THE WORLD BANK ECONOMIC REVIEW, VOL. 16, NO. 1 109–137

Bank Risk and Deposit Insurance

Luc Laeven

Arguing that a relatively high cost of deposit insurance indicates that a bank takes excessive risks, this article estimates the cost of deposit insurance for a large sample of banks in 14 economies to assess the relationship between the risk-taking behavior of banks and their corporate governance structure. The results suggest that banks with concentrated ownership tend to take the greatest risks, and those with dispersed ownership engage in a relatively low level of risk taking. Moreover, as a proxy for bank risk, the cost of deposit insurance has some power in predicting bank distress.

Banking crises have shown not only that banks often take excessive risks but that risk taking differs across banks. Some banks engage in more risks than their capital could bear if the downside potential of the risks fully materialized; others are more prudent and would be able to weather a banking crisis. Whether different types of banks take different risks is not well known.

To see whether there is a relationship between risk-taking behavior and bank characteristics such as ownership structure, I analyze a large sample of banks in different economies. I measure the degree of a bank's risk taking by the value of deposit insurance services implicitly extended to the bank by the safety net to guarantee its deposits. This implicit deposit insurance cost is calculated by applying a well-known technique that models deposit insurance as a put option on the bank's assets.

The results provide empirical support for this method of assessing the risks of a bank. Implicit deposit insurance premiums are higher for banks in crisis countries and have some power in predicting bank distress.

Luc Laeven is with the World Bank, Financial Sector Department, Financial Sector Strategy and Policy Unit. His e-mail address is llaeven@worldbank.org. The author is grateful to François Bourguignon, two anonymous referees, Thorsten Beck, Jerry Caprio, Stijn Claessens, Asli Demirgüç-Kunt, Simeon Djankov, Patrick Honohan, Ed Kane, Giovanni Majnoni, Maria Soledad Martinez Peria, George Pennacchi, Sweder van Wijnbergen, and participants in the World Bank Financial Economics Seminar and the 18th Latin American Meetings of the Econometric Society for their valuable comments; to Paola Bongini, Stijn Claessens, and Giovanni Ferri for making available their dataset on bank intervention in selected East Asian countries; and to Ying Lin for excellent research assistance. The views expressed are those of the author and should not be interpreted as reflecting those of the World Bank or its affiliated institutions.

I. Literature

Many countries have implemented deposit insurance schemes to prevent bank runs and to provide liquidity to banks in case bank runs do occur. In most countries that have explicit deposit insurance the schemes insure deposits only up to a certain limit, offering limited-coverage deposit insurance. In some countries, such as Turkey, the schemes insure deposits in full, providing a blanket guarantee. The advantage of a deposit insurance system that provides a blanket guarantee is that it fully eliminates bank runs. The disadvantage is that it destroys all potentially beneficial information production and monitoring by depositors. Bhattacharya, Boot, and Thakor (1998) show that partial deposit insurance encourages market discipline, exercised through bank monitoring by informed depositors, and that regulatory measures, such as limited regulatory forbearance and tough bank closure rules, may control bank risk taking. Underlying the partial insurance conclusion is the presumption that informed depositors—with their own assets at risk—will do a better job of monitoring banks than government regulators will.

Demirgüç-Kunt and Huizinga (1999) find empirical evidence that adopting an explicit deposit insurance scheme involves a tradeoff between increased depositor safety and reduced market discipline by bank creditors. Demirgüç-Kunt and Detragiache (1999) provide empirical evidence based on a large sample of countries that explicit deposit insurance increases banking system vulnerability in countries with weak institutional environments. More generally, Kane (2000) argues that the design of financial safety nets should take country factors into account, particularly the informational environment and the enforceability of private contracts.

Since Merton (1977), deposit insurance has typically been modeled in the literature as a put option on the bank's assets. Marcus and Shaked (1984) were the first to implement Merton's (1977) model and empirically test over- and underpricing of insurance premiums. Ronn and Verma (1986) claim that Marcus and Shaked (1984) incorrectly look at the preinsurance value of bank assets. They designed a model that looks at the postinsurance value of bank assets and incorporates capital forbearance by the bank regulators. Duan (1994, 2000) develops a maximum likelihood framework to estimate the value of deposit insurance. Duan's method is free of some of the statistical problems of Ronn and Verma's (1986) method, an issue discussed in more detail later.

Many empirical studies have applied these methods. Few of them look at developing economies, however. Duan and Yu (1994) calculate deposit insurance premiums for 10 exchange-listed depository institutions in Taiwan (China) in 1985–92. Using Duan's (1994, 2000) maximum likelihood estimation method to assess implicit deposit insurance premiums, they find that the deposit insurance agency subsidized these institutions in all years except 1989. They also find that the methods of Ronn and Verma (1986) and Duan (1994, 2000) produce significantly different estimates of the cost of deposit insurance. Fries, Mason,

and Perraudin (1993) apply Ronn and Verma's (1986) method to 16 Japanese banks in 1975–92 and similarly find that the institutions were subsidized by the deposit insurance agency. Kaplan (1998) applies Duan's (1994, 2000) method to calculate risk-adjusted deposit insurance premiums for 15 Thai banks during the precrisis period of 1992–97. She finds that the cost of deposit insurance was highest for the banks that were nationalized, closed, subject to intervention, or sold to foreigners during the crisis period of 1998.

In this article I claim that the implicit cost of deposit insurance for a bank is a proxy for the risk taking of that bank, because the cost of insuring the deposits of a risky bank should be higher. The argument underlying this claim is that providing deposit insurance generates incentives for banks to take on risk, often reflected by excessive loan growth. This moral hazard behavior of banks has been described at length in the deposit insurance literature (for an excellent overview see Bhattacharya, Boot, and Thakor 1998). Merton (1977, 1978) first highlighted the attendant moral hazards of deposit insurance. Using a formal model, Bhattacharya and Thakor (1993) show that deposit insurance invites insured banks to seek excessive portfolio risk and to maintain liquid reserves lower than the social optimum. I estimate the cost of deposit insurance by calculating the risk-adjusted deposit insurance premium that a bank should have been paying under a risk-adjusted deposit insurance scheme, given its risk taking. This is the implicit deposit insurance premium. A high implicit cost of deposit insurance is taken as an indication of a risky bank. I use this approach both for countries with explicit deposit insurance and for countries with implicit insurance.

Because no country has actually implemented a market-based risk-adjusted deposit insurance scheme,[1] the risk-adjusted deposit insurance premium is fictitious. In fact, Chan, Greenbaum, and Thakor (1992) showed that it is impossible to implement a risk-sensitive deposit insurance pricing scheme that is incentive compatible unless banks are permitted access to rents, through explicit regulatory subsidies or restrictions on entry into banking.

In countries with an explicit deposit insurance scheme, the difference between the implicit premium and the premium that the bank actually pays to the deposit insurance fund indicates whether deposit insurance is under- or overpriced. Deposit insurance would be underpriced if the difference between the implicit premium (also known as the fair premium) and the actual premium is positive. I am not interested in the over- or underpricing of deposit insurance, but merely in estimating overall banking risks, so I focus on the implicit deposit insurance premiums.

Many countries do not have an explicit deposit insurance scheme in which every bank pays a certain premium to a deposit insurance fund. Nevertheless, most governments are expected to rescue troubled banks to protect depositors

1. Although most countries with an explicit deposit insurance scheme have designed flat-rate premiums, some countries, such as Argentina and the United States, have risk-sensitive premiums.

from losses, even if deposits are not officially insured. That is, these countries have implicit deposit insurance. In banking systems with implicit deposit insurance, the cost of the insurance is measured by the value of the deposit insurance put option.

II. Methodology

Merton's (1977) model of deposit insurance can be used to calculate the implicit cost of deposit insurance. Merton shows that the payoff of a third-party guarantee of payment to a firm's bondholders where there is no uncertainty about the guarantee obligation being met is identical to that of a put option where the promised payment corresponds to the exercise price and the value of the firm's assets V corresponds to the underlying asset.

Merton (1977) applies this model to a bank for which the debt issue corresponds to deposits. Because most deposits are of the demand type, the model's assumption of term debt issue is not strictly applicable. However, if one interprets the time until maturity as the time until the next audit of the bank's assets, then from the point of view of the guarantor, deposits can be treated as if they were term and interest bearing. Two more assumptions are made. First, it is assumed that deposits equal total bank debt and that both principal and interest are insured. Second, it is assumed that the bank's asset values follow geometric Brownian motion.

$$d\ln V_t = \mu dt + \sigma dW_t \tag{1}$$

where V is the value of assets, t is time, μ is the instantaneous expected return on assets, σ is the instantaneous expected standard deviation of asset returns, and W indicates a standard Wiener process. The Black and Scholes (1973) option pricing model can be used to value the deposit insurance per unit of deposits:

$$g = \Phi\left(\sigma\sqrt{T-t} - h_t\right) - \left[\frac{(1-\delta)V_t}{D}\right]\Phi(-h_t), \tag{2}$$

where $h_t = \dfrac{\ln[(1-\delta)V_t/D] + [\sigma^2/2](T-t)}{\left(\sigma\sqrt{T-t}\right)}$, g is the value of the deposit insurance guarantee per dollar of insured deposits, Φ is the cumulative normal distribution function, T is the time until maturity of the bank debt, D is the face value of the bank debt, and δ is the annualized dividend yield.

To implement the model, the two unobservable variables, the bank's asset value V and the volatility parameter σ, have to be estimated. Ronn and Verma (1986) suggest using two restrictions for the identification of these two unknowns. The first restriction is obtained by viewing the equity value of the bank, which is directly observable, as a call option on the bank's assets with a strike price equal to the value of the bank's debt:

$$E_t = V_t\Phi(d_t) - D\Phi\left(d_t - \sigma\sqrt{T-t}\right), \tag{3}$$

where $d_t = \frac{\ln[V_t / D] + [\sigma^2 / 2][T - t]}{(\sigma\sqrt{T - t})}$. Ronn and Verma (1986) modeled equity as being dividend protected; therefore dividends do not appear in equation (3). The Black-Scholes (1973) formula thus defines a one-to-one mapping between the unknown asset value and the observed equity value.

Ronn and Verma (1986) used the relationship between the equity and asset volatility, which can be obtained by applying Ito's Lemma to equation (3), as the second restriction

$$\sigma = (\sigma_E E_t) / [V_t \Phi(d_t)] \tag{4}$$

where σ_E is the standard deviation of equity returns.

Because the market value of equity is observable and the equity volatility can be estimated, two nonlinear restrictions are now in place for identifying the two unknowns. Using data on bank debt, bank equity, and equity volatility, equations (3) and (4) can be solved simultaneously for V and σ. Given these values, equation (2) is used to solve for the value of deposit insurance per dollar of deposits, which I interpret as the implicit cost of deposit insurance. For this approach to be valid, the time until maturity, T, of the put and call options must be the same. Ronn and Verma (1986) use Merton's (1977) assumption that the time until maturity of the debt is equal to the time until the next audit. They interpret the strike price of the put option as equal to the total debt of the bank, rather than to total deposits only. This assumes that all the debts of the bank are insured and that they are issued at the risk-free interest rate.

Ronn and Verma (1986) estimate instantaneous equity volatility by the sample standard deviation of daily equity returns and therefore impose the condition that equity volatility is constant. Duan (1994, 2000) points out that this premise is inconsistent with the underlying theoretical model of Merton (1977), in which equity volatility is stochastic. Therefore, the Ronn and Verma (1986) estimator does not possess the properties normally expected from a sound statistical procedure, such as consistency and efficiency.

Duan's (1994, 2000) maximum likelihood framework for estimating the value of deposit insurance is consistent with the assumption of Merton's (1977) theoretical model that equity volatility is stochastic. With the process in equation (1), the one-period transition density of the unobserved values of the bank's assets can be characterized by $\ln(V_{t+1} / V_t) \sim N(\mu, \sigma^2)$. Therefore, the log-likelihood function for a sample of unobserved V_t can be expressed as

$$\begin{aligned} L_v(V_t, t = 1, \ldots, n; \mu, \sigma) = &-[(n-1)/2]\ln(2\pi\sigma^2) - \sum_{t=2}^{n} \ln V_t \\ &-[1/2\sigma^2]\sum_{t=2}^{n}\left[\ln(V_t / V_{t-1}) - \mu\right]^2 \end{aligned} \tag{5}$$

Because the call option formula (equation [3]) is an element-by-element transformation from an unobserved sample of asset values to an observed time series

of equity values, the log-likelihood function for the observed sample of equity values can be written as

$$L(E_t, t=1,\ldots,n;\mu,\sigma) = -[(n-1)/2]\ln(2\pi\sigma^2) - \sum_{t=2}^{n}\ln\left[\hat{V}_t(\sigma)\Phi(\hat{d}_t)\right] - (1/2\sigma^2)\sum_{t=2}^{n}\left[\ln\left(\hat{V}_t(\sigma)/\hat{V}_{t-1}(\sigma)\right) - \mu\right]^2, \tag{6}$$

where $\hat{V}_t(\sigma)$ is the unique solution to equation (3) for any σ, and $\hat{d}_t$ corresponds to $\hat{d}_t$ with $\hat{V}_t(\sigma)$ in place of V_t. In the expression above, I have used the fact that $\partial E_t / \partial V_t = \mathrm{F}(d_t)$.

With the log-likelihood function in equation (6), an iterative optimization routine can be used to compute the maximum likelihood estimates. According to Duan (1994, 2000), these estimators are consistent. Given starting values for μ and σ and data on equity values E_t and debt D_t, equation (3) can be solved to yield a series of bank asset values V_t. Equation (6) is then used to solve for $\hat{\mu}$ and $\hat{\sigma}$. This process is iterated to find the maximum likelihood estimates of $\hat{\mu}$ and $\hat{\sigma}$ and their standard errors. Using the put option formula for deposit insurance (equation [2]), one can solve for the value of the guarantee per dollar of deposits and its standard error. The asymptotic distribution of the estimator for the deposit insurance premium is reported in Duan (1994, 2000). Although Duan (1994, 2000) correctly points out the deficiency of the Ronn and Verma (1986) method, I nevertheless apply both methods for comparative purposes. The main focus, however, is on the Duan (1994, 2000) estimates. (In the section on estimates I compare those obtained from applying these two methods.)

I calculate the deposit insurance premiums under the assumption that all bank debts (both deposits and other debt liabilities) are fully insured. Total bank liabilities are therefore used for the variable D in equation (3). This assumption is made for simplicity. In reality, banks carry both insured and uninsured debts. In particular, some deposit insurance schemes insure only certain types of deposits or provide only partial insurance by insuring up to a certain level. Nevertheless, given the bailout practices of deposit insurance funds around the world, a valid argument can be made that de facto insurance extends to all liabilities of an insured bank. Moreover, some countries have explicitly covered bank debt other than deposits.

I assume that the next audit of the bank will take place in one year and that the maturity of the debt also equals one year. I thus model deposit insurance as a limited-term contract. Because the government is likely to give the bank some forbearance after it finds out that the bank is undercapitalized, modeling deposit insurance as a one-year contract seems restrictive. Moreover, Pennacchi (1987) has shown that the assumption of a limited-term contract can lead to underestimates of the cost of insurance. However, because the level of regulatory control is unknown ex ante, I prefer to model deposit insurance as a limited-term contract, acknowledging that the cost of deposit insurance might be underestimated. As long as a possible underestimation is similar across banks, the method remains valid

for comparative purposes. Moreover, it is likely that regulatory control is weaker in countries with weak banks, so that the cost of deposit insurance would be underestimated for the riskiest banks. Any comparative results found using a limited-term contract would thus probably have been even stronger had deposit insurance been modeled in a multiperiod environment. (For models that allow for unlimited-term contracts, see Pennacchi 1987 and Hovakimian and Kane 2000.)

I estimate annual equity volatility by using a sample of daily equity returns and following Fama (1965), who suggested ignoring days on which the exchange is closed. Observations are also excluded for days on which it is announced that the bank will be restructured, merged, or closed down, because such announcements tend to lead to large jumps in share prices, which have a distortionary effect on the estimated volatility of equity returns. These corrections imply that $\sigma_E = \sqrt{n\sigma_{E,n}}$ is used as the estimate of annualized equity volatility to compute the Ronn and Verma (1986) deposit insurance estimates, where n is the actual number of trading days per year minus the trading days on which large jumps occurred, and $\sigma_{E,n}$ is the bank's daily equity volatility based on n daily equity returns. In most countries n is around 252 days. In estimating the Duan (1994, 2000) deposit insurance premiums, I correct for missing data by accommodating the log-likelihood function in equation (6) accordingly. This correction was used by Duan and Yu (1994).

III. Data

The selection of economies and banks for the sample was based on several criteria. I wanted to focus on banks in emerging market economies, because these banks are thought to be riskiest and because they tend to have more diverse ownership structures. As a control group, I also wanted to include a number of highly developed economies, whose banks were expected to provide a benchmark for a low level of risk taking. Within each economy I had to restrict the sample to exchange-listed banks because I needed data on bank market capitalization and dividend yields.

Because the put option approach to valuing deposit insurance assumes that stock markets are efficient, the sample is limited to economies that have relatively large and liquid stock markets. The International Finance Corporation classifies 14 economies as emerging markets in which the total market capitalization of listed companies exceeded US$50 billion and the monthly turnover ratio 2 percent in mid-1999. The sample is also limited by excluding countries with heavily regulated financial sectors. To this end, the financial liberalization dates in Williamson and Mahar (1998) were used to exclude countries that had not started to liberalize their financial sectors before 1990.[2] The remaining sample of emerging market economies numbers 12. As a result of banking data limitations, related mostly to a lack of data on the ownership structure of banks, an-

2. This criterion excludes China and India.

other five countries were excluded.[3] The final sample of emerging market economies numbers seven: Argentina, Chile, Indonesia, the Republic of Korea, Malaysia, Taiwan (China), and Thailand.

This sample includes the four East Asian countries that experienced banking crises in 1997–98: Indonesia, Korea, Malaysia, and Thailand. In addition to Taiwan (China), several other Asian economies were included in the sample to examine whether implicit deposit insurance costs differ between economies that have been heavily affected by the 1997 East Asian financial crisis and those that have not been. These are Hong Kong (China), Japan, and Singapore, the only three economies in Asia considered to be developed. To assess the effects of the crisis, data are needed for the crisis years 1997–98 as well as for some years before the crisis. As a benchmark group for a low level of risk taking, the sample includes the four largest Western economies: France, Germany, the United Kingdom, and the United States.

Thus the final data set includes listed banks from 14 economies: 2 Latin American countries, the 4 East Asian crisis countries, 4 other economies in East Asia, and the 4 major Western economies. Across these 14 economies data were collected on 144 listed banks during the period 1991–98. The banks in the sample include most major listed banks in each economy.[4]

To limit the number of listed banks in Japan, the sample includes only the long-term credit banks (3), the city banks (9), and the trust banks (7) and thus excludes the mostly smaller regional banks (127). To limit the number of listed banks in the United States, the sample includes only the 22 largest U.S. banks: the multinational banks (6) and the super-regional banks (16) as defined by Goldman Sachs (2000).

Data on daily stock market capitalization and annualized dividend yields were collected from Datastream. The data range from 1991 to 1998 and thus include the East Asian crisis years 1997–98. Total deposits at year-end, net loans at year-end, and ownership data were taken from BankScope. For missing observations, Bloomberg was consulted. Ownership data were collected as follows. Four forms of concentrated ownership were distinguished: state-owned (the state, treasury, military, or another government institution owns shares in the bank), family-owned (a family or individual owns shares in the bank), company-owned (a manufacturing company owns shares in the bank), and owned by another financial institution (another financial institution owns shares in the bank). Banks with no concentrated owners (dispersed ownership) are classified as widely held. A number of ownership dummy variables were defined that are related to this classification of ownership and based on different thresholds of shareholdings. The threshold for a majority shareholding is 50 percent of shares and that for a major shareholding

3. These data limitations exclude Brazil, Greece, Israel, Mexico, and South Africa.

4. The distribution of banks across economies is as follows: Argentina (5), Chile (2), France (4), Germany (8), Hong Kong (China) (12), Indonesia (8), Japan (19), Korea (22), Malaysia (10), Singapore (5), Taiwan (China) (8), Thailand (12), the United Kingdom (7), and the United States (22).

is 20 percent. The BankScope data set is also used to construct a dummy variable that indicates whether the bank is affiliated with a business group or not. A bank is classified as group affiliated if it is either a subsidiary of a diversified business group or if more than 50 percent of its shares are held by a nonfinancial company.

For the 144 banks, 950 observations were collected, spanning eight years. Data are missing for 202 observations. These data are missing for several reasons. Some banks did not report accounting data for each year, some were listed on the exchange during only part of the sample period, and some were delisted during the sample period because of government intervention or merger activity.[5] Missing observations for 1998 are due largely to bank restructuring that took place after the East Asian financial crisis of 1997.

Country-specific data were also collected. Gross domestic product (GDP) per capita and inflation rates were taken from the International Monetary Fund's International Financial Statistics database. As a proxy for the quality and enforcement of a country's legal system, figures were taken from the law and order index of the *International Country Risk Guide,* published by the PRS Group. The law and order index ranges from 0 to 6, with higher values indicating higher quality (less risk). Law and order are assessed separately, with the value for each ranging from 0 to 3. The law subcomponent is an assessment of the strength and impartiality of the legal system, and the order subcomponent is an assessment of popular observance of the law. Data on bank concentration and foreign bank penetration were taken from the World Bank's Financial Structure Database. Finally, data were taken from Demirgüç-Kunt and Huizinga (1999) and Demirgüç-Kunt and Sobaci (2000) on the features of economies' deposit insurance schemes, particularly on whether insurance is implicit or explicit and on the size of the officially charged, explicit insurance premiums (table 1).

5. In Indonesia Bank Tiara Asia, a private foreign exchange bank, was taken over in 1998 by the Indonesian Bank Restructuring Agency and is therefore missing for 1998. Although Indonesian Bank Danamon merged with state-owned bank PDCFI in 1998, both banks continued reporting separately for another year, so Bank Danamon's 1998 data could be included. In Japan two long-term credit banks have been delisted—Long Term Credit Bank (October 26, 1998) and Nippon Credit Bank (December 14, 1998)—and nationalized. Because both banks reported 1998 deposit data, 1998 data for these two banks could be included as well. For Korea, Commercial Bank of Korea and Korea Long Term Credit Bank were excluded because they were not listed, and Donghwa Bank was excluded because it began operation only in 1996. The sample of Korean banks changes in 1998 because of merger activity. Commercial Bank of Korea and Hanil Bank merged in 1998, creating a new bank called Hanvit Bank, and on September 8, 1998, Hana Bank announced a merger with Boram Bank (to become effective in 1999). Korea First Bank was sold to New Bridge Capital (United States) as of December 30, 1998, although trading was not suspended until June 25, 1999; Kookmin Bank announced a merger with Korea Long Term Credit Bank on August 25, 1998. Accounting data for Seoul Bank continued to be reported until 1998, although the bank was nationalized in 1998 and subsequently sold to HSBC Bank on February 22, 1999. In Malaysia Kwong Yik Bank was acquired by RHB Capital and officially delisted on August 26, 1997, so it was not included. In Thailand lack of data required the exclusion of Laem Thong Bank, Nakornthon Bank, and Union Bank of Bangkok. In addition, for 1998 data are missing for Bangkok Bank of Commerce, which was closed and delisted that year, and for First Bangkok City Bank, which was acquired by the government in February 1998 and merged with state-owned Krung Thai Bank in 1999.

TABLE 1. Features of the Deposit Insurance Schemes in the Sample Economies

Economy	Type of scheme	Year established	Insurance premium (percentage of insured deposits)
Argentina	Explicit	1979	0.36–0.72 (risk based)
Chile	Explicit	1986	Callable
France	Explicit	1980	Callable, but limited
Germany	Explicit	1966	0.03, but can be doubled
Hong Kong (China)	Implicit	NA	NA
Indonesia	Implicit	NA	NA
Japan	Explicit	1971	0.04
Korea, Rep. of	Explicit	1996	0.05
Malaysia	Implicit	NA	NA
Singapore	Implicit	NA	NA
Taiwan (China)	Explicit	1985	0.015
Thailand	Implicit	NA	NA
United Kingdom	Explicit	1982	On demand (with a maximum of 0.3 percent)
United States	Explicit	1934	0.00–0.27 (risk based)

NA: Not applicable.

Note: If an economy has an explicit deposit insurance scheme, the table reports the year in which it was established and the size of the annual insurance premium. Korea had implicit deposit insurance before 1996.

Source: Demirgüç-Kunt and Sobaci (2000).

IV. DEPOSIT INSURANCE ESTIMATES

I calculate the annual implicit costs of deposit insurance as one-year put options on the value of bank assets for the 144 banks for each year in 1991–98 using both the Ronn and Verma (1986) method and the Duan (1994, 2000) method (table 2, panel 1). (Throughout the rest of the article RV indicates estimates based on the Ronn and Verma method, and Duan indicates estimates based on the Duan method.) At first sight the estimates produced by the two methods seem to differ widely. In particular, the RV estimates seem to be higher on average than the Duan estimates. Nevertheless, the correlation between the estimates from the two methods is 57 percent,[6] and Spearman's rank correlation is 85 percent.[7] These results indicate that although the two methods produce estimates that differ in size, they produce similar rankings. In other words, the methods tend to identify similar groups of banks as the riskiest.

Because the distribution of both estimates is highly skewed to the right because of some large positive outliers, I also compare the estimates once they have been

6. The high correlation is confirmed in a simple OLS regression with the Ronn and Verma (1986) estimates as the dependent variable and the Duan (1994, 2000) estimates as the explanatory variable. In fact, a Wald test does not reject (at the 5 percent significance level) the hypothesis that the regression coefficient of this regression differs from one. These regression results should be interpreted with caution, however, because measurement error in the explanatory variable causes the OLS estimates to be statistically inconsistent.

7. Note that these figures suffer from measurement error in the deposit insurance estimates.

TABLE 2. Implicit Deposit Insurance Costs for the Sample Banks Estimated Using Two Methods, 1991–98
(basis points of total bank debt)

	Panel 1		Panel 2	
	RV	*Duan*	*RV**	*Duan**
Summary statistics				
Mean	35.13	19.36	1.14	1.03
Median	0.42	0.08	0.35	0.09
Maximum	4,721.06	1,431.95	8.46	7.27
Minimum	0.00	0.00	0.00	0.00
SD	206.13	85.66	1.64	1.58
Skewness	15.00	10.40	1.76	1.55
Correlation				
Correlation coefficient	0.57		0.80	
Rank correlation coefficient (Spearman's rho)	0.85		0.85	

Note: RV indicates the deposit insurance cost estimated by applying the Ronn and Verma (1986) method, and *Duan* the deposit insurance cost estimated by applying the Duan (1994, 2000) method. In panel 2 the estimates are transformed as follows: $RV^* = \ln(1 + RV)$ and $Duan^* = \ln(1 + Duan)$.

Source: Author's calculations.

transformed by the log operator. Because the estimated cost of deposit insurance is zero for some banks, I first add one to each estimate of the cost of deposit insurance before applying the log operator. After this rescaling of the estimates, the results of the two methods are more similar (table 2, panel 2). The correlation is around 80 percent, and the rank correlation around 85 percent.[8]

Despite strong rank correlation, the results of the comparison indicate some remaining variation between the two estimates. I therefore conclude that the RV method and the Duan method produce different estimates of the cost of deposit insurance. This result was found earlier by Duan and Yu (1994), although their assessment is restricted by the small number of banks in their study (10, compared with 144 in my analysis).

In the subsequent analysis I focus on the Duan estimates of the cost of deposit insurance, because they are theoretically and statistically superior. This means that all findings are based on these estimates. The Duan method has the added advantage of allowing estimation of the standard error of the deposit insurance cost estimates. For comparative purposes, I also report the RV estimates.

Estimates of the implicit cost of deposit insurance averaged by year show that for most economies in the sample the cost of deposit insurance increases over the period, from an average of 7 basis points in 1991 to 62 in 1998. More specifically, the average cost of deposit insurance is higher during the crisis period 1997–98 than during the precrisis years (table 3).

8. Again, it should be noted that these figures suffer from measurement error.

TABLE 3. Estimated Implicit Deposit Insurance Costs across Years, Economies, and Ownership Forms, 1991–98
(basis points of total bank debt)

Across years				Across economies				Across ownership forms			
Year	*RV*	*Duan*	No.	Economy	*RV*	*Duan*	No.	*Owner20*	*RV*	*Duan*	No.
1991	2.12	6.66	71	Argentina	31.36	17.81	25	*Company*	82.14	43.93	111
	(4.80)	(22.93)			(66.09)	(58.43)			(289.06)	(107.22)	
1992	4.68	3.40	88	Chile	0.02	0.00	8	*Family*	106.42	56.58	78
	(9.25)	(7.63)			(0.04)	(0.01)			(551.70)	(212.82)	
1993	1.03	2.70	116	France	2.37	7.72	29	*OtherFI*	54.67	23.02	79
	(3.15)	(18.24)			(4.98)	(12.93)			(149.55)	(55.57)	
1994	1.22	3.19	129	Germany	0.18	6.17	54	*State*	35.67	16.53	63
	(2.84)	(17.38)			(0.51)	(17.20)			(161.12)	(36.95)	
1995	5.75	5.47	136	Hong Kong	37.85	13.74	79	*Widely*	15.06	10.04	627
	(29.93)	(28.32)		(China)	(98.67)	(31.61)			(73.96)	(51.44)	
1996	0.79	4.04	138	Indonesia	154.37	83.99	55				
	(2.33)	(20.84)			(412.59)	(147.90)					
1997	35.30	53.20	143	Japan	12.43	13.91	149				
	(72.96)	(138.37)			(69.95)	(55.33)					
1998	206.20	61.88	129	Korea,	36.58	20.13	125				
	(522.44)	(163.04)		Rep. of	(89.12)	(88.60)					
				Malaysia	25.85	20.86	60				
					(81.91)	(45.67)					

Singapore	5.98	0.35	37
	(28.79)	(0.90)	
Taiwan	1.34	3.81	57
(China)	(2.22)	(10.41)	
Thailand	135.95	58.26	93
	(530.62)	(196.76)	
United	1.34	2.29	48
Kingdom	(3.56)	(7.15)	
United	0.40	0.63	131
States	(1.44)	(2.71)	
Average	35.13	19.36	950
	(206.13)	(85.66)	

Note: The cost of deposit insurance across years is averaged over all banks and across all economies. The cost for each economy is averaged over all banks in the economy and across all years. The cost across ownership forms is averaged over all banks in the ownership category and across all years. The variable *Owner20* is identical to "company" if a company owns more than 20 percent of the shares, "family" if a family owns more than 20 percent, "otherFI" if another financial institution owns more than 20 percent, "state" if a government institution owns more than 20 percent, and "widely" if no concentrated group owns more than 20 percent. Standard deviations of the costs of deposit insurance are in parentheses. No. refers to the number of observations in each category.

Source: Author's calculations.

Over the sample period the cost of deposit insurance (averaged across all banks in the economy and over all years) is highest for the four East Asian crisis countries: Indonesia (84 basis points), Thailand (58), Malaysia (21), and Korea (20). The cost is lowest for the four highly developed Western economies—the United States (0.6), the United Kingdom (2.3), Germany (6.2), and France (7.7)—as well as for highly developed Singapore (0.4) and for Chile (0.0) and Taiwan (China) (3.8). In Taiwan (China) the financial system is predominantly state-owned and banking is heavily regulated, which might explain the result suggesting that Taiwanese banks take low risks. The low estimate for Chile may not accurately reflect the riskiness of the average Chilean bank, because the sample includes only two Chilean banks. The implicit deposit insurance premiums calculated for banks in Hong Kong (China) (14 basis points), Japan (14), and Argentina (18) are somewhere in the middle.

The estimates of deposit insurance cost indicate that risk taking also differs across forms of ownership. The cost estimates (averaged over all banks in the economy and over all years) are as follows: family (57 basis points), company (44), other financial institution (23), state (17), and widely held (10). These figures indicate that concentrated ownership links between banks and other parties, such as in the Japanese *keiretsu* or the Korean *chaebol*, increase risk taking by banks and that dispersed ownership of banks is to be preferred. State ownership has an intermediate impact on a bank's risk taking. Note that not all economies have banks in all five ownership categories. In Western countries, for example, most banks are widely held. On the other extreme, in Indonesia most banks have concentrated ownership, with 32 percent of Indonesian banks in the sample having an owner that holds at least 20 percent of shares.

Group affiliation also increases the cost of deposit insurance. For the 35 banks in the sample that are affiliated with a business group, the cost averages 45 basis points, whereas the cost for the nonaffiliated banks averages 18 basis points.

V. Empirical Analysis

In the previous section I quickly interpreted the summary statistics of the calculated implicit costs of deposit insurance. Although these summary statistics show some clear patterns, in this section I conduct a more accurate analysis of the differences in the cost of deposit insurance across economies, periods, and ownership forms using econometric techniques to control for bank-specific effects. I transform the variables with the log operator and estimate a log-linear model. Because the cost of deposit insurance is estimated to be zero for some banks, I use $\ln(1 + Cost)$ as the dependent variable, rather than $\ln(Cost)$, where *Cost* is the implicit cost of deposit insurance in basis points of total debt, calculated using either the RV method or the Duan method. With the transformed estimate of the implicit cost of deposit insurance as the dependent variable, I

estimate a series of ordinary least squares (OLS) regression models. Although the costs of deposit insurance are estimates, measurement error in the dependent variable can be absorbed in the disturbance of the regression and ignored. The results are presented with White's (1980) heteroskedasticity-consistent standard errors.

Ownership, Size, and Credit Growth

First I regress the cost of deposit insurance on dummy variables for dispersed ownership, country, and year. The dispersed ownership dummy variable takes the value one if no shareholder owns more than 5 percent of the shares in the bank, and zero otherwise. The country dummy variables control for differences in institutional environments across economies. The United States and the year 1991 are used as benchmark variables to prevent multicolinearity.

The results show that the cost of deposit insurance in 1991–98 is higher on average for banks in Argentina, France, Germany, Hong Kong (China), Indonesia, Japan, the Republic of Korea, Malaysia, Taiwan (China), Thailand, and the United Kingdom than for banks in Chile, Singapore, and the United States (table 4, model [a]). Notably, the cost of deposit insurance is relatively high for banks in the financial crisis countries. In the sample period the cost is highest for Indonesian banks—around 7.7 basis points higher than for U.S. banks.[9] For Thai, Korean, and Malaysian banks the cost is 3.4, 1.9, and 1.5 basis points higher than for U.S. banks.

The cost of deposit insurance is relatively high in 1997 and 1998—5.0 and 5.5 basis points, respectively, higher than in 1991. This result is expected because 1997 and 1998 are the East Asian crisis years. Controlling for country and time effects, I find that the cost of deposit insurance for widely held banks is 0.2 basis points lower than for banks with concentrated ownership. I find similar results if I use a dispersed ownership dummy variable that takes the value one if no shareholder owns more than 20 percent of the shares in the bank rather than a dummy variable using 5 percent as the cutoff.

To control for bank-specific size effects, I add the amount of net loans outstanding at the end of the year as a variable to the previous model. The results are similar (table 4, model [b]). Again, the cost of deposit insurance for widely held banks is 0.2 basis points lower than for banks with concentrated ownership. In addition, the cost is higher for small banks, with bank size measured by total net loans outstanding. The size effect is only marginal, however. For example, all other things equal, a 10 percent increase in loans would lead to a 1.2 percent decrease in the cost of deposit insurance. A possible explanation for this

9. The effect on the cost of deposit insurance is calculated as $\exp(\beta) - 1$, where β is the coefficient of the respective dummy variable. The effect is an average effect for the sampled banks in the economy over the sample period.

TABLE 4. Deposit Insurance Cost and Dispersed Ownership

	(a)		(b)		(c)		(d)	
Variable	*RV*	*Duan*	*RV*	*Duan*	*RV*	*Duan*	*RV*	*Duan*
Constant	–0.342**	–0.134	2.378***	1.875***	1.820***	1.535***	0.105	–0.071
	(0.164)	(0.196)	(0.553)	(0.657)	(0.417)	(0.584)	(0.103)	(0.163)
Argentina	1.505***	0.864**	0.981**	0.475	1.850***	1.044***	1.811***	0.020
	(0.434)	(0.340)	(0.442)	(0.384)	(0.467)	(0.423)	(0.649)	(0.285)
Chile	–0.269	–0.408	–0.652*	–0.692**	–0.286	–0.465***	–0.136	–0.563***
	(0.388)	(0.355)	(0.388)	(0.355)	(0.107)	(0.133)	(0.086)	(0.131)
France	0.455***	0.866***	0.584***	0.959***	0.127	0.771**	–0.003	0.885**
	(0.134)	(0.310)	(0.141)	(0.318)	(0.091)	(0.319)	(0.065)	(0.352)
Germany	0.082	0.451**	0.192	0.530**	–0.102	0.148	–0.133**	0.219
	(0.140)	(0.216)	(0.150)	(0.222)	(0.063)	(0.193)	(0.056)	(0.204)
Hong Kong	1.052***	0.725***	0.743***	0.492***	–0.080	–0.217	0.083	–0.220
(China)	(0.171)	(0.175)	(0.177)	(0.181)	(0.083)	(0.145)	(0.068)	(0.147)
Indonesia	2.336***	2.160***	1.838***	1.792***	1.001***	0.762***	1.222***	0.591**
	(0.217)	(0.253)	(0.232)	(0.269)	(0.198)	(0.249)	(0.199)	(0.259)
Japan	0.984***	1.012***	1.223***	1.186***	0.461***	0.237**	0.439***	0.313***
	(0.108)	(0.122)	(0.119)	(0.141)	(0.072)	(0.118)	(0.068)	(0.098)
Korea,	1.677***	1.063***	1.390***	0.855***	0.505***	0.018	0.669***	0.103
Rep. of	(0.120)	(0.130)	(0.130)	(0.147)	(0.076)	(0.106)	(0.073)	(0.122)
Malaysia	1.060***	0.917***	0.628***	0.576***	0.042	–0.336**	0.151	–0.278
	(0.168)	(0.193)	(0.188)	(0.216)	(0.139)	(0.147)	(0.138)	(0.171)
Singapore	0.203	–0.084	–0.047	–0.272*	–0.365***	–0.512***	–0.231***	–0.478***
	(0.153)	(0.159)	(0.161)	(0.165)	(0.076)	(0.102)	(0.071)	(0.120)
Taiwan	0.363*	0.482**	0.192	0.353*	0.358***	0.245	0.283***	–0.074
(China)	(0.201)	(0.197)	(0.204)	(0.198)	(0.122)	(0.172)	(0.106)	(0.119)
Thailand	1.878***	1.477***	1.648***	1.303***	0.576***	0.169	0.617***	0.188
	(0.183)	(0.197)	(0.184)	(0.198)	(0.106)	(0.167)	(0.110)	(0.192)
United	0.309**	0.240	0.465***	0.354**	0.155**	–0.003	0.074	0.047
Kingdom	(0.131)	(0.173)	(0.132)	(0.177)	(0.067)	(0.149)	(0.064)	(0.157)

1992	0.440***	0.094	0.444***	0.101	0.450***	0.101	0.584***	0.759***
	(0.141)	(0.182)	(0.144)	(0.186)	(0.127)	(0.170)	(0.126)	(0.173)
1993	–0.065	–0.311*	–0.049	–0.300*	–0.158	–0.423***	–0.019	0.190
	(0.133)	(0.169)	(0.133)	(0.170)	(0.104)	(0.155)	(0.103)	(0.155)
1994	–0.015	–0.039	0.023	–0.011	–0.105	0.159	0.018	0.447***
	(0.129)	(0.165)	(0.129)	(0.167)	(0.101)	(0.152)	(0.102)	(0.154)
1995	0.057	–0.086	0.106	–0.050	–0.035	–0.206	0.108	0.418***
	(0.131)	(0.168)	(0.131)	(0.171)	(0.101)	(0.154)	(0.097)	(0.153)
1996	–0.197	–0.117	–0.121	–0.061	–0.283***	–0.237	–0.136	0.455***
	(0.121)	(0.167)	(0.123)	(0.170)	(0.098)	(0.160)	(0.926)	(0.169)
1997	1.538***	1.786***	1.587***	1.814***	—	—	—	—
	(0.157)	(0.197)	(0.158)	(0.199)				
1998	2.734***	1.869***	2.796***	1.915***	—	—	—	—
	(0.188)	(0.196)	(0.190)	(0.198)				
Widely5	–0.182**	–0.203**	–0.159**	–0.189**	–0.128***	–0.284***	–0.128***	–0.297***
	(0.082)	(0.096)	(0.081)	(0.097)	(0.051)	(0.087)	(0.053)	(0.092)
Loan	—	—	–0.161***	–0.118***	–0.089***	–0.051	—	—
			(0.031)	(0.038)	(0.024)	(0.035)		
Loan growth	—	—	—	—	—	—	0.275	0.715**
							(0.207)	(0.341)
Adjusted R^2	0.583	0.431	0.593	0.593	0.410	0.151	0.375	0.122
Observations	950	950	944	944	673	673	569	569

— Not available.
*Significant at the 10 percent level.
**Significant at the 5 percent level.
***Significant at the 1 percent level.

Note: The dependent variable is ln(1 + *Insurance*), where *Insurance* is the cost of deposit insurance in basis points of total debt calculated using either the RV method or the Duan method. *Widely5* is a dummy variable that takes the value one if no shareholder owns more than 5 percent of the shares in the bank, and zero otherwise. *Loan* is ln(*Loan*), where *Loan* is the amount of net loans outstanding at year-end in thousands of U.S. dollars. *Loan growth* is ln(1 + *Dloan*), where *Dloan* is the growth of net loans during the year. The United States provides the benchmark for the country effects, and 1991 the benchmark for the year effects. In addition to country and year effects, model (a) controls only for dispersed ownership. Model (b) adds net loans to control for the size effect. Models (c) and (d) are estimated using 1991–96 data only. Model (c) controls for loan size, and model (d) for credit growth. Heteroskedasticity-consistent standard errors are in parentheses.

Source: Author's calculations.

finding is that the fierce competition many small banks face from large banks may lead the smaller banks to take on more risk.

To check robustness, I repeat the previous analysis while excluding the crisis years 1997–98 (table 4, model [c]). Again, the cost of deposit insurance for widely held banks is significantly lower, this time by about 0.3 basis points. However, the small size effect that I found for the entire sample period is not significant for the period 1991–96.

Because banks often take risks in the form of excessive credit growth, I also estimate a model that controls for loan growth. If the cost of deposit insurance correctly indicates a bank's risk taking, there should be a strong correlation between credit growth and the cost of deposit insurance. The results show that the cost of deposit insurance is larger for banks with high loan growth (table 4, model [d]). For example, all other things equal, a 10 percent increase in credit growth leads on average to a 7.2 percent increase in the cost of deposit insurance. Excessive credit growth has been cited by many as a major factor in the banking crisis that unfolded in East Asia during 1997. This finding is therefore unsurprising, because the sample includes a large number of East Asian banks, some of which we now know took excessive risks.

We have already seen that concentrated ownership leads to a higher cost of deposit insurance. To find out whether the cost of deposit insurance differs across categories of concentrated ownership, I regress the cost on the different categories. I include the ownership dummy variables with absolute majority shareholdings (that is, larger than 50 percent) and the ownership variables with major shareholdings (20–50 percent). For the entire sample period (1991–98) the cost of deposit insurance is higher for banks with majority shareholdings by companies (around 0.9 basis points higher than for banks without concentrated ownership) and other financial institutions (around 0.7 basis points higher; table 5, model [a]). In addition, there is weak evidence that the cost of deposit insurance is higher for banks that are majority owned by the state. Although the effect is statistically significant only at the 11 percent level, the estimated difference (0.8 basis points) is substantial. These banks might have greater access to the safety net not only because they are riskier but also because they have better connections.

When the amount of net loans outstanding is added to the model specification to control for bank-specific size effects, the higher cost of deposit insurance for majority state-owned banks becomes statistically significant. The cost is now 0.9 basis points higher than for widely held banks, even higher than for banks with majority shareholdings by companies and other financial institutions (table 5, model [b]). For these banks the cost of deposit insurance is 0.8 and 0.6 basis points higher than for widely held banks. In addition, the cost of deposit insurance for small banks is slightly higher than for large banks.

For a robustness check, I also exclude the crisis years. The results for 1991–96 again show that majority shareholdings by companies increase risk (table 5, model [c]). But majority shareholdings by other financial institutions or the state no longer increase risk, nor are small banks riskier. Instead, the results show that

TABLE 5. Deposit Insurance Cost and Majority Ownership

	(a)		(b)		(c)	
Variable	*RV*	*Duan*	*RV*	*Duan*	*RV*	*Duan*
State20	0.249	0.164	0.239	0.155	0.234	0.041
	(0.241)	(0.237)	(0.244)	(0.242)	(0.161)	(0.203)
State50	–0.109	0.834	0.001	0.920*	–0.011	1.041
	(0.320)	(0.520)	(0.322)	(0.522)	(0.164)	(0.673)
OtherFI20	0.275	0.059	0.249	0.044	0.182	–0.029
	(0.180)	(0.191)	(0.182)	(0.190)	(0.183)	(0.176)
OtherFI50	0.855***	0.687***	0.752***	0.579**	0.306*	0.241
	(0.265)	(0.254)	(0.267)	(0.254)	(0.175)	(0.195)
Family20	–0.234	0.222	–0.272	0.190	0.070	0.512**
	(0.241)	(0.270)	(0.239)	(0.270)	(0.161)	(0.245)
Family50	0.292	0.254	0.148	0.131	0.319	0.309
	(0.442)	(0.410)	(0.445)	(0.402)	(0.378)	(0.391)
Company20	0.068	0.003	0.058	0.004	–0.111	0.089
	(0.175)	(0.199)	(0.174)	(0.198)	(0.162)	(0.163)
Company50	0.923***	0.898***	0.775***	0.778**	0.568***	0.789**
	(0.263)	(0.317)	(0.264)	(0.319)	(0.220)	(0.395)
Loan	—	—	–0.148***	–0.117***	–0.076***	–0.048
			(0.032)	(0.038)	(0.025)	(0.034)
Adjusted R^2	0.593	0.645	0.600	0.440	0.418	0.159
Observations	950	950	944	944	673	673

— Not available.
*Significant at the 10 percent level.
**Significant at the 5 percent level.
***Significant at the 1 percent level.

Note: The dependent variable is ln(1 + *Insurance*), where *Insurance* is the cost of deposit insurance in basis points of total debt calculated using either the RV method or the Duan method. *Loan* is the log of net loans outstanding at year-end. *State20* is a dummy variable that takes the value one if the state owns 20–50 percent of the shares in the bank; *state50* indicates 50–100 percent state ownership. *Family20* is a dummy variable that takes the value one if a family owns 20–50 percent; *family50* indicates 50–100 percent family ownership. *OtherFI20* is a dummy variable that takes the value one if another financial institution owns 20–50 percent; *otherFI50* indicates 50–100 percent ownership by another financial institution. *Company20* is a dummy variable that takes the value one if a company owns 20–50 percent; *company50* indicates 50–100 percent company ownership. For models (a–d) a constant term and country and year dummy variables were added but are not reported. The United States provides the benchmark for the country effects, and 1991 the benchmark for the year effects. In addition to country and year effects, model (a) controls only for majority ownership effects. Model (b) includes net loans to control for size effects. Model (c) is identical to model b but is estimated for 1991–96 only. Heteroskedasticity-consistent standard errors are in parentheses.

Source: Author's calculations.

major shareholdings by families[10] or individuals increase risk, although to a smaller extent than for companies.

I also compare the cost of deposit insurance for banks affiliated with a business group with the cost for other banks. Because banks affiliated with a busi-

10. Family ownership of firms is common in emerging market economies, particularly in East Asia. Claessens, Djankov, and Lang (2000) show that there is extensive family control in more than half of East Asian corporations and that managers of closely held firms tend to be relatives of the controlling shareholder's family.

ness group might be prepared to support a group member facing financial distress, the cost of deposit insurance for such banks could be expected to be higher than the cost for nonaffiliated banks. I classify a bank as group affiliated if the bank is a subsidiary of a diversified business group or if a nonfinancial company holds more than 50 percent of its shares. I regress the cost of deposit insurance on loan size and on a dummy variable that takes the value one if the bank is group affiliated and zero otherwise. I also include country and year dummy variables. I estimate this regression model both for the entire sample period and for the precrisis period 1991–96. For both periods the cost of deposit insurance is significantly higher for group-affiliated banks, suggesting that those banks might have supported some group members (table 6).

Country-Specific Factors

Thus far I have used country dummy variables to control for differences across economies. In this section I expand the model with country-specific variables. In a first specification I control for differences in two macroeconomic fundamentals: GDP per capita and the inflation rate. Banking systems can be expected to be less risky in economies with high GDP per capita and low inflation. I find that this is indeed the case for the sample when I regress the cost of deposit insurance on a constant, year dummy variables, a dispersed ownership dummy variable, net loans outstanding, GDP per capita, and inflation (table 7, model [a]). The findings are of economic importance. A 10 percent increase in GDP per capita

TABLE 6. Deposit Insurance Cost and Group Affiliation

	(a)		(b)		(c)	
Variable	*RV*	*Duan*	*RV*	*Duan*	*RV*	*Duan*
Group	0.622***	0.651**	0.512**	0.573*	0.476**	0.634*
	(0.251)	(0.301)	(0.251)	(0.301)	(0.214)	(0.387)
Loan	—	—	–0.153***	–0.110***	–0.082***	–0.043
			(0.032)	(0.038)	(0.024)	(0.034)
Adjusted R^2	0.586	0.434	0.594	0.437	0.415	0.151
Observations	950	950	944	944	673	673

— Not available.
*Significant at the 10 percent level.
**Significant at the 5 percent level.
***Significant at the 1 percent level.

Note: The dependent variable is ln(1 + *Insurance*), where *Insurance* is the cost of deposit insurance in basis points of total debt calculated using either the RV method or the Duan method. *Group* is a dummy variable that takes the value one if the bank is affiliated with a group, and zero otherwise. A bank is classified as group affiliated if it is a subsidiary of a diversified business group or if a nonfinancial company holds more than 50 percent of its shares. *Loan* is the logarithm of net loans outstanding at year-end. For each model a constant term and country and year dummy variables were added but are not reported. The United States provides the benchmark for the country effects, and 1991 the benchmark for the year effects. Models (b) and (c) include net loans to control for size effects. Models (a) and (b) are estimated for the full sample period, and model (c) for the precrisis years 1991–96 only. Heteroskedasticity-consistent standard errors are in parentheses.

Source: Author's calculations.

TABLE 7. Deposit Insurance Cost and Macroeconomic and Institutional Variables

	(a)		(b)		(c)	
Variable	*RV*	*Duan*	*RV*	*Duan*	*RV*	*Duan*
State20	0.249	0.164	0.239	0.155	0.234	0.041
Widely5	–0.143*	–0.238***	–0.246***	–0.334***	–0.300***	–0.456***
	(0.078)	(0.091)	(0.078)	(0.089)	(0.084)	(0.117)
Loan	–0.028	0.060*	–0.100***	–0.008	–0.121***	–0.048
	(0.028)	(0.032)	(0.025)	(0.030)	(0.033)	(0.045)
GDP *per capita*	–0.352***	–0.319***	—	—	—	—
	(0.051)	(0.058)				
Inflation	0.410***	0.368***	—	—	0.223***	0.389***
	(0.082)	(0.081)			(0.085)	(0.096)
Law and order	—	—	–2.315***	–2.034***	–1.371***	–1.423***
			(0.366)	(0.368)	(0.445)	(0.556)
Explicit	—	—	—	—	–0.230	–0.002
					(0.157)	(0.177)
Concentration	—	—	—	—	–0.247**	–0.076
					(0.102)	(0.145)
Foreign	—	—	—	—	–0.174***	–0.214***
					(0.041)	(0.052)
Adjusted R^2	0.525	0.389	0.492	0.359	0.349	0.285
Observations	944	944	944	944	688	688

— Not available.
*Significant at the 10 percent level.
**Significant at the 5 percent level.
***Significant at the 1 percent level.

Note: The dependent variable is ln(1 + *Insurance*), where *Insurance* is the cost of deposit insurance in basis points of total debt calculated using either the RV method or the Duan method. *Widely5* is a dummy variable that takes the value one if no shareholder owns more than 5 percent of the shares in the bank, and zero otherwise. *Loan* is the log of the amount of net loans outstanding at year-end. GDP *per capita* is the logarithm of GDP per capita in U.S. dollars. *Inflation* is ln(1 + *Infl*), where *Infl* is the inflation rate in percentage points based on the economy's consumer price index. *Law and order* is the logarithm of the law and order index of the PRS Group, which ranges from 0 to 6 (with 6 indicating an excellent system of law and order). *Explicit* is a dummy variable that takes the value one if the economy has explicit deposit insurance, and zero otherwise. C*oncentration* is the log of the ratio of the three largest banks' assets to total banking assets. *Foreign* is the logarithm of the share of foreign bank assets in total banking sector assets. A constant term and year dummy variables were added but not reported. The year 1991 provides the benchmark for the year effects. In addition to year effects, model (a) controls for dispersed ownership, loan size, GDP per capita, and inflation effects. Model (b) controls for dispersed ownership, loan size, and quality of legal system effects. Model (c) controls for dispersed ownership, loan size, the quality of the legal system, the existence of explicit deposit insurance, the concentration ratio, and foreign entry. Model c uses data for 1991–97, because no competition data are available for 1998. Heteroskedasticity-consistent standard errors are in parentheses.

Source: Author's calculations.

leads to a reduction in the cost of deposit insurance of around 3 percent, and a 10 percent decrease in the inflation rate causes a reduction of around 4 percent. In addition, I again find that widely held banks are less risky. However, contrary to the earlier finding, large banks now take on slightly more risk than smaller banks. But this result is not significant at the 5 percent level.

In a second specification I control for differences across economies in the quality and enforcement of laws. Banking systems in economies with poor legal systems are expected to be riskier. This is indeed the case for the sample when the cost of deposit insurance is regressed on a constant, year dummy variables, a dispersed ownership dummy variable, net loans outstanding, and a law and order index (table 7, model [b]). The relationship between the law and order index and the cost of deposit insurance has economic importance. For example, other things equal, an improvement in the law and order index from 3 to 4, or an increase of 25 percent in the rescaled index, is estimated to cause a reduction in the cost of deposit insurance of around 50 percent. Widely held banks are again found to be less risky. This time there is no loan size effect.

In a third specification I add a variable indicating whether the economy has an explicit deposit insurance scheme or not, a variable measuring the concentration of the banking market, and a variable measuring penetration by foreign banks. This specification looks at the combined effect of the macroeconomic environment, the quality of the legal system, the type of deposit insurance scheme, and the market structure of the banking sector on the cost of deposit insurance. To indicate the type of deposit insurance, I use a dummy variable that takes the value one if the economy has an explicit deposit insurance scheme and the value zero if it has an implicit scheme. Nine of the 14 sample economies have an explicit deposit insurance scheme; the other 5 have implicit schemes. I measure the concentration of the banking market by the share of the three largest banks' assets in total banking sector assets, and the penetration of foreign banks by the share of foreign bank assets in total banking sector assets. Because the measure of the quality of the legal system—the law and order index—is highly correlated with GDP per capita (with a correlation of 0.80), I include only the inflation rate to control for the macroeconomic environment. I also add a constant, year dummy variables, a dispersed ownership dummy variable, and net loans outstanding to the model.

The results show that the cost of deposit insurance is lower in economies with low inflation rates and sound quality and enforcement of laws (table 7, model [c]). In addition, foreign bank penetration reduces the cost of deposit insurance. The estimated regression coefficients show that a 10 percent increase in the presence of foreign banks would reduce the cost of deposit insurance by 2 percent. But neither the degree of bank concentration nor the type of deposit insurance scheme has an impact on the cost of deposit insurance. Widely held banks are again found to be less risky.

The economies with explicit insurance are the most highly developed ones in the sample, and the correlation between the explicit dummy variable and the

law and order index is 0.51. Any difference between the impact of explicit insurance and that of a good institutional environment on the cost of deposit insurance should therefore be interpreted with caution. The findings do suggest, however, that it is not the type of deposit insurance scheme that matters for the cost of deposit insurance—and for the riskiness of a banking system—but the overall quality and enforcement of rules. This finding does not necessarily contradict Demirgüç-Kunt and Detragiache (1999), who provide empirical evidence showing that explicit deposit insurance increases banking system vulnerability in countries with weak institutional environments.

In addition to moral hazard, explicit deposit insurance schemes can lead to fiscal problems if the premiums charged to the banks are underpriced. I therefore investigate whether the economies in the sample with explicit schemes underprice deposit insurance by setting premiums too low. The official deposit insurance premiums in the sample economies range from 0.0 percent to 0.72 percent of insured deposits (table 8).

In two countries with explicit deposit insurance schemes, Japan and Korea, the premiums actually charged are substantially lower than the average implicit cost of deposit insurance over the period 1991–98. The differences between actual and fair premiums do not differ statistically from zero at any reasonable level of significance, however. So for the economies in the sample with explicit deposit insurance schemes, it cannot be concluded that the official premiums were inadequate, although some banks in the sample probably should have been charged higher premiums to reflect their risks.

TABLE 8. Risk-Adjusted and Official Deposit Insurance Premiums in Sample Economies with Explicit Schemes, 1991–98
(basis points of deposits)

Economy	Risk-adjusted premium (*RV*)	Risk-adjusted premium (*Duan*)	Official premium
Argentina	31.36	17.81	36.0–72.0 (risk based)
	(66.09)	(58.43)	
Germany	0.18	6.17	3.0
	(0.51)	(17.20)	
Japan	12.43	13.91	4.0
	(70.00)	(55.33)	
Korea, Rep. of	36.60	20.13	5.0
	(89.10)	(45.67)	
Taiwan (China)	1.34	3.81	1.5
	(2.22)	(10.41)	
United States	0.40	0.63	0.0–27.0 (risk based)
	(1.44)	(2.71)	

Note: Standard deviations are in parentheses. Note that Korea had implicit deposit insurance before 1996.

Source: For official premiums, Demirgüç-Kunt and Sobaci (2000).

Forecasting Bank Distress

If the cost of deposit insurance is indeed closely related to the risk taking of a bank, as I argue, this proxy for bank risk should have power in predicting bank distress. As a first assessment of the information embedded in the cost of deposit insurance as a proxy for bank risk, I compare the cost of deposit insurance for the sample banks in 1996 across economies to check whether this measure indicates which economies were at risk of a banking crisis. Only for Indonesia, Korea, and Thailand is the average cost of deposit insurance in 1996 significantly higher than zero in both economic and statistical terms. Along with Malaysia, these are the East Asian countries that experienced a banking crisis one year later. Thus the implicit cost of deposit insurance in 1996 correctly indicates banking problems in three of the four East Asian countries that experienced a banking crisis in 1997.

In this section I explore the ex ante power of deposit insurance cost estimates to forecast bank distress in more detail and at a bank level using information on actual bank distress. Governments intervened in banks across East Asia in 1998 (table 9). I analyze the link between intervention in banks and the cost of deposit insurance before 1998 for the sample of banks to assess the power of the method to forecast bank problems.

First I analyze whether the cost of deposit insurance is indeed higher for banks in which the government intervened. I regress the cost of deposit insurance in 1998 on the cost in 1997 and add a dummy variable indicating whether the bank was subject to intervention. As expected, the cost of deposit insurance is higher for banks subject to intervention (table 10). With the difference equal to 91 basis points, the effect is economically significant. Interestingly, the implicit deposit insurance premium for banks not subject to intervention, as measured by the Duan method,

TABLE 9. Banks Subject to Intervention in Selected East Asian Economies, 1998

Economy	Banks
Indonesia	Bank Bali, Bank Danamon, Bank International Indonesia, Bank Lippo, Bank Niaga, Bank Tiara Asia
Japan	Long Term Credit Bank, Nippon Credit Bank
Korea, Rep. of	Cho Hung Bank, Chung Chong Bank, Dae Dong Bank, Dong Nam Bank, Hana Bank, Hanil Bank, Housing and Commercial Bank, Kookmin Bank, Koram Bank, Korea First Bank, Kyungki Bank, Seoul Bank, Shinhan Bank
Malaysia	AMMB Holdings, RHB Capital
Thailand	Bangkok Bank, Bangkok Bank of Commerce, Bangkok Metropolitan Bank, Bank of Asia, Bank of Ayudhya, DBS Thai Danu Bank, First Bangkok City Bank, Krung Thai Bank, Siam City Bank, Siam Commercial Bank, Union Bank of Bangkok, Thai Farmers Bank, Thai Military Bank

Note: Interventions include closure, recapitalization, nationalization, sale to foreigners, and domestic takeovers. The table includes only banks in the sample.

Source: Bongini, Claessens, and Ferri (2001) for Indonesia, Korea, Malaysia, and Thailand. Peek and Rosengren (2001), table 1, for Japan.

TABLE 10. Deposit Insurance Cost and Banks Subject to Intervention

Variable	*RV*	*Duan*
Constant	35.56**	–4.12
	(16.47)	(4.67)
Insurance 1997	1.44*	1.04***
	(0.87)	(0.17)
Intervention	572.82***	91.25***
	(165.27)	(42.08)
Adjusted R^2	0.282	0.393
Observations	128	122

*Significant at the 10 percent level.
**Significant at the 5 percent level.
***Significant at the 1 percent level.

Note: The dependent variable is the cost of deposit insurance in basis points of total debt calculated for 1998 using either the RV method or the Duan method. *Insurance 1997* is the cost of deposit insurance in basis points of total debt for 1997. *Intervention* is a dummy variable that takes the value one if the bank was subject to intervention in 1998, and zero otherwise. Interventions include closure, recapitalization, nationalization, sale to foreigners, and domestic takeovers. Both models are estimated using OLS. Country dummy variables were added but not reported. Heteroskedasticity-consistent standard errors are in parentheses.

Source: Author's calculations.

did not differ between 1998 and 1997. Although not reported in the table, the country effects for the banks subject to intervention are insignificant.

Banks with a high estimated cost of deposit insurance are expected to have a higher chance of failing, because they are thought to take higher risks. To assess the power of deposit insurance cost estimates to forecast bank failure, I estimate a model with a dummy variable taking the value one if the bank is subject to intervention in 1998 as the dependent variable and the cost of deposit insurance in 1996 or 1997 as the independent variable. In 1998 some East Asian governments intervened more heavily in their banking sectors than did others. In Thailand, for example, the government intervened in all banks, whereas the Malaysian government allowed banks to continue operating even though many were undercapitalized. To control for differences in the level of intervention, I add country dummy variables to the model. None is included for Thailand (because all Thai banks in the sample were subject to intervention) or for economies in which no banks were subject to intervention in 1998. I estimate the model using OLS and, because of the discrete nature of the dependent variable, also estimate both a probit and a logit model.

The results show that banks with a high cost of deposit insurance in 1996 or 1997 had a higher chance of failing or being subject to intervention in 1998 than did banks with a low cost of deposit insurance (table 11). In addition to Thai-

TABLE 11. Predicting Bank Distress

	(a)		(b)		(c)	
Variable	*RV*	*Duan*	*RV*	*Duan*	*RV*	*Duan*
Panel A						
Constant	0.089***	0.098***	–1.367***	–1.869***	–2.255	–3.229***
	(0.028)	(0.032)	(0.170)	(0.120)	(0.313)	(0.436)
Insurance	0.002**	0.0011***	0.005**	0.018***	0.009*	0.032***
	(0.001)	(0.0004)	(0.002)	(0.003)	(0.005)	(0.007)
Indonesia	0.551***	0.404	1.686***	–0.362	2.759***	–0.078
	(0.167)	(0.179)	(0.523)	(0.948)	(0.912)	(1.953)
Japan	–0.022	–0.037	–0.030	–0.341	–0.129	–0.625
	(0.078)	(0.077)	(0.421)	(0.458)	(0.811)	(0.893)
Korea, Rep. of	0.479***	0.488***	1.485***	1.552***	2.438***	2.692***
	(0.116)	(0.110)	(0.329)	(0.369)	(0.572)	(0.691)
Malaysia	0.113	0.041	0.523	–0.614	0.887	–1.102
	(0.139)	(0.131)	(0.484)	(0.489)	(0.832)	(0.879)
(Pseudo)-R^2	0.288	0.333	0.266	0.463	0.259	0.457
Observations	143	143	143	143	143	143
Panel B						
Constant	0.131***	0.117***	–1.153***	–1.226***	–1.900***	–2.052***
	(0.036)	(0.036	(0.161)	(0.176)	(0.298)	(0.326)
Insurance	0.039*	0.005***	0.174	0.024	0.298	0.042
	(0.021)	(0.001)	(0.111)	(0.016)	(0.249)	(0.040)
Indonesia	0.347	0.622***	0.867	1.853***	1.530	3.060***
	(0.252)	(0.158)	(0.736)	(0.505)	(1.306)	(0.862)
Japan	–0.027	–0.013	–0.103	–0.032	–0.247	–0.099
	(0.080)	(0.080)	(0.419)	(0.424)	(0.800)	(0.815)
Korea, Rep. of	0.368***	0.414***	1.065***	1.284***	1.753***	2.142***
	(0.134)	(0.122)	(0.371)	(0.345)	(0.642)	(0.576)
Malaysia	0.087	0.105	0.370	0.461	0.612	0.799
	(0.147)	(0.146)	(0.494)	(0.497)	(0.855)	(0.866)
(Pseudo)-R^2	0.199	0.233	0.194	0.222	0.190	0.219
Observations	138	138	138	138	138	138

*Significant at the 10 percent level.
**Significant at the 5 percent level.
***Significant at the 1 percent level.

Note: The dependent variable is a dummy variable that takes the value one if the bank was subject to intervention in 1998, and zero otherwise. Interventions include closure, recapitalization, nationalization, sale to foreigners, and domestic takeovers. *Insurance* is the cost of deposit insurance in basis points of total debt calculated using either the RV method or the Duan method. Country dummy variables have been added for Indonesia, Japan, Korea, and Malaysia. A probit model is estimated. The models in panel A use deposit insurance cost data for 1997 and intervention data for 1998; the models in panel B use deposit insurance cost data for 1996 and intervention data for 1998. Model (a) uses the OLS estimation method. Model (b) estimates a probit model. Model (c) estimates a logit model.

Source: Author's calculations.

land, Indonesia, and Korea also intervened more heavily in their banks than did other countries. These results support my claim that the cost of deposit insurance has some power in predicting the riskiness of banks and forecasting bank distress. The results based on the Duan method show that a one-basis-point increase in the cost of deposit insurance in 1997 raises the likelihood of intervention in 1998 by roughly 1.8 percent according to the probit model and by 3.2 percent according to the logit model.

VI. Conclusions

Arguing that a relatively high cost of deposit insurance indicates that a bank takes excessive risks, I use the cost of deposit insurance to assess the relationship between the risk taking behavior of banks and their governance structure. To do so, I estimate the cost of deposit insurance for a large number of banks in different economies, using RV and Duan techniques. The results show that the cost is highest for banks with concentrated private ownership, especially those predominantly owned by a single company or another financial institution, and, to a lesser extent, for state- or family-owned banks—indicating that these banks tend to take the greatest risks. In contrast, banks with dispersed ownership engage in a relatively low level of risk taking. The cost of deposit insurance also tends to be higher for banks that are affiliated with a business group, are small, have high credit growth, and are located in countries with low GDP per capita, high inflation, poor quality and enforcement of laws, or low penetration by foreign banks. Finally, I find that as a proxy for bank risk, the cost of deposit insurance has some power in predicting bank failures.

The findings support the view that existing government deposit insurance schemes create moral hazard for banks. They also suggest that these incentive problems differ in magnitude between different types of banks—in particular, between banks with different governance structures—and between different types of institutional environments. Banks characterized by concentrated private ownership and operating in an environment with weak institutions tend to take high risks. The ultimate goal should be a financial system in which banks have dispersed private ownership and both shareholders and depositors are protected by proper enforcement of prudent regulation.

Both the findings of the article and the method it proposes for measuring bank risk have importance for policymakers. First, the findings support the view of many policymakers that one of the keys to a sound financial system is dispersed private ownership of banks. Second, the findings indicate that dispersed private ownership of banks is even more important for the stability of financial systems where corporate governance systems, and institutional environments in general, are weak, as in many developing countries. Finally, the article shows that as a proxy for bank risk, the cost of deposit insurance could be a useful additional tool for identifying troubled financial institutions and, at an aggregate level, for providing early warning of banking crises.

References

Bhattacharya, S., and A. Thakor. 1993. "Contemporary Banking Theory." *Journal of Financial Intermediation* 3(1):2–50.

Bhattacharya, S., A. Boot, and A. Thakor. 1998. "The Economics of Bank Regulation." *Journal of Money, Credit, and Banking* 30(4):745–70.

Black, F., and M. Scholes. 1973. "The Pricing of Options and Corporate Liabilities." *Journal of Political Economy* 81(3):637–54.

Bongini, P., S. Claessens, and G. Ferri. 2001. "The Political Economy of Distress in East Asian Financial Institutions." *Journal of Financial Services Research* 19(10):5–25.

Chan, Y.-S., S. Greenbaum, and A. Thakor. 1992. "Is Fairly Priced Deposit Insurance Possible?" *Journal of Finance* 47(1):227–46.

Claessens, S., S. Djankov, and L. Lang. 2000. "The Separation of Ownership and Control in East Asian Corporations." *Journal of Financial Economics* 58(1–2):81–112.

Demirgüç-Kunt, A., and E. Detragiache. 1999. "Does Deposit Insurance Increase Banking System Stability? An Empirical Investigation." Policy Research Working Paper 2247, World Bank, Development Research Group, Washington, D.C.

Demirgüç-Kunt, A., and H. Huizinga. 1999. "Market Discipline and Financial Safety Net Design." Policy Research Working Paper 2183, World Bank, Development Research Group, Washington, D.C.

Demirgüç-Kunt, A., and T. Sobaci. 2000. "Deposit Insurance around the World: A Data Base." World Bank, Development Research Group, Washington, D.C.

Duan, J.-C. 1994. "Maximum Likelihood Estimation Using Price Data of the Derivative Contract." *Mathematical Finance* 4(2):155–67.

———. 2000. "Correction: Maximum Likelihood Estimation Using Price Data of the Derivative Contract." *Mathematical Finance* 10(4):461–62.

Duan, J.-C., and M.-T. Yu. 1994. "Assessing the Cost of Taiwan's Deposit Insurance." *Pacific-Basin Finance Journal* 2(1):73–90.

Fama, E. E. 1965. "The Behavior of Stock-Market Prices." *Journal of Business* 38(1):34–105.

Fries, S., R. Mason, and W. Perraudin. 1993. "Evaluating Deposit Insurance for Japanese Banks." *Journal of the Japanese and International Economy* 7(4):356–86.

Goldman Sachs. 2000. *Global Banks Fact Sheet*. New York, N.Y.

Hovakimian, A., and E. Kane. 2000. "Effectiveness of Capital Regulation at U.S. Commercial Banks, 1985 to 1994." *Journal of Finance* 55(1):451–68.

Kane, E. 2000. "Designing Financial Safety Nets to Fit Country Circumstances." Boston College, Finance Department, Boston.

Kaplan, I. 1998. "The Put Option Approach to Banking Crises in Emerging Markets: Valuing Implicit Deposit Insurance in Thailand." University of Washington, Department of Economics, Seattle.

Marcus, A., and I. Shaked. 1984. "The Valuation of FDIC Deposit Insurance Using Option-Pricing Estimates." *Journal of Money, Credit, and Banking* 16(4):446–60.

Merton, R. 1977. "An Analytical Derivation of the Cost of Deposit Insurance and Loan Guarantees." *Journal of Banking and Finance* 1(2):3–11.

———. 1978. "On the Cost of Deposit Insurance When There Are Surveillance Costs." *Journal of Business* 51(3):439–52.

Peek, J., and E. Rosengren. 2001. "Determinants of the Japan Premium: Actions Speak Louder than Words." *Journal of International Economics* 53(2):283–305.

Pennacchi, G. 1987. "A Reexamination of the Over- (or Under-) Pricing of Deposit Insurance." *Journal of Money, Credit, and Banking* 19(3):340–60.

PRS Group. Various years. *International Country Risk Guide*. East Syracuse, N.Y.

Ronn, E., and A. Verma. 1986. "Pricing Risk-Adjusted Deposit Insurance: An Option-Based Model." *Journal of Finance* 41(4):871–95.

Williamson, J., and M. Mahar. 1998. "A Survey of Financial Liberalization." Essays in International Finance No. 211, Princeton University, Department of Economics, Princeton, N.J.

White, H. 1980. "A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity." *Econometrica* 48(4):817–38.