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How does deposit insurance affect bank risk? Evidence from the recent crisis ☆

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A B S T R A C T

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 lead to excessive risk-taking. We examine the relation between deposit insurance and bank risk and systemic fragility in the years leading up to and during the recent financial crisis. We find 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. Our 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. 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. In addition, we find 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.

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 market 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 systemic stability during a period of global financial instability. This is an important gap in the literature since economic theories suggest that deposit insurance brings both benefits and costs that are likely to vary with economic conditions. That is, 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 4109 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 3 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 marginal expected shortfall (MES) of Acharya et al. (2012) 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

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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 sector 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; 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 et al. (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 premium 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 tends to destabilize the banking system and to undermine market discipline. Hovakimian et al. (2003) and Laeven (2002) show that weak institutional environments undermine deposit-insurance design. Cull et al. (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 (Demirguc-Kunt and Kane, 2002).

In this paper we test to see if the impact of deposit insurance on bank risk and systemic stability is different during normal times and during crises periods. 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 4109 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 and during 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 crisis period and compare it to normal times. Our paper is also related to Fahlenbrach et al. (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 to be important in deposit-insurance adoption, design and performance (see for instance, Demirguc-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, albeit having contributed to the occurrence of the crisis in the first place, with an overall destabilizing effect over the full sample. 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 US 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

[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.

standard source for stock price information of US companies. Our final sample consists of 4109 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) to compute *z*-score which is an accounting based measure of bank risk commonly used in the literature. *Z*-score is calculated as the sum of average bank return on assets (net income divided by total assets) and bank equity to assets ratio, scaled by the standard deviation of return on assets over a 5-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 expected capital shortfall framework developed by Acharya et al. (2012).

The systemic expected shortfall of an institution describes the capital shortage a financial firm would experience in case of a systemic event. It is based on the notion that a shortage of capital is dangerous for the individual firm, but becomes dangerous for the whole economy if it occurs just when the rest of the banking sector is also undercapitalized. This measure is meant to capture how much each firm contributes to the risk of the banking system as a whole. The capital short fall depends on the firm's leverage and equity loss conditional on an aggregate market decline. Marginal Expected Shortfall (MES) of a firm is the expected loss an equity investor in a financial firm would experience if the market declined substantially. Following Acharya et al. (2010), we use MES as our systemic risk measure.[3] MES measures the average firm return on days when the market as a whole is in the tail of its loss distribution:

$$MES_t^i = E\left(R_t^i | R_t^m < C\right) \tag{1}$$

Above, R_t^i is the financial firm *i*'s equity return and R_t^m is the aggregate market index return. A systemic event is defined as a drop of the market index below a threshold, *C*, over a given time horizon. The systemic event is thus denoted by $R_t^m < C$. Acharya et al. (2012) show that MES can be used to set capital limits based on systemic risk contributions. Since the book value of debt will be will be relatively unchanged while equity values fall by MES, a regulator can require a bank to hold equity to satisfy a prudential capital ratio of *k*% to make sure that the systemic risk posed by the bank is zero:

$$Equity_t^i \geqslant \frac{k \times Debt_t^i}{(1-k) \times \left(1 + MES_t^i\right)} \tag{2}$$

We compute MES using a threshold that corresponds to the index at its lowest 5% level over the previous 1 year of return data.[4] For this computation we use daily stock returns from Compustat for international financial firms and daily stock market information from CRSP for US financial firms. For the aggregate market index, we use the country stock index in which the financial firm is incorporated.[5] We obtain the daily country stock indices data from Compustat Global.

2.3. Deposit insurance and other country level variables

Country level variables are collected from a number of sources. We use two separate measures of deposit insurance. The first measure comes from Barth et al. (2008). Specifically, deposit insurance dummy is created and set equal to 1 if a country has explicit deposit insurance and depositors were fully compensated the last time a bank failed. It is set equal to 0 otherwise. The second deposit insurance measure comes from Demirguc-Kunt et al. (2008). Full coverage dummy is created and set 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 reverse 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.[6]

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

[3] As an alternative measure of systemic risk, we also compute the conditional value-at-risk (CoVar) measure of Adrian and Brunnermeier (2010). Our results on systemic risk remain robust to the use of this alternative measure. However, one disadvantage of the CoVar variable is that its calculation requires the use of state variables such as change in the term spread (TERM), change in the default spread (DEF), CBOE implied volatility index (VIX), S&P 500 return (SPRET), and change in the 3 month *t*-bill rate (RATE). Due to data availability, we are only able to use the US data as state variables for all banks in our sample. While US specific state variables better capture global market conditions, they may not be able to reflect country specific risks. Therefore, we choose to report results using MES as our measure of systemic risk in the paper.

[4] We find similar results using changes in Merton (1974) distance-to-default measure instead of stock market returns in the calculation of MES.

[5] Because of data limitations, for Bahrain, Botswana, Egypt, Jordan, Kenya, Kuwait, Lebanon, Morocco, Nigeria, Oman, Qatar, Saudi Arabia, Tunisia, United Arab Emirates, we use the FTSE Middle East & Africa Index.

[6] 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 of deposit insurance may indicate high potential to the offering of generous financial safety nets (Gropp and Vesala 2004; Demirguc-Kunt et al. 2005).

Table 1
Summary statistics.

Variables	*N*	P25	Mean	Median	P75	STD
Log (*z*-score)	14,664	2.854	3.500	3.598	4.256	1.076
Volatility	5473	0.016	0.028	0.022	0.034	0.019
MES	6188	−3.703	−2.455	−1.882	−0.631	2.584
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
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

This table reports the summary statistics of the variables used in this paper. The sample consists of 4109 banks in 96 countries over the time period 2004–2009. Log(*z*-score) is the natural logarithm of the sum of ROA and equity ratio (ratio of book equity to total assets), averaged over the past 5 years, divided by the standard deviation of ROA over the past 5 years. We require a bank to have at least 4 years of data in the past 5 years. Volatility is the stock return volatility, calculated as the standard deviation of daily stock return over the fiscal year. MES is the average bank return on days when the corresponding country market return is at its lowest 5% level in a year. MES is reported as a percentage. Log (Total Assets) is the log value of total assets in millions of US dollars. Leverage is total liabilities divided by total assets. Provisions is loan loss provisions divided by net interest income. Deposits is total deposits divided by total assets. ROA is net income divided by total assets. Log (GDP Per Capita) is the log value of GDP per capital in nominal constant US 2000 dollars. GDP Growth Volatility is the variance of GDP growth for the previous 5 years. Log (Population) is the log value of population in millions. Trade/GDP is imports plus exports of goods and services as a percentage of GDP. Stock Market Cap/GDP is stock market capitalization divided by GDP. Private Credit/GDP is private credit by deposit money banks and other financial institutions to GDP. Deposit Insurance Dummy is a variable that 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 is a variable that equals 1 if a country offers full insurance coverage in 2003 and 0 otherwise. Supervisory Quality is a variable that ranges from zero to fourteen, with fourteen indicating the highest power of the supervisory authorities.

exports of goods and service divided GDP to measure global integration (Karolyi et al., 2012). We also use stock market capitalization divided by GDP and private credit divided by GDP from the Financial Structure Dataset (Beck et al. (2010)) to control for differences in financial development and structure. We define a crisis dummy to be equal to 1 for years 2007–2009 and 0 for years 2004–2006.

As mentioned earlier, we are interested in how regulation and supervision impact the relationship between deposit insurance and systemic stability. The adverse consequence of deposit insurance can potentially be mitigated through better bank regulation and supervision. To examine this relationship, we use 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 et al. (2008).[7] 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.

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 −2.46. 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 et al. (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 lower systemic risk. During crisis years bank risk, stock return volatility and systemic risk increases substantially. More importantly, compared to countries with deposit insurance coverage, countries without such coverage experience 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 offers full coverage and whether the country is in a crisis year. The results are similar to those in Panel A of Table 2. The differences between deposit insurance and no deposit insurance sub-samples are statistically and economically significant. Overall, the univariate results in Table 2 are consistent with our conjecture that the effect of deposit insurance on bank risk is time varying. Next, we conduct formal tests of our hypothesis using multivariate regressions controlling for country and firm differences.

[7] This is 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?

Table 2
Sub-sample comparison of variable means.

Crisis Period Dummy	Deposit Insurance Dummy	0	1	Diff in mean	*p*-value
Panel A					
0	Log (zscore)	3.9580	3.0472	0.9107	0.0000
	Volatility	0.0186	0.0202	−0.0016	0.0009
	MES	−0.9822	−1.8071	0.8249	0.0000
1	Log (zscore)	3.3349	3.2774	0.0574	0.0312
	Volatility	0.0412	0.0276	0.0135	0.0000
	MES	−3.4114	−3.3303	−0.0811	0.4385
Crisis Period Dummy	Full Coverage Dummy	0	1	Diff in mean	*p*-value
Panel B					
0	Log (zscore)	3.7611	2.4710	1.2901	0.0000
	Volatility	0.0184	0.0295	−0.0111	0.0000
	MES	−1.2617	−2.0150	0.7534	0.0001
1	Log (zscore)	3.3148	3.1170	0.1978	0.0218
	Volatility	0.0369	0.0303	0.0067	0.0020
	MES	−3.3644	−3.0699	−0.2945	0.0000

The table reports univariate analyses of the impact of deposit insurance during crisis and non-crisis periods. The table reports average values of Log(*z*-score), Volatility and MES for the subsamples of banks created based on whether the bank is covered by deposit insurance and whether the it is a crisis time period. Panel A reports subsample means, the difference between banks with explicit deposit insurance and those without, as well as the pvalue for test of the differences. Panel B reports subsample means, the difference between banks with fully covered deposit insurance and those without, as well as the pvalue for test of the differences. The sample consists of 4109 banks in 96 countries over the time period 2004–2009. Definitions of variables are provided in Table 1.

3.2. Bank risk

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

$$\begin{aligned} logzscore_{ijt} = \beta_0 + \Omega \times bank\,and\,country\,controls_{ijt-1} + \beta_1 \\ \times deposit\,insurance_{ij2003} \times crisis_{ijt} + \beta_2 \\ \times deposit\,insurance_{ij2003} \times noncrisis_{ijt} + \beta_3 \\ \times crisis_{ijt} + \varepsilon_{ijt} \end{aligned} \tag{3}$$

Our dependent variable is bank *i*'s risk (in country *j* in year *t*), $logzscore_{ijt}$, which is equal to the sum of average bank return on assets (net income divided by total assets) and bank equity to assets ratio scaled by the standard deviation of return on assets over a 5-year rolling window. 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. Since we include a crisis dummy, the coefficients on the interaction terms correspond to differences in risk for banks with deposit insurance coverage and those without, similar to the differences we reported in Table 2. In the regression, we control for bank characteristics that can affect risk. 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 controls including the 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 1 year to alleviate any reverse causality problems.

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 reduced bank risk during the recent crisis and increased 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 negatively correlated with private credit offered by financial institutions. Finally, as expected, bank risk is substantially higher in crisis years.

We consider an alternative regression specification that allows us to estimate an incremental effect of deposit insurance on bank risk in crisis years directly.[8] Specifically, we estimate the following OLS regression:

$$\begin{aligned} logzscore_{ijt} = \beta_0 + \Omega \times bank\,and\,country\,controls_{ijt-1} + \beta_1 \\ \times deposit\,insurance_{ij2003} \times crisis_{ijt} + \beta_2 \\ \times deposit\,insurance_{ij2003} + \beta_3 \times crisis_{ijt} + \varepsilon_{ijt} \end{aligned} \tag{4}$$

This is a diff-in-diff specification. The coefficient on the interaction term corresponds to the difference during crisis and non-crisis period of the differences in risk for banks with deposit insurance coverage and those without. 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 identical 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 excessive risk taking during

[8] 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.

Table 3
Deposit insurance, crisis, and bank risk.

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

This table reports regression results described in Section 3. The dependent variable is the log value of bank zscore. The sample consists of 4109 banks in 96 countries over the time period 2004–2009. Definitions of variables are provided in Table 1. Standard errors are reported in parentheses below their coefficient estimates and adjusted for both heteroskedasticity and within correlation clustered at the bank level.

* Significance at 10% two tailed level.

** Significance at 5% two tailed level.

*** Significance at 1% two tailed level.

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

As an alternative measure of deposit insurance coverage, we use full coverage dummy to replace the deposit insurance coverage dummy. 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 during our sample period 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.

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

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	5469	5469	5090	5090
R-squared	0.347	0.347	0.368	0.368

This table reports regression results described in Section 3. The dependent variable is the bank stock return volatility. The sample consists of 4109 banks in 96 countries over the time period 2004–2009. Definitions of variables are provided in Table 1. Standard errors are reported in parentheses below their coefficient estimates and adjusted for both heteroskedasticity and within correlation clustered at the bank level.
* Significance at 10% two tailed level.
** Significance at 5% two tailed level.
*** Significance at 1% two tailed level.

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. 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 at the same time. That is, deposit insurance not only increases bank level risk taking through the standard moral hazard channel, but may also increase correlated risk-taking as well. Although the use of level systemic risk measures is relatively new (and allows us to test the effects of deposit insurance during crisis and non-crisis periods), much of the earlier empirical work has also examined the relationship between deposit insurance and systemic stability by using the incidence of banking crisis at the country level as a measure of systemic risk. In this section, we examine the relationship between deposit insurance and bank systemic risk. The regression specifications and control variables are the same as those used in Section 3.2. We use marginal expected shortfall (MES) as the dependent variable to measure bank i's systemic risk (in country j in year t), described in Section 2.2.

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 during our sample period but the adverse 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, lower reliance on deposits as funding, and higher loan loss provisions are associated with higher systemic risk. For country level variables, we find that countries with lower GDP per capita, higher GDP volatility, smaller populations, and lower international trade have banks with higher systemic risk. These results are consistent with those in Anginer and Demirguc-Kunt (2012). 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 the regression analysis of systemic risk. The results are consistent with those in

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

Variables	(1)	(2)	(3)	(40)
Log (Total Assets)	−0.551***	−0.551***	−0.558***	−0.558***
	(0.027)	(0.027)	(0.029)	(0.029)
Leverage	2.788***	2.788***	2.836***	2.836***
	(0.644)	(0.644)	(0.731)	(0.731)
Deposits	0.627**	0.627**	0.373	0.373
	(0.266)	(0.266)	(0.295)	(0.295)
Provisions	−0.866***	−0.866***	−1.173***	−1.173***
	(0.211)	(0.211)	(0.239)	(0.239)
ROA	3.399	3.399	2.683	2.683
	(3.031)	(3.031)	(3.620)	(3.620)
Log (GDP Per Capita)	0.155***	0.155***	0.300***	0.300***
	(0.060)	(0.060)	(0.081)	(0.081)
GDP Growth Volatility	−0.119***	−0.119***	−0.102**	−0.102**
	(0.041)	(0.041)	(0.047)	(0.047)
Log (Population)	−0.366***	−0.366***	−0.297***	−0.297***
	(0.040)	(0.040)	(0.065)	(0.065)
Trade/GDP	−0.003***	−0.003***	−0.002	−0.002
	(0.001)	(0.001)	(0.003)	(0.003)
Stock Market Cap/GDP	0.388***	0.388***	0.632***	0.632***
	(0.112)	(0.112)	(0.144)	(0.144)
Private Credit/GDP	−0.581***	−0.581***	−1.139***	−1.139***
	(0.187)	(0.187)	(0.178)	(0.178)
Crisis Period Dummy	−2.101***	−2.101***	−1.959***	−1.959***
	(0.090)	(0.090)	(0.074)	(0.074)
Deposit Insurance Dummy × Crisis Period Dummy	0.572***	0.628***		
	(0.141)	(0.121)		
Deposit Insurance Dummy × Pre-Crisis Period Dummy	−0.055*			
	(0.029)			
Deposit Insurance Dummy		−0.055*		
		(0.029)		
Full Coverage Dummy × Crisis Period Dummy			0.323*	1.513***
			(0.179)	(0.249)
Full Coverage Dummy × Pre-Crisis Period Dummy			−1.193***	
			(0.289)	
Full Coverage Dummy				−1.193***
				(0.289)
Constant	6.423***	6.423***	4.411**	4.411**
	(1.095)	(1.095)	(1.942)	(1.942)
Observations	5447	5447	4898	4898
R-squared	0.341	0.341	0.351	0.351

This table reports regression results described in Section 3. The dependent variable is bank systemic risk, MES. The sample consists of 4109 banks in 96 countries over the time period 2004–2009. Standard errors are reported in parentheses below their coefficient estimates and adjusted for both heteroskedasticity and within correlation clustered at the bank level.
* Significance at 10% two tailed level.
** Significance at 5% two tailed level.
*** Significance at 1% two tailed level.

Columns (3) and (4) of Table 5, and are again supportive of our hypothesis.

3.5. Bank supervision, deposit insurance, and systemic risk

As mentioned earlier, we are 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 be potentially mitigated through better 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 at a particular bank. This variable comes from the banking surveys conducted by Barth et al. (2008) and described in Section 2.3.

Our dependent variable is bank *i*'s systemic risk, measured by MES described in Section 2.3. The regression specifications and control variables are the same as those used in Section 3.2. Table 6 reports the regression results. We first partition the 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 denoted as *High Supervisory Quality*, and Column (2) of Table 6 presents that the regressions coefficients for the subsample where bank supervisory quality is lower than sample median denoted as *Low Supervisory Quality*. In Columns (3) and (4), we repeat the same regression using the full coverage as the deposit insurance measure.

We find that, in Column (1) of Table 6, deposit insurance is associated with lower bank systemic risk during global crisis years and has no significant adverse impact on bank systemic risk in non-crisis years, when bank supervisory quality is high. In contrast, Column (2) of Table 6 indicates that, deposit insurance increases bank systemic risk in non-crises years and has no significant positive impact during crisis years when bank supervisory quality is low. We obtain similar results using the full coverage dummy as the deposit insurance measure in Columns (3) and (4). The results are stronger as full coverage is expected to lead to the most egregious moral hazard problems during good times. Moreover, high supervisory quality itself appears to reduce bank systemic risk during the sample period. Overall, the results in Table 6 suggest that better bank supervision can help mitigate the adverse

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

Variables	(1) High Supervisory Quality	(2) Low Supervisory Quality	(3) High Supervisory Quality	(4) Low Supervisory Quality
Log (Total Assets)	−0.728***	−0.435***	−0.491***	−0.773***
	(0.038)	(0.043)	(0.046)	(0.044)
Leverage	4.722***	0.264	0.924	5.366***
	(1.072)	(0.849)	(0.972)	(1.220)
Deposits	0.332	1.029***	0.824**	−0.120
	(0.430)	(0.372)	(0.388)	(0.529)
Provisions	−1.719***	0.200	0.160	−2.603***
	(0.386)	(0.227)	(0.266)	(0.559)
ROA	8.516	−2.710	−9.350**	9.678
	(6.345)	(3.311)	(4.179)	(7.814)
Log (GDP Per Capita)	−0.276**	0.221***	0.535***	−0.988***
	(0.139)	(0.079)	(0.088)	(0.238)
GDP Growth Volatility	−0.064	0.049	−0.037	0.048
	(0.055)	(0.062)	(0.067)	(0.060)
Log (Population)	−0.701***	−0.257***	−0.230***	−0.812***
	(0.081)	(0.070)	(0.082)	(0.213)
Trade/GDP	−0.006***	−0.007***	−0.009**	−0.017*
	(0.001)	(0.002)	(0.004)	(0.010)
Stock Market Cap/GDP	0.895***	0.550***	1.040***	1.078***
	(0.224)	(0.147)	(0.212)	(0.281)
Private Credit/GDP	−0.601*	−0.248	−0.918***	0.729
	(0.326)	(0.267)	(0.297)	(0.571)
Crisis Period Dummy	−2.212***	−1.046***	−1.653***	−2.403***
	(0.101)	(0.242)	(0.112)	(0.109)
Supervisory Quality	1.762***	0.140***	0.042	0.860**
	(0.231)	(0.039)	(0.046)	(0.344)
Deposit Insurance Dummy × Crisis Period Dummy	1.234***	0.016		
	(0.261)	(0.238)		
Deposit Insurance Dummy × Pre-Crisis Period Dummy	−0.141	−0.609***		
	(0.343)	(0.220)		
Full Coverage Dummy × Crisis Period Dummy			1.054***	−0.986**
			(0.332)	(0.463)
Full Coverage Dummy × Pre-Crisis Period Dummy			−0.023	−3.397***
			(0.277)	(0.534)
Constant	39.613***	4.990***	1.564	35.220***
	(4.001)	(1.814)	(2.390)	(7.340)
Observations	2885	1828	2571	1638
R-squared	0.401	0.297	0.439	0.317

This table reports regression results described in Section 3. The dependent variable is bank systemic risk, MES. The sample consists of 4109 banks in 96 countries over the time period 2004–2009. We first partition the sample by the bank supervisory quality index. Columns (1) and (3) report the regression results for the subsample where bank supervisory quality is greater than or equal to sample median denoted as *High Supervisory Quality*, and Column (2) and (4) report regressions coefficients for the subsample where bank supervisory quality is lower than sample median denoted as *Low Supervisory Quality*. Standard errors are reported in parentheses below their coefficient estimates and adjusted for both heteroskedasticity and within correlation clustered at the bank level.

* Significance at 10% two tailed level.

** Significance at 5% two tailed level.

*** Significance at 1% two tailed level.

consequences of deposit insurance while low bank supervisory quality 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 seem to have 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 consequence 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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