises the absolute value of both the deposit insurance and creditor rights coefficients. This suggests that there is a tradeoff between deposit insurance and creditor rights in the setting of deposit risk premia. When deposit insurance is present, creditor rights are less important; when creditor rights are accorded a high priority, deposit insurance is less important. From the perspective of policymakers, this result is consistent with the view that deposit insurance

[12] We also considered interactions between deposit insurance and the bank regulatory variables, but found no evidence for any such effects.

and creditor rights legislation may act as substitute methods for providing depositor protection.

Our analysis to this point has implicitly assumed that policy credibility is the same across all countries. However, a promise to insure depositors may, in some countries, have low credibility because of investor concerns about the solvency and/or liquidity of the insurance fund. Similarly, a refusal to offer formal insurance to depositors may, for some countries, be seen as irrelevant because of perceived implicit insurance, e.g., political factors may make bank failure impossible even if no explicit insurance scheme exists. To the extent that any such differences in policy credibility are systematically correlated with the other variables, the previously-reported coefficients on the latter may be biased. To address this issue, we construct a depositor loss variable set equal to one if depositors of a country have ever lost money in a bank failure between 1970 and 1993 and zero otherwise. All else being equal, countries with no history of bank failure can be assumed to have a greater likelihood of rescuing depositors from future bank defaults than countries where banks have been allowed to fail. We obtained the information required to construct this variable from Appendix 3 of the comprehensive survey of bank failures documented by Goodhart and Schoenmaker (1993); countries in which depositors had suffered losses were Belgium, France, West Germany, Netherlands, New Zealand, the UK, and the US.

We include the depositor loss variable in our base model and report the results of this modification in column (3) of Table 4; in column (4), to consider joint as well as individual significance, we estimate a model which contains both the depositor loss variable and the insurance-creditor rights interaction variable. The results from these two models are virtually identical and reveal two principal findings. First, the effect of formal deposit insurance on the insurance premium is now associated with a 50 basis point fall in the risk premium, somewhat higher than the 43 basis point difference in our base model. Thus, the ex-ante promise to protect depositors appears to be important even when ex-post differences in protection are taken into account. Second, an established track record in actually rescuing—as opposed to simply promising to rescue—reduces the risk premium by 36 basis points on average. At first glance, this additional depositor protection appears indicative of imperfect policy credibility. However, such a conclusion may not be justified unless all countries offer 100% insurance.[13] If deposits are insured only up to some maximum level, as is the case in our sample, then the depositor loss variable may simply be proxying for differences in maximum coverage, i.e., countries that allowed losses did so because they offered lower maximum coverage, not because their promise to insure is less credible. Analysis of the relationship between the depositor loss coefficient and the maximum insurance coverage indicated that, in our sample, the risk premium is a decreasing function of the maximum insurance coverage in countries that have not allowed losses, consistent with these countries being seen as having high credibility, but it is independent of the maximum insurance coverage in countries that have allowed

[13] We are grateful to the referee for pointing this out to us.

losses, suggesting that the market views these countries as having imperfect credibility.

These latter results suggest that the nature of the relationship between the risk premium and the maximum promised level of insurance coverage should be examined in more detail, an issue we turn to next.

5.2. Differences in insurance coverage

Our results thus far indicate that the risk premium on uninsured deposits is greater than that on insured deposits. This raises the question of whether or not this effect is monotonic. On the one hand, greater insurance coverage (i.e., a higher maximum limit) assists holders of partially insured deposits by reducing the portion of their deposit that is at risk. On the other hand, greater insurance coverage may result in stronger moral hazard incentives, thereby making it more likely that depositors will lose the portion of their deposits not covered by the insurance scheme. To clarify the nature of this tradeoff, note that Eq. (2) implies

$$\frac{\partial \pi_{\mathrm{I}}}{\partial \gamma} = -p_{\mathrm{I}} c_{\mathrm{I}} + (1 - \gamma c_{\mathrm{I}}) \frac{\partial p_{\mathrm{I}}}{\partial \gamma}. \tag{4}$$

The first term on the right side of Eq. (4) is negative and captures the greater protection afforded by a higher maximum insurance coverage. The second term is positive and reflects the greater risk of bank default. Thus, the net effect of increases in the maximum insurance coverage on the deposit risk premium depends on which of these two factors dominates. Note also that the right side of Eq. (4) is a constant if and only if $\partial p_{\mathrm{I}}/\partial \gamma = 0$, i.e., there is no moral hazard effect. In this case, the risk premium is a linear function of the maximum insurance coverage.

To investigate this issue, we repeat our earlier regression models, but replace the deposit insurance dummy with the normalized US dollar value of the maximum insurance coverage available on each deposit and its square.[14] To create this normalized value, each country's maximum insurance coverage is first translated into US dollars using the contemporaneous spot exchange rate and then expressed as a proportion of the US coverage by dividing by US$100,000. The results of this procedure appear in column (5) of Table 4. The coefficient on the maximum level of insurance coverage is negative at the 1% significance level while that on the squared value is positive. The latter coefficient has only minor economic significance. For example, if a country's maximum insurance coverage level is US$ 25,000, then its normalized value is $(25000/100000) = 0.25$ and the linear term in the column (5) regression indicates that the risk premium is $(0.25)(33) = 8.25$ basis points lower than it would be

[14] In our sample, these limits were: Japan ¥10,000,000, United Kingdom £15,000, France FF400,000, Canada C$60,000, United States US$100,000, Netherlands FL40,000, Belgium BF500,00, Italy L840,000,000 (from July 1987), Denmark Dkr250,000 (from March 1988). The West German system mandated that up to 30% of a bank's liable capital was covered per depositor. In practice, this meant that all but the largest deposits were covered, so we set the insurance coverage for West German deposits equal to that of the country with the highest basic protection (the US).

if insurance were absent. The squared term indicates that this reduction is offset by only $3(0.25)^2 = 0.19$ basis points. However, at the maximum insurance coverage of US$ 100,000, the squared term lowers the risk premium by three basis points. In general, the effect of insurance on the risk premium is almost entirely determined by the linear term at low levels of insurance, but the squared term becomes more important at higher insurance levels. This is consistent with the view that high levels of insurance coverage generate moral hazard incentives and that these are recognized and priced by bank CD holders.[15,16]

To summarize, our results suggest several characteristics of deposit risk premia. First, the premium is lower in insured countries. Second, the relationship between the risk premium and the maximum dollar value of insurance coverage is non-linear, suggesting that moral hazard incentives are recognized and priced by investors. Third, the risk premium is lower in countries with strong creditor rights. Fourth, the effect of deposit insurance on the risk premium is lower in countries with strong creditor rights, implying that investors view the latter as a substitute for explicit deposit insurance. Fifth, the risk premium tends to be higher in countries that place few restrictions on bank activities, suggesting that so-called universal banking may have an adverse effect on banking system risk.

5.3. Sensitivity analysis

There may be legitimate concerns about the robustness of these results, primarily on two grounds. First, our model could be misspecified due to omitted or extraneous variables. Second, with only thirteen countries, our results could be due to outlier data from one country. To address these concerns, we adopt a procedure similar to that used by Levine and Renelt (1992) and Lott and Opler (1996). The underlying premise, based on Leamer (1983), is that economic theory rarely provides anything more than an approximate guide to the appropriate form of the corresponding empirical model. Consequently, very different regression models can have equal theoretical validity but generate very different coefficients for the variables of interest. To deal with this issue, we estimate a large number of other possible specifications of our base models and assess the sensitivity of the coefficient parameters in which we are most interested. We find, as a result of this procedure, that there are many model specifications consistent with our principal conclusions.

[15] Of course, banks could use the implicit subsidy provided by deposit insurance to offer higher CD rates. In this case, the CD spread would not be a pure risk premium and the positive coefficient on the squared level of deposit insurance could indicate a subsidy effect rather than a moral hazard effect. However, if banks offer higher-than-required CD rates, then portfolio substitutions will cause T-Bill rates to rise by a similar amount, thereby leaving the spread unaffected. In this context, Shoven et al. (1992) attribute movements in the spread (in the US market) to changes in the risk premium. Moreover, capital flows in integrated markets seem likely to eliminate any inter-country difference in spreads over and above that justified by respective risks.

[16] For completeness, we also estimated an equation that added both the depositor loss variable and the insurance-creditor rights interaction variable to the column (5) model. However, this resulted in multicollinearity problems, so we do not include the results in the table.

We first examine our Table 4 finding of a significantly lower premium in countries with (i) explicit deposit insurance schemes and (ii) strong creditor rights. We start with the base model appearing in column (1) of that table. We then create a number of additional specifications by (i) dropping one explanatory variable (other than the deposit insurance and creditor rights variables) at a time, (ii) adding, one at a time, six additional country-specific explanatory variables (a country risk variable based on Euromoney rankings, a country equity premium, average country bank size and book-equity ratio taken from the COMPUSTAT files, per-capita GDP, interest rate volatility). Including the base model, this yields twelve different model specifications. Each specification is estimated 98 times by successively dropping, first, one country at a time and, second, one year at a time. Finally, we repeat this entire procedure using OLS estimation. In all, we run 2352 regressions.

A summary of the results of this exercise appear in Table 5. First, the average values of the deposit insurance and creditor rights coefficients have the same sign as that reported for the base model. Second, the average *t*-statistics both exceed 3.5 in absolute value. Third, virtually all of the 2352 regressions generate coefficient estimates that have the same sign as those of the base model and the vast majority of these are significant at the 5% level or better. Perhaps most tellingly, none of the coefficient estimates (i) has the opposite sign to the base model and (ii) is statistically significant. That is, regardless of the particular model specification, and regardless of how the data are split (subject to retaining a sufficient number of uninsured coun-

Table 5
Sensitivity analysis for estimated deposit insurance coefficients

Coefficient of interest (base model)	Mean coefficient	Proportion of coefficients with same sign as base model	Mean *t*-statistic	Proportion of coefficients with *t*-status significant at 0.05 level and with same sign as base model	Proportion of coefficients with *t*-status significant at 0.05 level and with different sign to base model
Deposit insurance provided (Column (1) of Table 4)	−0.33	1.000	−4.85	0.98	0.00
Creditor rights index (Column (1) of Table 4)	−0.22	0.995	−5.44	0.96	0.00
Deposit insurance provided × Creditor rights index (Column (3) of Table 4)	0.17	1.000	3.53	0.93	0.00
Deposit insurance coverage (Column (4) of Table 4)	−0.32	0.955	−2.78	0.72	0.01
Square of deposit insurance coverage (Column (4) of Table 4)	0.10	0.907	1.94	0.45	0.01

This table summarizes the results from estimating 2352 alternative versions of the models appearing in Table 4. The mean coefficient for each variable is the average value of this coefficient from these regressions. The mean *t*-stat for each variable is the average *t*-stat for the corresponding variable from these regressions. All variables are described in Table 4.

tries), the signs of the critical coefficients are unaffected. Given that we estimate a large number of "unlikely" models, and thereby overstate the degree of uncertainty about coefficient parameters, the results of this analysis suggest that our original findings are fairly robust with respect to possible model or data error.

We also apply this procedure to the models appearing in columns (3) and (4) of Table 4 in order to focus on (i) the positive relationship between the risk premium and the deposit insurance-creditor rights interaction variable and (ii) the non-linear relationship between the risk premium and the maximum deposit insurance coverage. With regard to (i), the picture is again reassuring: the average coefficient and t-statistic are similar to those generated by the base model of Table 4. All model specifications yield a positive coefficient, and 93% of these are significant at the 5% level. Thus, the positive relationship between the risk premium and the interaction variable also seems to be a robust result.

The outcome is not so sanguine for relationship (ii). Although the negative coefficient on the maximum coverage variable appears reasonably robust, a small number of model specifications yield positive coefficients that are significant at the 5% level. Similarly, although the coefficient on squared coverage is positive for more than 90% of model specifications, only half of these are significant at the 5% level. Thus, we cannot conclude that the non-linear relationship implied by the base model is robust; the evidence for a moral hazard component of the deposit risk premium is therefore more limited than for the other components previously discussed.

6. Concluding remarks

Using pooled financial and institutional data from 13 countries, we find that the risk premium on large deposits is over 40 basis points higher on average in uninsured countries than it is in countries where deposits are formally insured up to some prespecified maximum. However, there is some weak evidence that the rate of decrease in the risk premium tails off at higher levels of insurance, suggesting that holders of large deposits recognize and price moral hazard risks. We also find that the risk premium is generally lower in countries that place restrictions on the abilities of banks to engage in non-banking activities and in countries that provide significant rights to creditors in the event of borrower default. Finally, the negative relationship between the provision of deposit insurance and the risk premium is strongest in countries with weak creditor rights, implying that investors view these policies as substitute methods of protection.

These results are interesting from at least two perspectives. First, they shed further light on the manner in which financial markets set interest rates, and in particular the role of depositor protection policies in this process. Our findings suggest that markets perceive explicit deposit insurance schemes as having low guarantor risk, but potentially significant moral hazard risk. Whether either view is justified is another matter; future research in this area could well concentrate on the extent to which risk premia on insured deposits adequately reflect the inherent risks. Second, our results have important macroeconomic implications. For many firms, particularly smaller ones, bank loans are the primary source of investment capital and a significant proportion of these loans are funded by deposits. Thus, lower deposit rates serve to lower many firms' costs of capital. Our finding that deposit insurance and restrictions on non-bank activities are associated with a lower risk premium suggests that these policies can have beneficial implications for aggregate investment activity.

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