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How Does Deposit Insurance Affect Bank Risk?

Evidence from the Recent Crisis

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Abstract

Deposit insurance is widely offered in a number of countries as part of a financial system safety net to promote stability. An unintended consequence of deposit insurance is the reduction in the incentive of depositors to monitor banks, which leads to excessive risk-taking. This paper examines the relation between deposit insurance and bank risk and systemic fragility in the years leading to and during the recent financial crisis. It finds that generous financial safety nets increase bank risk and systemic fragility in the years leading up to the global financial crisis. However, during the crisis, bank risk is lower and systemic stability is greater in countries with deposit insurance coverage. The findings suggest that the "moral hazard effect" of deposit insurance dominates in good times while the "stabilization effect" of deposit insurance dominates in turbulent times. Nevertheless, the overall effect of deposit insurance over the full sample remains negative since the destabilizing effect during normal times is greater in magnitude compared with the stabilizing effect during global turbulence. In addition, the analysis finds that good bank supervision can alleviate the unintended consequences of deposit insurance on bank systemic risk during good times, suggesting that fostering the appropriate incentive framework is very important for ensuring systemic stability.

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How Does Deposit Insurance Affect Bank Risk? Evidence from the Recent Crisis

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1. Introduction

In response to the global financial crisis, a number of countries substantially increased the coverage of their financial safety nets in order to restore confidence and to avert potential contagious runs on their banking sectors. This has rekindled the debate on the impact of deposit insurance on banking sector stability and performance. While previous studies suggest that deposit insurance exacerbates moral hazard problems in bank lending and is associated with higher likelihood of banking crisis (Demirguc-Kunt and Detragiache 2002), to the best of our knowledge, there is no study that examines the impact of deposit insurance on bank risk and stability during a period of global financial instability. This is an important gap in our knowledge since economic theories suggest that deposit insurance brings both benefits and costs that are likely to vary with economic conditions. Hence while deposit insurance can increase moral hazard and make financial systems more vulnerable to crises during good times, it can also enhance depositor confidence and reduce the likelihood of contagious bank runs during turbulent periods such as the recent global financial crisis. The net effect of deposit insurance on bank risk and stability, therefore, depends on whether the benefits of deposit insurance can outweigh its costs.

In this paper, we take advantage of the global financial crisis and study whether deposit insurance schemes have a stabilizing effect during financially turbulent periods. Specifically, using a sample of 4,109 publicly traded banks in 96 countries, we examine the impact of deposit insurance on bank risk and systemic stability separately for the crisis period from 2007 to 2009, as well as the three years from 2004 to 2006 leading up to the global financial crisis. We use z-score and stock return volatility to measure standalone risk of an individual bank, and the conditional value at risk measure (CoVar) of Adrian and Brunnermeier (2010) to measure the risk posed by an individual bank to the banking system as a whole. We find that generous financial safety nets increase bank risk and reduce systemic stability in non-crisis years. However, bank risk is lower and systemic stability is greater during the global financial crisis in countries with deposit insurance coverage. Nevertheless, the overall effect of deposit insurance over the full sample we study remains negative since the destabilizing effect during normal times is greater in magnitude compared to the stabilizing effect during global turbulence. Consistent with the prior literature, we also find that good supervision can enhance the positive effects of deposit insurance during turbulent periods and dampen the negative effects due to moral hazard during normal times. Our findings offer new insights into the effect of deposit insurance on banking sector stability and have important policy implications for the design of banking section regulation and supervision.

Starting with Merton (1977), a number of theoretical papers have studied the relationship between deposit insurance and banking sector stability.[2] Deposit insurance protects the interests of unsophisticated depositors and helps prevent bank runs which can improve social welfare. This positive stabilization effect of deposit insurance is, naturally, more important during economic downturns when contagious bank runs are more likely to occur. Consistent with this view, Gropp and Vesala (2004) show that the adoption of deposit insurance is associated with lower bank risk in the European Union. Chernykh and Cole (2011) also document that the adoption of deposit insurance in Russia is associated with better financial intermediation. Karels and McClatchey (1999) find stabilization effects from the adoption of deposit insurance for US credit unions.

There is also considerable consensus in the literature that deposit insurance exacerbates moral hazard problems in the banking sector by incentivizing banks to take on excessive risk. Depositors can limit bank risk taking by charging higher interest rates. When deposits are insured, however, bank depositors lack incentives to monitor (Demirguc-Kunt and Huizinga 2004 and Ioannidou and Penas 2010). The lack of market discipline leads to excessive risk taking culminating in banking crises. Demirguc-Kunt and Detragiache (2002), Demirguc-Kunt and Kane (2002) and Barth, Caprio and Levine (2004) find supportive evidence for this view. Moreover, critics of deposit insurance argue that the government may lack the resources, information or incentives to correctly assess bank risk and charge deposit insurance premiums accordingly. Any risk based premium charged may be deemed "unfair" leading to distortions and inefficiencies in the banking sector.

A number of papers have emphasized how design features of deposit insurance schemes and the larger institutional environment may affect the relationship between deposit insurance and banking risk and bank system fragility. In poor institutional settings, generous design features tend to destabilize the banking system and to undermine market discipline. Hovakimian, Kane and Laeven (2003) and Laeven (2002) show that weak institutional environments

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[2] See Morrison and White (2011) for recent development in the theoretical literature and references therein. The focus of the theoretical literature seems to be the design of the optimal deposit insurance scheme.

undermine deposit-insurance design. Cull, Senbet and Sorge (2004) produce evidence that in weak institutional environments deposit insurance reduces financial development. Features of a country's private and public contracting environments have been shown to be important in deposit-insurance adoption and design (Demirgüç-Kunt and Kane, 2002).

In this paper we test if the impact of deposit insurance is different during normal times and economic downturns. It is possible that the positive stabilization effects of deposit insurance can dominate the negative moral hazard effects during economic downturns. During downturns banks may face tightened funding and limited investment opportunities, leaving little room for excessive risk taking. Deposit insurance can then help enhance depositor confidence and prevent systemic bank runs during the crisis, leading to lower risk and greater systemic stability. During non-stress periods, however, the reverse could be true since there would be plenty of investment opportunities and little need for preventing bank runs. Alternatively, deposit insurance could also be a destabilizing (or stabilizing) influence throughout the whole sample period.

For a sample of 4,109 banks in 96 countries over the time period 2004-2009, we find supportive evidence that the influence of deposit insurance on bank risk is different during normal periods versus global systemic downturns. Specially, we show that existing deposit insurance coverage is associated with lower systemic stability and higher bank risk in the 2004-2006 pre-crisis period. However, the relationship between deposit insurance and bank risk and systemic stability is reversed in the 2007-2009 crisis period. Nevertheless, the overall effect of deposit insurance over the full sample we study remains negative since the destabilizing effect during normal times is greater in magnitude compared to the stabilizing effect during global turbulence.

Our paper is related to Demirguc-Kunt and Detragiache (2002), which studies the link between deposit insurance and the occurrence of banking crisis. Unlike Demirguc-Kunt and Detragiache (2002), who focus on the likelihood of crisis of a particular country, we study the impact of deposit insurance on bank risk and system stability during a global systemic shock and compare it to normal times. Our paper is also related to Fahlenbrach, Prilmeier, and Stulz (2011) and Beltratti and Stulz (2012), who investigate the determinants of bank performance during the recent crisis. While their focus is on bank characteristics that affect performance, we focus on the effect of deposit insurance on bank risk and stability. We also add to the literature that has shown that features of a country's private and public contracting environment are important in deposit-insurance adoption, design and performance (see for instance, Demirgüç-Kunt and Kane 2002). We show that good supervision can affect the state-varying benefits and costs of deposit insurance. Strong supervision and regulation can enhance the stabilization effects during crisis periods while dampening the negative effects associated with moral hazard during normal times.

While there is widespread agreement in the academic literature that deposit insurance affects bank risk through two channels, stabilization and moral hazard, our paper is the first to document that the net impact of deposit insurance varies with the relative importance of these two effects. Our results indicate that deposit insurance indeed enhanced depositor confidence and had positive stabilization effects during the recent global financial crisis. Our findings also emphasize the role of regulation and supervision in the effectiveness of deposit insurance schemes by maximizing the benefits of deposit insurance while minimizing costs associated with incentives and moral hazard.

The rest of the paper is organized as follows. Section 2 describes the construction of the sample and variables. Section 3 presents the empirical results and discusses the implications. Section 4 concludes.

2. Data

2.1. Sample and Bank Level Variables

Our sample consists of all publicly traded banks covered by the Bankscope database. We use stock market information from Compustat for international banks and stock market information from CRSP for U.S. banks. The Bankscope database reports detailed balance sheet and income statement information for both public and private banks and covers over 90% of the total banking assets in a given country. The Compustat database provides daily stock price information for both active and delisted companies, accounting for 98% of the global stock market capitalization. CRSP is the standard source for stock price information of U.S. companies. Our final sample consists of 4,109 banks in 96 countries over the time period 2004-2009.

Bank level variables are constructed from the Bankscope database. We follow Laeven and Levine (2009) and compute a traditional measure of bank risk, which is calculated as average bank return on assets (net income divided by total assets) plus bank equity to assets ratio, scaled by the standard deviation of return on assets over a five-year rolling window. Higher z-score indicates lower bank risk. We use the natural logarithm of z-score in our regressions because the distribution of z-score is highly skewed. We also compute an additional measure of bank risk using market prices. In particular, we use bank stock return volatility to measure bank risk. Bank stock return volatility is calculated as the standard deviation of bank daily stock returns in a fiscal year. Higher stock return volatility indicates higher bank risk

In addition, for each bank, each year, we calculate bank size (natural logarithm of total assets), leverage (liabilities divided by total assets), provisions (loan loss provisions divided by total assets), reliance on deposits for funding (deposits divided by total assets), and profitability (net income divided by total assets) as control variables. We winsorize all financial variables at the 1st and 99th percentile level of their distributions to reduce the influence of outliers and potential data errors.

2.2. Systemic Stability Measure

The global financial crisis has led to a re-examination of risk assessment practices and regulation of the financial system, with a renewed interest in systemic fragility and macro-prudential regulation. This requires a focus not on the risk of individual financial institutions, but on an individual bank's contribution to the risk of the financial system as a whole. Hence, there is a growing consensus that from a regulatory perspective of ensuring systemic stability, the correlation in the risk taking behavior of banks is much more relevant than the absolute level of risk taking in any individual institution. In addition to the bank level standalone measures of risk we also compute a measure of each bank's contribution to the system as a whole. Our measure is based on the conditional value at risk measure (CoVar) of Adrian and Brunnermeier (2010).[3] As this approach requires high frequency data, we focus on publicly traded banks and use market prices to compute measures of bank default risk. First, we use the Merton (1974) contingent claim framework to measure standalone bank default risk. We then use the methodology in Adrian and Brunnermeier (2010) to measure co-dependence of bank default risk in a given country using quantile regressions.

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[3] Huang, Zhou, and Zhou (2009), Chan-Lau and Gravelle (2005), Avesani et al. (2006), and Elsinger and Lehar (2008) also use a portfolio credit risk approach to compute the contribution of an individual bank to the risk of a portfolio of banks.

Merton's (1974) framework treats the equity value of a company as a call option on the company's assets. The probability of default is computed using the "distance-to-default" measure, which is the difference between the asset value of the firm and the face value of its debt, scaled by the standard deviation of the firm's asset value. The Merton (1974) distance-to-default measure has been shown to be good predictor of defaults outperforming accounting-based models (Campbell, Hilscher and Szilagyi (2008), Hillegeist, Keating, Cram, and Lundstedt (2004), and Bharath and Shumway (2008)). Although the Merton distance-to-default measure is more commonly used in bankruptcy prediction in the corporate sector, Merton (1977) points out the applicability of the contingent claims approach to pricing deposit insurance in the banking context. Bongini, Laeven and Majnoni (2002), Bartram, Brown and Hund (2007), Hovakimian, Kane, and Laeven (2012), among others, have used the Merton model to measure default risk of commercial banks.

We follow Campbell, Hilscher and Szilagyi (2008) and Hillegeist, Keating, Cram, and Lundstedt (2004) to calculate Merton's distance-to-default measure. Specifically, the market equity value of a company is modeled as a call option on the company's assets:

$$V_E = V_A e^{-dT} N(d_1) - X e^{-rT} N(d_2) + \left(1 - e^{-dT}\right) V_A$$
$$d_1 = \frac{\log\left(\frac{V_A}{X}\right) + \left(r - d + \frac{s_A^2}{2}\right)T}{s_A\sqrt{T}}; d_2 = d_1 - s_A\sqrt{T} \quad (1)$$

In equation (1), V_E is the market value of a bank. V_A is the value of the bank's assets. X is the face value of debt maturing at time T. r is the risk-free rate and d is the dividend rate expressed in terms of V_A. s_A is the volatility of the value of assets, which is related to equity volatility through the following equation:

$$s_E = \frac{V_A e^{-dT}\, N(d_1) s_A}{V_E} \quad (2)$$

We simultaneously solve the above two equations to find the values of V_A and s_A. We use the market value of equity for V_E and total liabilities to proxy for the face value of debt X. Since the accounting information is on an annual basis, we linearly interpolate the values for all dates over the period, using beginning and end of year values for accounting items. The interpolation method has the advantage of producing a smooth implied asset value process and avoids jumps in the implied default probabilities at year end. s_E is the standard deviation of daily equity returns over the past year. In calculating standard deviation, we require the bank to have at least 90 non-missing daily returns over the previous twelve months. *T* equals one year. *r* is the one year US treasury yield, which we take to be the risk free rate. We use the Newton method to simultaneously solve the two equations above. For starting values for the unknown variables, we use $V_A = V_E + X$ and $s_A = s_E V_E/(V_E+X)$. We winsorize s_E and $V_E/(V_E+X)$ at the 5th and 95th percentile levels to reduce the influence of outliers. After we determine asset values V_A, we follow Campbell, Hilscher and Szilagyi (2008) and assign asset return *m* to be equal to the equity premium (6%). Merton's distance-to-default (*dd*) is finally computed as:

$$dd = \frac{log\left(\frac{V_A}{X}\right) + \left(m - d - \frac{s_A^2}{2}\right)T}{s_A\sqrt{T}} \tag{3}$$

The default probability is the normal transform of the distance-to-default measure and is defined as $PD = F\ (-dd)$, where *F* is the cumulative distribution function of a standard normal distribution.

We calculate a bank systemic risk measure to examine the *correlation* in the risk taking behavior of banks. Following Adrian and Brunnermeier (2010), we compute a conditional value at risk measure (CoVar) for each of the banks in our sample using quantile regressions. Quantile regressions estimate the functional relationship among variables at different quantiles (Koenker and Hallock (2001)) and allows for a more accurate estimation of the credit risk co-dependence during stress periods by taking into account nonlinear relationships when there is a large negative shock. As in Adrian and Brunnermeier (2010), we estimate a time series CoVar measure using a number of state variables. We run the following quantile regressions over the sample period:

$$\Delta BankDD_{i,t} = \propto_i + \gamma_i M_{t-1} + \varepsilon_{i,t}$$
$$\Delta SystemDD_t = \propto_{system|i} + \beta_{system|i}\ \Delta BankDD_{i,t} + \gamma_{system|i} M_{t-1} + \varepsilon_{system|i,t} \tag{4}$$

In equation (4), $\Delta BankDD_{i,t}$ is the change in Merton distance-to-default variable for bank *i* in week *t*. $\Delta \mathrm{SystemDD_t}$ is similarly the change in the value-weighted Merton distance-to-default variable for all banks in a given country. $M_{t-1}$are lagged state variables and include change in the term spread (*TERM*), change in the default spread (*DEF*), CBOE implied volatility index (*VIX*), S&P 500 return (*SPRET*) and the change in the 3 month t-bill rate (*RATE*). The ΔCoVar variable is then computed as the change in the VaR of the system when the institution is at the q^{th} percentile (or when the institution is in distress) minus the VaR of the system when the institution is at the 50% percentile:

$$\Delta CovarSystem_t^q = \hat{\beta}_{system|i}^q \left(\Delta \widehat{BankDD}_{i,t}^q - \Delta \widehat{BankDD}_{i,t}^{50\%}\right) \quad (5)$$

We compute the ΔCoVar measure for each bank in our sample for the pre-crisis and post-crisis time periods separately, and higher ΔCoVar indicates lower systemic risk.

2.3. Country Level Variables

Country level variables are collected from a number of sources. We obtain a deposit insurance variable from Barth, Caprio, and Levine (2008). Specifically, deposit insurance is equal to 1 if a country has explicit deposit insurance and depositors were fully compensated the last time a bank failed and 0 otherwise. We obtain a second deposit insurance variable from Demirguc-Kunt, Kane, and Laeven (2008). Full coverage is equal to 1 if a country offers full coverage and 0 otherwise. Since deposit insurance schemes are often changed during times of crises and we are interested in the impact of deposit insurance on bank risk during the recent pre-crisis and crisis periods, we take the deposit insurance coverage in existence in 2003 as our independent variable and use bank-year observations from 2004 to 2009 in our study to mitigate the reserve causality problem. Although fixing the deposit insurance measure at year 2003 leads to measurement error in the deposit insurance variable and may bias us against finding any significant results, it alleviates the concern that some unobservable country characteristics drive both changes in deposit insurance and bank risk.[4]

[4] It might be argued that the deposit insurance scheme in 2003 is positively correlated with government interventions in the recent crisis, which seems to favor our hypothesis that deposit insurance is associated with lower bank risk in the crisis. However, there is no evidence for such a claim and in contrast previous studies have suggested that lack

We also control for a number of country level variables to further deal with the potential omitted variable problem. Specifically, since both bank performance and deposit insurance can be affected by economic conditions in a country, we obtain economic development measures from the World Bank's World Development Indictor (WDI) database. We use the natural logarithm of GDP per capita to measure the economic development of a country, the variance of GDP growth rate to measure economic stability, the natural logarithm of population to measure country size, and imports plus exports of goods and service divided GDP to measure global integration (Karolyi, Lee, and Van Dijk 2011). We also use stock market capitalization divided by GDP and private credit divided by GDP from the Financial Structure Dataset (Beck, Demirguc-Kunt, and Levine (2010)) to control for differences in financial development and structure.

We define a crisis dummy to be equal to 1 for years 2007 to 2009 and 0 for years 2004 to 2006. A full list of variables and definitions are provided in Appendix I.

3. Empirical Methodology and Results

3.1. Summary Statistics

Table 1 provides the summary statistics of variables used in this study. An average bank in the sample has a logzscore of 3.50, stock return volatility of 0.03 and systemic risk of -0.07. In addition, the average bank has log total asset value of 7.66, and leverage ratio of 0.90. These numbers are comparable to those in previous studies such as Anginer, Demirguc-Kunt, and Zhu (2012).

Table 2 presents the sub-sample comparisons of means of our main variables of interest. In Panel A of Table 2, we partition our sample by whether a country offers deposit insurance and whether the country is in a crisis period. The results suggests that in the non-crisis period, banks in countries without deposit insurance have higher z-score, lower return volatility, and slightly lower systemic risk. Entering into crisis years substantially increases bank risk, stock return volatility and systemic risk. More importantly, compared to countries with deposit insurance coverage, countries without such coverage experienced larger increases in bank risk, stock return volatility and systemic risk. In Panel B of Table 2, we partition our sample by whether a country

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of deposit insurance may indicate high potential to the offering of generous financial safety nets (Gropp and Vesala 2004 and Demirguc-Kunt, Karacaovali, and Laeven 2005).

offers full coverage and whether the country is in a crisis year. The results are similar to those in Panel A of Table 2. Overall, the univariate results in Table 2 are consistent with our conjecture that the effect of deposit insurance on bank risk is time varying. We then conduct formal tests of our hypothesis using multivariate regressions.

3.2. Bank Risk

We first examine whether the impact of deposit insurance on bank risk varies during crisis and pre-crisis years. While deposit insurance may lead to moral hazard and excessive bank risk taking (e.g., Demirguc-Kunt and Kane 2002 and Demirguc-Kunt and Huizinga 2004), it can also prevent bank runs (e.g., Merton 1977 and Matutes and Vives 1996) and thus ensure investor confidence and systemic stability during economic downturns. We use ordinary least squares (OLS) to estimate the following regression specification:

$$logzscore_{ijt} = \beta_0 + \Omega \times bank\ and\ country\ controls_{ijt-1} + \beta_1 \times deposit\ insurance_{ij2003} \times crisis_{ijt} + \beta_2 \times deposit\ insurance_{ij2003} \times noncrisis_{ijt} + \beta_3 \times crisis_{ijt} + \varepsilon_{ijt} \quad (7)$$

Our dependent variable is bank *i*'s risk (in country *j* in year *t*), $logzscore_{ijt}$, which is equal to bank average bank return on assets (net income divided by total assets) plus bank equity to assets ratio, scaled by the standard deviation of return on assets over a five-year rolling window. Our main explanatory variables of interest are the two interaction terms: one between deposit insurance coverage and crisis year dummy, and the other between deposit insurance coverage and non-crisis year dummy. This specification allows deposit insurance to have different effects on bank risk in crisis and non-crisis periods. We also control for bank characteristics that can affect risk. Our bank level control variables include log value of bank assets, leverage, provisions to net interest income ratio, reliance on deposits for funding, and profitability. We also include country level control variables such as natural logarithm of GDP per capita, variance of GDP growth rate, natural logarithm of population, imports plus exports of goods and service divided GDP, stock market capitalization divided by GDP, private credit divided by GDP, and crisis year dummy. All explanatory variables are lagged by one year to alleviate any reverse causality problem.

Table 3 presents the coefficient estimates. Column (1) of Table 3 shows that deposit insurance has a positive and statistically significant effect on bank zscore in crisis years and a negative and statistically significant effect on bank zscore in pre-crisis years. This suggests that deposit insurance reduces bank risk during the recent crisis and increases bank risk in the years leading up to the crisis. However, the average effect of deposit insurance over the full sample period is still negative, since the destabilizing effect during normal times is greater in magnitude compared to the stabilizing effect during the global financial crisis. In terms of control variables, we find that banks with higher leverage ratios have higher risk and banks that rely more on deposits have lower risk. Higher loan loss provisions seem to increase bank risk while greater profitability tends to be associated with lower risk. For country level variables, we find that bank risk is positively correlated with variance of GDP growth and is higher in crisis years, and bank risk is negatively correlated with private credit offered by financial institutions. Last, bank risk is substantially higher in crisis years.

In addition, we consider an alternative regression specification that allows us to estimate an incremental effect of deposit insurance on bank risk in crisis years directly.[5] Specifically, we estimate the following OLS regression:

$$\begin{aligned} logzscore_{ijt} = \beta_0 + \Omega \times bank\ and\ country\ controls_{ijt-1} + \beta_1 \times deposit\ insurance_{ij2003} \times crisis_{ijt} \\ + \beta_2 \times deposit\ insurance_{ij2003} + \beta_3 \times crisis_{ijt} + \varepsilon_{ijt} \qquad (8) \end{aligned}$$

Column (2) of Table 3 presents the results. Our dependent variable is still bank *i*'s risk (in country *j* in year *t*) $logzscore_{ijt}$. Our main explanatory variables of interest are deposit insurance and the interaction term between deposit insurance coverage and crisis year dummy. The control variables are similar to those we used in Column (1). We find that the main effect of deposit insurance is negatively and statistically significant at the 1% level. This indicates that, on average, deposit insurance exacerbates moral hazard and leads to excess risk taking in non-crisis years. The interaction term between deposit insurance and crisis year is positive and statistically significant at the 1% level. Moreover, the economic magnitude of the incremental effect is

[5] Note that this specification is identical to the previous one except that it offers the magnitude and significance of the incremental effect of deposit insurance directly.

greater than that of the main effect, suggesting that deposit insurance enhances investor confidence and reduces bank risk during a crisis.

As a robustness check, we also use full coverage dummy to replace the deposit insurance coverage dummy as a measure of deposit insurance coverage. The regression results are presented in Columns (3) and (4) of Table 3, and they are consistent with those in Columns (1) and (2) of Table 3. Overall, the evidence in Table 3 suggests that deposit insurance increases bank risk in pre-crisis years and decreases bank risk in crisis years, with an average negative effect for the entire sample period. In addition, Table 3 shows that the full coverage dummy has a slightly higher time varying impact on bank risk, consistent with previous studies which suggest that full coverage may further exacerbate the moral hazard problem (Demirguc-Kunt and Detragiache 2002).

3.3. Bank Stock Return Volatility

Next, we examine the impact of deposit insurance on bank stock return volatility. Our dependent variable is bank *i*'s volatility (in country *j* in year *t*), which is calculated as the standard deviation of daily stock returns in a fiscal year. The regression specifications and control variables are the same as those used in Section 3.2 and the regression results are reported in Table 4.

We find that, in Column (1) of Table 4, deposit insurance dummy is associated with lower stock return volatility in crisis years but is correlated with higher stock return volatility in pre-crisis years. Column (2) of Table 4 indicates that, deposit insurance increases bank stock return volatility in non-crisis years but the positive relationship between deposit insurance and stock return volatility is completely reversed during a crisis. In terms of control variables, we find that banks with larger size, higher reliance on deposits as funding, lower loan loss provisions, and higher profitability seem to have lower stock return volatility. For country level variables, we find that countries with higher GDP per capita, lower variance of GDP growth, smaller population, and lower private credits have banks with lower stock return volatility. In addition, stock return volatility is substantially higher in crisis years.

In Columns (3) and (4) of Table 4, we replace the deposit insurance dummy with a full coverage dummy. The results are consistent with those in Columns (1) and (2) of Table 4 and are again consistent with our conjecture that deposit insurance increases bank risk in normal years but reduces bank risk in crisis years.

3.4. Bank Systemic Risk

From a regulatory perspective, there is a growing consensus that the correlation in the risk taking behavior of banks is much more relevant than the absolute level of risk taking in any individual institution. We thus examine the relationship between deposit insurance and bank systemic risk. Acharya (2009) suggests that if there is an implicit guarantee provided by the State to cover losses stemming from a systemic crisis, banks will have incentives to take on correlated risks. Guaranteed banks will not have incentives to diversify their operations, since the guarantee takes effect only if other banks fail as well. However, Wagster (2007) finds that the adoption of deposit insurance in Canada seems to reduce banking sector systemic risk. In our test, our dependent variable is bank *i*'s systemic risk (in country *j* in year *t*), whose calculation is described in Section 2.2. The regression specifications and control variables are the same as those used in Section 3.2.

Table 5 presents the regression results. The results in Column (1) of Table 5 indicates that deposit insurance dummy is associated with lower bank systemic risk in crisis years but higher bank systemic risk in non-crisis years, and the overall effect of deposit insurance over the entire sample period is negative. Column (2) of Table 5 shows that deposit insurance increases bank systemic risk in non-crisis years but the positive effect of deposit insurance on bank systemic risk is reversed in crisis years. In terms of control variables, we find that banks with larger size, lower leverage, higher reliance on deposits as funding, and lower loan loss provisions are associated with higher systemic risk. For country level variables, we find that countries with higher GDP per capita, smaller population, and lower international trade have banks with higher systemic risk. Not surprisingly, bank systemic risk is also higher in crisis years.

In Columns (3) and (4) of Table 5, we replace the deposit insurance dummy with a full coverage dummy in our regression analysis of systemic risk. The results are consistent with those in Columns (3) and (4) of Table 5, and are again supportive of our hypothesis.

3.5. Bank Supervision, Deposit Insurance, and Systemic Risk

We are also interested in the impact of the regulatory and institutional framework on the deposit insurance and systemic risk relationship. The adverse consequence of deposit insurance may well depend on the institutional environment and can potentially be mitigated through bank regulation. For instance, better bank supervision may limit the extent to which banks can engage in correlated risk taking activities in the presence of deposit insurance.

We consider a bank supervisory quality index, which measures whether the supervisory authorities have the power and the authority to take specific preventive and corrective actions such as replacing the management team. This variable comes from the banking surveys conducted by Barth, Caprio, and Levine (2008). The surveys were conducted in the years 1999, 2002, and 2005. Because country level regulations change slowly over time, we use the previously available survey data until a new survey becomes available.

Our dependent variable is bank *i*'s systemic risk, whose calculation is described in Section 2.3. The regression specifications and control variables are the same as those used in Section 3.2. Because the full coverage dummy is expected to lead to the most egregious moral hazard problem during good times, we examine whether bank supervision can mitigate such an unintended consequence of full deposit insurance coverage.

Table 6 reports the coefficient estimates. We first partition our sample by the bank supervisory quality index. Column (1) of Table 6 shows the regression results for the subsample where bank supervisory quality is greater than or equal to sample median, and Column (2) of Table 6 presents that the regressions coefficients for the subsample where bank supervisory quality is lower than sample median. We find that, in Column (1) of Table 6, full coverage dummy is associated with lower bank systemic risk during global crisis years and has no adverse impact on bank systemic risk in non-crisis years, when bank supervision is strong. In contrast, Column (2) of Table 6 indicates that, full coverage increases bank systemic risk in all years when bank supervision is weak. Overall, the results in Table 6 suggest that better bank supervision may be able to mitigate the adverse consequences of deposit insurance while weak bank supervision exacerbates the negative impact of deposit insurance on bank stability.

4. Conclusion

As part of the International Monetary Fund's best practice recommendations to developing countries, deposit insurance has received increased attention from both academic researchers and public policy makers. While deposit insurance is aimed at ensuring depositor confidence and to prevent bank runs, it comes with an unintended consequence of encouraging banks to take on excessive risk. In this paper, we study the relation between deposit insurance and bank risk and system fragility during the global financial crisis and the period preceding it. We show that generous financial safety nets increase bank risk and systemic fragility in the years leading up to the crisis. However, both standalone bank risk and systemic risk are lower during the global financial crisis in countries with deposit insurance coverage. Our results suggest that deposit insurance offered significant stabilization effects during the recent banking crisis. Nevertheless, the overall impact of deposit insurance on bank risk over the full sample period remains negative, since the stabilization effect during the crisis period tends to be smaller than the destabilizing effect of the insurance in the period leading up to the crisis. We also find that good bank supervision can alleviate the adverse consequences of deposit insurance on systemic risk in good times. Our results stress the importance of the underlying regulatory and institutional framework and lend support to the view that fostering the appropriate incentive framework is very important for ensuring systemic stability.

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Table 1: Summary statistics

The sample consists of 4,109 banks in 96 countries over the time period 2004-2009. Definitions of variables are in Appendix I.

Variables	N	P25	Mean	Median	P75	STD
Log (zscore)	14,664	2.854	3.500	3.598	4.256	1.076
Volatility	5,473	0.016	0.028	0.022	0.034	0.019
ΔCoVar	4,389	-0.119	-0.069	-0.042	-0.008	0.079
Year	14,664	2,005	2,007	2,007	2,008	2
Log (Total Assets)	14,664	6.231	7.655	7.155	8.901	1.952
Leverage	14,664	0.889	0.899	0.913	0.933	0.074
Deposits	14,664	0.669	0.725	0.781	0.846	0.184
Provisions	14,664	0.024	0.124	0.064	0.155	0.199
ROA	14,664	0.005	0.010	0.009	0.014	0.014
Log (GDP Per Capita)	14,664	10.003	9.931	10.491	10.554	1.067
GDP Growth Volatility	14,664	0.852	1.345	1.256	1.587	0.951
Log (Population)	14,664	17.907	18.466	19.487	19.505	1.500
Trade / GDP	14,664	25.220	53.536	28.849	60.506	51.215
Stock Market Cap / GDP	14,664	0.831	1.146	1.322	1.397	0.581
Private Credit / GDP	14,664	0.984	1.433	1.733	1.884	0.620
Crisis Period Dummy	14,664	0.000	0.504	1.000	1.000	0.500
Deposit Insurance Dummy	14,634	0.000	0.324	0.000	1.000	0.468
Full Coverage Dummy	13,648	0.000	0.023	0.000	0.000	0.151
Supervisory Quality	14,632	11.000	11.872	13.000	13.000	2.041

Table 2: Sub-sample comparison of variable means

The sample consists of 4,109 banks in 96 countries over the time period 2004-2009. Definitions of variables are in Appendix I.

Panel A Crisis Period Dummy	Deposit Insurance Dummy	0	1	Diff in mean	p-value
0	Log (zscore)	3.9580	3.0472	0.9107	*0.0000*
	Volatility	0.0186	0.0202	-0.0016	*0.0009*
	ΔCoVar	-0.0106	-0.1118	0.1013	*0.0000*
1	Log (zscore)	3.3349	3.2774	0.0574	*0.0312*
	Volatility	0.0412	0.0276	0.0135	*0.0000*
	ΔCoVar	-0.0993	-0.1012	0.0018	*0.6234*

Panel B Crisis Period Dummy	Full Coverage Dummy	0	1	Diff in mean	p-value
0	Log (zscore)	3.7611	2.4710	1.2901	*0.0000*
	Volatility	0.0184	0.0295	-0.0111	*0.0000*
	ΔCoVar	-0.0290	-0.0523	0.0233	*0.0001*
1	Log (zscore)	3.3148	3.1170	0.1978	*0.0218*
	Volatility	0.0369	0.0303	0.0067	*0.0020*
	ΔCoVar	-0.1026	-0.0468	-0.0559	*0.0000*

Table 3: Deposit insurance, crisis, and bank risk

The sample consists of 4,109 banks in 96 countries over the time period 2004-2009. The dependent variable is the log value of bank zscore. Standard errors are reported in parentheses below their coefficient estimates and adjusted for both heteroskedasticity and within correlation clustered at the bank level. *** (**) (*) indicates significance at 1% (5%) (10%) two tailed level, respectively.

Variables	(1)	(2)	(3)	(4)
Log (Total Assets)	0.002	0.002	0.002	0.002
	(0.009)	(0.009)	(0.009)	(0.009)
Leverage	-0.762***	-0.762***	-0.512*	-0.512*
	(0.273)	(0.273)	(0.304)	(0.304)
Deposits	0.694***	0.694***	0.707***	0.707***
	(0.091)	(0.091)	(0.097)	(0.097)
Provisions	-1.320***	-1.320***	-1.483***	-1.483***
	(0.067)	(0.067)	(0.072)	(0.072)
ROA	2.888**	2.888**	4.889***	4.889***
	(1.255)	(1.255)	(1.408)	(1.408)
Log (GDP Per Capita)	0.030	0.030	-0.007	-0.007
	(0.026)	(0.026)	(0.030)	(0.030)
GDP Growth Volatility	-0.152***	-0.152***	-0.144***	-0.144***
	(0.016)	(0.016)	(0.018)	(0.018)
Log (Population)	-0.009	-0.009	-0.025	-0.025
	(0.016)	(0.016)	(0.024)	(0.024)
Trade / GDP	0.000	0.000	-0.002	-0.002
	(0.000)	(0.000)	(0.001)	(0.001)
Stock Market Cap / GDP	0.004	0.004	0.041	0.041
	(0.036)	(0.036)	(0.049)	(0.049)
Private Credit / GDP	0.226***	0.226***	0.262***	0.262***
	(0.052)	(0.052)	(0.057)	(0.057)
Crisis Period Dummy	-0.555***	-0.555***	-0.365***	-0.365***
	(0.024)	(0.024)	(0.023)	(0.023)
Deposit Insurance Dummy × Crisis Period Dummy	0.221***	0.693***		
	(0.042)	(0.044)		
Deposit Insurance Dummy × Pre-Crisis Period Dummy	-0.472***			
	(0.049)			
Deposit Insurance Dummy		-0.472***		
		(0.049)		
Full Coverage Dummy × Crisis Period Dummy			0.245**	0.960***
			(0.103)	(0.136)
Full Coverage Dummy × Pre-Crisis Period Dummy			-0.716***	
			(0.150)	
Full Coverage Dummy				-0.716***
				(0.150)
Constant	3.837***	3.837***	4.138***	4.138***
	(0.456)	(0.456)	(0.665)	(0.665)
Observations	14,634	14,634	13,648	13,648
R-squared	0.227	0.227	0.221	0.221

Table 4: Deposit insurance, crisis, and bank stock return volatility

The sample consists of 4,109 banks in 96 countries over the time period 2004-2009. The dependent variable is bank stock return volatility. Standard errors are reported in parentheses below their coefficient estimates and adjusted for both heteroskedasticity and within correlation clustered at the bank level. *** (**) (*) indicates significance at 1% (5%) (10%) two tailed level, respectively.

Variables	(1)	(2)	(3)	(4)
Log (Total Assets)	-0.001***	-0.001***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
Leverage	-0.001	-0.001	-0.002	-0.002
	(0.005)	(0.005)	(0.006)	(0.006)
Deposits	-0.008***	-0.008***	-0.007***	-0.007***
	(0.002)	(0.002)	(0.002)	(0.002)
Provisions	0.021***	0.021***	0.025***	0.025***
	(0.002)	(0.002)	(0.002)	(0.002)
ROA	-0.146***	-0.146***	-0.199***	-0.199***
	(0.028)	(0.028)	(0.032)	(0.032)
Log (GDP Per Capita)	-0.002***	-0.002***	-0.002***	-0.002***
	(0.000)	(0.000)	(0.000)	(0.000)
GDP Growth Volatility	0.004***	0.004***	0.003***	0.003***
	(0.000)	(0.000)	(0.000)	(0.000)
Log (Population)	0.001***	0.001***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
Trade / GDP	-0.000	-0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Stock Market Cap / GDP	-0.000	-0.000	-0.002**	-0.002**
	(0.001)	(0.001)	(0.001)	(0.001)
Private Credit / GDP	0.007***	0.007***	0.009***	0.009***
	(0.001)	(0.001)	(0.001)	(0.001)
Crisis Period Dummy	0.020***	0.020***	0.018***	0.018***
	(0.001)	(0.001)	(0.001)	(0.001)
Deposit Insurance Dummy × Crisis Period Dummy	-0.004***	-0.011***		
	(0.001)	(0.001)		
Deposit Insurance Dummy × Pre-Crisis Period Dummy	0.006***			
	(0.001)			
Deposit Insurance Dummy		0.006***		
		(0.001)		
Full Coverage Dummy × Crisis Period Dummy			-0.005***	-0.016***
			(0.002)	(0.002)
Full Coverage Dummy × Pre-Crisis Period Dummy			0.012***	
			(0.003)	
Full Coverage Dummy				0.012***
				(0.003)
Constant	0.008	0.008	0.014	0.014
	(0.008)	(0.008)	(0.013)	(0.013)
Observations	5,469	5,469	5,090	5,090
R-squared	0.347	0.347	0.368	0.368

Table 5: Deposit insurance, crisis, and bank systemic risk

The sample consists of 4,109 banks in 96 countries over the time period 2004-2009. The dependent variable is bank systemic risk, ΔCoVar. Standard errors are reported in parentheses below their coefficient estimates and adjusted for both heteroskedasticity and within correlation clustered at the bank level. *** (**) (*) indicates significance at 1% (5%) (10%) two tailed level, respectively.

Variables	(1)	(2)	(3)	(4)
Log (Total Assets)	-0.016***	-0.016***	-0.017***	-0.017***
	(0.001)	(0.001)	(0.001)	(0.001)
Leverage	0.061***	0.061***	0.067**	0.067**
	(0.023)	(0.023)	(0.027)	(0.027)
Deposits	-0.041***	-0.041***	-0.046***	-0.046***
	(0.011)	(0.011)	(0.011)	(0.011)
Provisions	0.020***	0.020***	0.012*	0.012*
	(0.006)	(0.006)	(0.007)	(0.007)
ROA	0.095	0.095	0.136	0.136
	(0.116)	(0.116)	(0.132)	(0.132)
Log (GDP Per Capita)	-0.005*	-0.005*	0.001	0.001
	(0.003)	(0.003)	(0.004)	(0.004)
GDP Growth Volatility	0.003	0.003	0.014***	0.014***
	(0.002)	(0.002)	(0.002)	(0.002)
Log (Population)	0.010***	0.010***	0.017***	0.017***
	(0.002)	(0.002)	(0.004)	(0.004)
Trade / GDP	0.000***	0.000***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
Stock Market Cap / GDP	0.007	0.007	0.017**	0.017**
	(0.005)	(0.005)	(0.007)	(0.007)
Private Credit / GDP	-0.002	-0.002	-0.014*	-0.014*
	(0.009)	(0.009)	(0.008)	(0.008)
Crisis Period Dummy	-0.077***	-0.077***	-0.067***	-0.067***
	(0.003)	(0.003)	(0.003)	(0.003)
Deposit Insurance Dummy × Crisis Period Dummy	0.032***	0.082***		
	(0.007)	(0.007)		
Deposit Insurance Dummy × Pre-Crisis Period Dummy	-0.051***			
	(0.008)			
Deposit Insurance Dummy		-0.051***		
		(0.008)		
Full Coverage Dummy × Crisis Period Dummy			0.035***	0.096***
			(0.009)	(0.009)
Full Coverage Dummy × Pre-Crisis Period Dummy			-0.061***	
			(0.013)	
Full Coverage Dummy				-0.061***
				(0.013)
Constant	-0.077	-0.077	-0.293***	-0.293***
	(0.057)	(0.057)	(0.106)	(0.106)
Observations	4,389	4,389	4,036	4,036
R-squared	0.376	0.376	0.376	0.376

Table 6: Deposit insurance, crisis, bank supervision, and systemic risk

The sample consists of 4,109 banks in 96 countries over the time period 2004-2009. The dependent variable is bank systemic risk, ΔCoVar. Standard errors are reported in parentheses below their coefficient estimates and adjusted for both heteroskedasticity and within correlation clustered at the bank level. *** (**) (*) indicates significance at 1% (5%) (10%) two tailed level, respectively.

Variables	(1) Supervisory Quality >= Sample Median	(2) Supervisory Quality < Sample Median
Log (Total Assets)	-0.013***	-0.017***
	(0.001)	(0.003)
Leverage	0.068*	-0.001
	(0.039)	(0.043)
Deposits	-0.027***	0.008
	(0.010)	(0.020)
Provisions	0.022***	0.039***
	(0.008)	(0.011)
ROA	-0.265	0.334**
	(0.220)	(0.147)
Log (GDP Per Capita)	-0.053***	0.016***
	(0.012)	(0.005)
GDP Growth Volatility	0.016***	0.012***
	(0.003)	(0.003)
Log (Population)	-0.023**	0.020***
	(0.011)	(0.004)
Trade / GDP	-0.002***	0.001***
	(0.001)	(0.000)
Stock Market Cap / GDP	0.043***	-0.012
	(0.015)	(0.008)
Private Credit / GDP	0.068***	-0.054***
	(0.026)	(0.014)
Crisis Period Dummy	-0.099***	0.006
	(0.004)	(0.006)
Supervisory Quality		
Full Coverage Dummy × Crisis Period Dummy	0.114***	-0.060***
	(0.015)	(0.015)
Full Coverage Dummy × Pre-Crisis Period Dummy	-0.006	-0.042**
	(0.020)	(0.017)
Constant	0.886***	-0.500***
	(0.299)	(0.123)
Observations	2,819	1,217
R-squared	0.490	0.288

Appendix I: Variable definitions

Variables	Definitions
Dependent variables	
Log(z-score)	Log value of zscore, where bank zscore is calculated as the sum of ROA and equity ratio (ratio of book equity to total assets), averaged over the past five years, divided by the standard deviation of ROA over the past five years. We require a bank to have at least four years of data in the past five years.
Volatility	Stock return volatility, which is the standard deviation of fiscal year daily stock return.
ΔCoVar	Measure of bank systemic risk, which is the change in the VaR of the system when the institution is at the 5% percentile minus the VaR of the system when the institution is at the 50% percentile.
Bank level control variables	
Log (Total Assets)	Log value of total assets in millions of US dollars.
Leverage	Total liabilities divided by total assets.
Provisions	Loan loss provisions divided by net interest income.
Deposits	Total deposits divided by total assets.
ROA	Net income divided by total assets.
Country level variables	
Deposit insurance	
Deposit Insurance Dummy	A variable indicates whether a country has explicit deposit insurance (Yes=1/No=0) and whether depositors were fully compensated the last time a bank failed (Yes=1/No=0). The variable is equal to 1 if both are true in 2003 and 0 otherwise.
Full Coverage Dummy	A variable that equals 1 if a country offers full insurance coverage in 2003 and 0 otherwise.
Country level control variables	
Crisis Period Dummy	A dummy variable that equals 1 for years 2007 to 2009 and 0 for years 2004 through 2006.
Pre-Crisis Period Dummy	A dummy variable that equals 0 for years 2007 to 2009 and 1 for years 2004 through 2006.
Supervisory Quality	A variable that ranges from zero to fourteen, with fourteen indicating the highest power of the supervisory authorities. For each of the following fourteen questions, a value of 1 is added to the index if the answer is yes: 1. Does the supervisory agency have the right to meet with external auditors to discuss their report without the approval of the bank? 2. Are auditors required by law to communicate directly to the supervisory agency any presumed involvement of bank directors or senior managers in illicit activities, fraud, or insider abuse? 3. Can supervisors take legal action against external auditors for negligence? 4. Can the supervisory authority force a bank to change its internal organizational structure? 5. Are off-balance sheet items disclosed to supervisors? 6. Can the supervisory agency order the bank's directors or management to constitute provisions to cover actual or potential losses? 7. Can the supervisory agency suspend the directors' decision to distribute: a) dividends? b)

	bonuses? c) management fees? 8. Can the supervisory agency legally declare-such that this declaration supersedes the rights of bank shareholders-that a bank is insolvent? 9. Does the banking Law give authority to the supervisory agency to intervene that is, suspend some or all ownership rights-a problem bank? 10. Regarding bank restructuring and reorganization, can the supervisory agency or any other government agency do the following: a) supersede shareholder rights? b) remove and replace management? c) remove and replace directors?
Log (GDP Per Capita)	Log value of GDP per capital in nominal constant US 2000 dollars.
GDP Growth Volatility	Variance of GDP growth for the previous five years.
Log (Population)	Log value of population in millions.
Trade / GDP	Imports plus exports of goods and services as a percentage of GDP.
Stock Market Cap / GDP	Stock market capitalization divided by GDP.
Private Credit / GDP	Private credit by deposit money banks and other financial institutions to GDP.