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Capital Adequacy, Deposit Insurance, and the Effect of Their Interaction on Bank Risk

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Abstract: This paper investigates how deposit insurance and capital adequacy affect bank risk for five developed and nine emerging markets over the period of 1992–2015. Although full coverage of deposit insurance induces moral hazard by banks, deposit insurance is still an effective tool, especially during the time of crisis. On the contrary, capital adequacy by itself does not effectively perform the monitoring role and leads to the asset substitution problem. Implementing the safety nets of both deposit insurance and capital adequacy together could be a sustainable financial architecture. Immediate-effect analysis reveals that the interplay between deposit insurance and capital adequacy is indispensable for banking system stability.

Keywords: deposit insurance; capital adequacy; bank risk

JEL Classification: G21; G28

1. Introduction

Banking crises have a long history, spreading over a hundred years from the 18th century until the latest one in December 2016, which was triggered by the resignation of the Italian prime minister upon a failed referendum to amend their constitution to give the government more power. A banking crisis usually has an adverse effect on the overall economy. The Great Depression in 1930s and the Global Financial Crisis (GFC) in 2008 are two most prominent examples of banking crises. The great depression in the 1930s was caused by the loss of confidence in financial institutions and the widespread insolvency of debtors, resulting in bank panic and bank runs, while the 2008 GFC was triggered by the liquidity shortfall in the US banking system, caused by subprime lending and resulting in many bank runs, and also a loss of confidence in the financial system. These examples highlight the importance of maintaining public confidence and financial system stability.

One of the major roles played by banks is to accept deposits from their clients. Bank deposits are basic and common instruments that people use to park their funds. Individuals usually perceive bank deposits as the least risky investments, due to the deposit guarantee that is made by their governments. As noted above, the failure of the banking system could lead to potentially disastrous events such as financial crises and recessions. As such, to protect bank depositors, many countries have set up financial safety nets such as deposit insurance, bank regulation and supervision, central bank lender-of-last resort facilities, and bank insolvency resolution procedures. To ensure that banks

are prudently managed, and in order to promote public confidence and financial system stability, most countries set up bank regulations and supervisions by establishing rules stating that financial institutions must hold enough capital to safeguard the banking system. The capital requirement, also known as the regulatory capital or capital adequacy, is the amount of capital that a bank must hold to meet the regulatory requirement. In essence, regulators set capital adequacy to protect the banks themselves, and their customers, as well as the government, who would be liable for the cost of deposits in the case of a bank run.

A deposit insurance scheme is another popular tool that is adopted by authorities in many countries to promote public confidence and to stabilize the financial system. Typically, two types of guarantee (e.g., implicit and explicit deposit insurances) are used; however, the guarantee level differs among countries. Some countries that do not have explicit deposit insurance usually implement some implicit forms of insurance by giving a higher priority to depositors over other claimants of insolvent banks in the solvency proceeding, while some countries implement more advanced forms of implicit deposit insurance, such as implicit coverage where relevant authorities are always responsible, albeit partially, in case of bank failure. As noted by Demirgüç-Kunt and Kane (2002), the use of a deposit insurance scheme is controversial, as it could lead to moral hazard problems and excessive risk-taking by banks.

Although the unintended consequences of deposit insurance are widely debated in the literature, few empirical studies have explicitly tested the relation between deposit insurance and bank risk. For example, Davis and Obasi (2009) examine the link between deposit insurance and bank risk for 914 banks in 64 countries using the International Monetary Fund financial soundness indicators, and they find that deposit insurance mainly affects bank risk through its relationship with profitability and asset quality. Recently, Anginer et al. (2013) studied the relation between deposit insurance and bank risk before and after the GFC, and documented that generous financial safety nets increase bank risk in the pre-GFC period, but not during the GFC period. They concluded that deposit insurance schemes lead to the moral hazard problem during normal times, but they provide stability during the crisis period.

In a seminal paper by Calem and Rob (1999), they document a U-shaped relationship between capital and risk-taking. As a bank's capital increases, it first takes less risk, then more risk. Their argument is as follows: "a deposit insurance premium surcharge on undercapitalized banks induces them to take more risk. An increased capital requirement, whether flat or risk-based, tends to induce more risk-taking by ex-ante well-capitalized banks that comply with the new standard". Further, Blum (1999) notes that capital adequacy rules may increase the bank's riskiness.

This paper fills the gap in the literature by investigating the interplay between deposit insurance and capital adequacy on bank risk. Specifically, we aim to answer the following research questions. First, does deposit insurance affect bank risk? Second, is there a relation between bank risk and capital adequacy? Third, what is the interplay effect between changes in the level of deposit insurance and capital adequacy on bank risk? Finally, how does the financial crisis affect these relations? By addressing these research questions, we contribute to the existing debate on the moral hazard generated by the tools used by regulators to maintain the stability of the financial system.

Overall, we find that deposit insurance induces moral hazard in the normal period. Further, during the time of crisis, implementing only deposit insurance does not reduce bank risk. When considering only capital adequacy, we find that it does not properly perform its monitoring function during the normal period. However, during a time of stress, capital adequacy helps to monitor the system. When considering the interaction between deposit insurance and capital adequacy during the normal period, we find that reduction in deposit insurance is not harmful. Nevertheless, deposit insurance may be necessary, since it creates confidence among depositors, attracts small depositors to invest money in banks, and hence, alleviates the adverse selection problem. The interaction between deposit insurance and capital adequacy during the stressful period indicates the asset substitution problem. That is why banks gamble even more during the crisis period. This raises the question of whether we need blanket deposit insurance during a time of stress, as it does increase moral hazards by banks even more.

The remainder of this paper is organized as follows. Section 2 reviews the related literature. Section 3 describes the data and the methods. Section 4 presents the empirical results. Section 5 concludes.

2. Literature Review

To promote a healthy financial system and avoid bank run, regulators provide financial safety nets such as deposit insurance, bank regulation and supervision, a central bank lender of last resort facilities, and bank insolvency resolution procedures. Among these tools, this paper focuses on capital adequacy and deposit insurance, and the interaction between the two.

2.1. Capital Adequacy and Bank Risk

As noted by Demirgüç-Kunt and Kane (2002), a deposit insurance scheme could lead to moral hazard problems, as banks have incentives to take excessive risk. As such, regulators need to establish some regulations to alleviate this moral hazard problem. Kim and Santomero (1988) argue that bank capital regulation is a way to curb excessive risk-taking by banks. Further, Calem and Rob (1999) examine the effect of capital adequacy and risk taking in the banking industry from 1984 to 1993, and find that the relation between capital and risk-taking is U-shaped. That is, when a bank first increases its capital, risk is lowered. However, as the level of capital keeps rising, the risk increases. Similarly, Blum (1999) notes that capital adequacy rules may increase the bank's riskiness. More recently, Lin et al. (2005) examine the relation between bank failure and capital adequacy in the banking industry in Taiwan from 1993–2000, and find a significant positive relation between the two. Hao and Zheng (2015) show that competition in the banking industry can reduce risk taking activities by banks. Therefore, with competition, banks with low capital engage in lower risk in lending.

Shrieves and Dahl (1992) and Altunbas et al. (2007) document a positive association between changes in bank capital and risk-taking. Some prior studies suggest that higher regulatory capital requirements result in lower bank risk-taking. For instance, Keeley and Furlong (1990) report that higher regulatory capital requirements reduce the moral hazard problem generated by deposit insurance, and as a result, they weaken incentives for banks to take on higher risk. Similarly, several empirical studies such as Jacques and Nigro (1997) for American banks, Ediz et al. (1998) for British banks, Konishi and Yasuda (2004) for Japanese banks, and Maji and De (2015) for Chinese banks, report an inverse association between bank capital and risk-taking.

Recently, Ashraf et al. (2016) investigate the effect of risk-based capital requirements on bank risk-taking behavior, using a panel data set of Pakistani banks. They find that commercial banks reduce asset portfolio risk in response to stringent risk-based capital requirements. Ashraf et al. (2017) study the effect of trade openness on bank risk-taking behavior using a sample of 291 banks from 37 emerging markets. The results suggest that higher trade openness diminishes bank risk-taking. Ashraf (2018) document that higher trade openness promotes bank development by raising the volume and decreasing the cost and risk of bank credit.

2.2. Deposit Insurance and Bank Risk

A bank run happens when depositors withdraw their deposits simultaneously, due to concerns over the bank's solvency. Panic withdrawals by depositors during a bank run could destabilize the banking system. Therefore, the government introduces deposit insurance to protect depositors, banks, and the financial system. Illiquidity is often known as the prime cause of a bank run. Diamond and Rajan (2005) document the contagious nature of bank failures by arguing that bank failures can squeeze the common pool of liquidity, leading to the exacerbation of aggregate liquidity shortages, and eventually a contagion of bank failures and a total collapse of the system. They further suggest that it is difficult to determine what causes a banking crisis, as liquidity and solvency problems interact and cause each other. Levy-Yeyati et al. (2010) examine bank runs in Argentina and Uruguay over the period of 2000–2002 and find that macroeconomic risk is also a key factor for a bank run.

Given that a bank run can lead to a meltdown of the system, it is important for the government to intervene and to provide a safety net to the system. Diamond and Dybvig (1983) propose a deposit insurance system to promote stability for the banking system. Existing studies on the effect of deposit insurance on bank risk-taking and the potential for banking sector fragility are mixed. For example, Wheelock and Wilson (1995) and Alston et al. (1994) find no relationship between historical US bank failure rates and deposit insurance. Karel and McClatchey (1999) also find no evidence that the adoption of deposit insurance increases the risk-taking of US credit unions. On the other hand, Grossman (1992), Wheelock (1992), and Thies and Gerlowski (1989) document a positive and significant relationship between deposit insurance and bank risk. Similarly, Demirgüç-Kunt and Detragiache (2002) find recent evidence of a positive relation between deposit insurance and the probability of a banking crisis in a sample of 61 countries over the period 1980–1997.

More recently, Acharya and Mora (2015) empirically study the onset of the 2007–2009 crisis and find that deposit inflows into banks weakened—this increased banks' loan-to-deposit shortfalls. As this problem worsened, banks needed to attract deposits by offering higher rates, but the resulting private funding was insufficient to cover the shortfalls and, as a result, they reduced new credit. Obviously, banks weather this crisis through the government's support. Angkinand (2009) investigates how deposit insurance systems and the ownership of banks affect the degree of market discipline on banks' risk-taking, and document a U-shaped relationship between explicit deposit insurance coverage; she also finds that banks' risk-taking is influenced by country-specific institutional factors, including bank ownership. Anginer et al. (2013) study how deposit insurance affects bank risk during the recent crisis, and suggest that deposit insurance works well during a crisis, but it leads to moral hazard during normal times.

Further, some studies empirically explore the impact of deposit insurance coverage. Demirgüç-Kunt and Detragiache (2002) find that a greater coverage of deposit insurance leads to more bank risk. Imai (2006) provides evidence that changing from a blanket deposit insurance to limited coverage results in less risk-taking in the banking industry in Japan. Schotter and Yorulmazer (2009) also report that partial insurance reduces bank risk. However, Madiès (2006) does not support such findings.

Shy et al. (2014) compare three systems of deposit insurance: no deposit insurance, unlimited deposit insurance, and limited deposit insurance. They show that limited deposit insurance coverage softens the bank competition for deposits, and this leads to a loss in total welfare, compared with unlimited or no deposit insurance. Limited deposit coverage induces some depositors to transfer money between banks, in order to improve their insurance coverage. Therefore, they conclude that limited deposit insurance will soften the lending rate competition, and that banks can target specific borrowers with less competition. This implies that limited deposit insurance leads to higher bank risk.

2.3. The Interplay

Cooper and Ross (1988) extend the Diamond–Dybvig model to theoretically analyze the effect of deposit insurance in the presence of capital adequacy requirements. They theoretically show that regardless of whether the deposit insurance is full or partial, banks will take excessively risky projects. Thus, capital requirements are needed in order to overcome the adverse incentive problem from deposit insurance. In their model, the combination of these two regulatory policies can generate the first-best allocation. Manz (2009) concludes that capital adequacy regulation is not a substitute for deposit insurance. An insight from Manz's model is that blanket deposit insurance can be detrimental, and an optimal level of deposit insurance and its interaction with capital regulation can be beneficial in risk reduction.[1]

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[1] In the literature, capital adequacy regulation and deposit insurance can be viewed either as substitutes or complements. To the extent that they are substitutes, when one mechanism exists, the other is less likely to be adopted. According to Manz (2009), however, these two mechanisms can be complements and therefore they can co-exist and be beneficial.

3. Data and Methodology

3.1. Data

As shown in Table 1, our sample includes 2129 banks from five developed and nine emerging countries from 1992 to 2015. The key variables of interest in this paper are deposit insurance and capital adequacy. Transition dates for deposit insurance are from various sources as follows. The data for Australia, Germany, and Denmark are sourced from Demirgüç-Kunt et al. (2014). The others are collected from the research paper of the International Association of Deposit Insurers (IADI) from 2005 and 2012. Based on the transition dates reported in Table 1, we define the limited guarantee of deposit insurance dummy variable (LDI) as 0 for full deposit insurance and 1 otherwise.

Table 1. Deposit Insurance Reduction Dates.

Country	Deposit Insurance Reduction Date	No. of Firm-Year Observations	No. of Firm Observations	Sample Period
Developed Markets				
Australia	1 February 2012	261	31	2005–2015
Germany	1 January 2011	25,577	1446	1992–2015
Denmark	30 September 2010	974	70	1992–2015
Ireland	1 October 2008	166	17	2000–2015
Japan	1 April 2005	2681	179	1992–2014
Sweden	1 July 1996	997	81	1995–2015
Emerging Markets				
Ecuador	1 January 2002	217	14	2000–2015
Indonesia	1 March 2007	1090	78	1992–2015
South Korea	1 January 2001	146	22	1993–2015
Mexico	1 January 2003	773	60	1992–2015
Malaysia	1 January 2011	322	67	1995–2015
Nicaragua	1 July 2003	73	5	1992–2014
Thailand	11 August 2012	399	27	1993–2015
Turkey	1 July 2004	343	32	1999–2015

This table reports the date when each country in our samples reduces its deposit insurance. Data are collected from various sources as follows: For Australia, Germany, and Denmark, data are sourced from Demirgüç-Kunt et al. (2014). The others are sourced from research paper of International Association of Deposit Insurers (IADI, IADI).

Bank characteristics are sourced from Bankscope. For bank capital adequacy, which is another key variable of interest, we follow Demirgüç-Kunt et al. (2013), and we define capital adequacy (CAR) as the risk-adjusted regulatory capital ratio, calculated according to Basel rules (the sum of Tier I and Tier II capital, divided by the risk-adjusted assets and off-balance sheet exposures).

To measure bank risk, we used two accounting based measures as follows. First, we followed Laeven and Levine (2009) and computed the z-score, a common measure of bank risk in the banking literature, as the summation of the current bank return on assets (ROA), which is the net income divided by the total assets and the bank's equity-to-assets ratio, scaled by the standard deviation of the return on assets over the full sample period. The lower z-score indicates a higher bank risk. Following Laeven and Levine (2009), we use the natural logarithm of the z-score in our analysis due to the highly-skewed distribution of the z-score (as reported in Table 2 below). Another accounting-based measure of bank risk adopted in this paper is the earnings volatility, which is the standard deviation of the ratio of earnings before tax and loan loss provision to the average assets from year t to $t-5$.

In addition, we include various bank- and country-level control variables as follows. For the bank-level control variables, for each bank and each year, we include provisions (loan loss provisions divided by total assets), bank size (natural logarithm of total assets), deposit representation (deposits of each bank divided by total deposit of each country), leverage (equities divided by total assets),

revenue growth (total revenue (EBIT) over the past year), and loan proportion (net loans divided by total assets).[2]

Table 2. Descriptive Statistics.

Variables	Full Sample			Developed Markets			Emerging Markets		
	N	μ	σ	N	μ	σ	N	μ	σ
Log(Z-Score)	33,908	1.5935	0.7247	30,610	1.5257	0.6850	3298	2.2228	0.7781
Earning volatility	24,662	0.0040	0.0093	22,586	0.0029	0.0038	2076	0.0162	0.0265
CAR	15,902	0.1709	0.1258	13,457	0.1634	0.1027	2445	0.2124	0.2070
LDI	34,019	0.3288	0.4698	30,656	0.2924	0.4549	3363	0.6604	0.4736
LLP	33,420	0.1516	0.3696	30,217	0.1461	0.3059	3203	0.2040	0.7345
Log(Asset)	34,019	13.8614	1.8863	30,656	13.7873	1.8322	3363	14.5365	2.2106
Deposit	34,019	0.0003	0.0026	30,656	0.0001	0.0018	3363	0.0018	0.0060
Equity/Total Assets	34,019	0.0732	0.0647	30,656	0.0658	0.0397	3363	0.1413	0.1509
Revenue growth	31,826	0.0489	2.2553	28,784	0.0484	1.2121	3042	0.0540	6.2708
Loan	33,995	0.5946	0.1477	30,655	0.5993	0.1377	3340	0.5515	0.2143
Log(GDP Per Capita)	33,687	10.2873	0.7229	30,530	10.4875	0.2482	3157	8.3510	0.9188
Trade/GDP	34,019	0.6628	0.2350	30,656	0.6573	0.2089	3363	0.7126	0.3975
Log(Population)	34,019	18.0976	0.6992	30,656	18.0760	0.6666	3363	18.2946	0.9232
Stock Market Cap/GDP	34,019	0.4414	0.2264	30,656	0.4426	0.1990	3363	0.4310	0.3968
GDP Growth Volatility	31,808	6.5860	8.4382	28,731	5.8939	6.2583	3077	13.0492	18.0054

This table reports the descriptive statistics of all variables included in this study for the full sample, the developed and the emerging markets. Log(Z-Score) is the natural logarithm of the average return on assets (ROA) plus the equity–asset ratio, divided by the standard deviation of ROA. Earning volatility is the average standard deviation of the ratio of total earnings before taxes and loan loss provisions to the average total assets over the past five years. CAR is the Capital Adequacy Ratio: Tier I capital plus Tier II capital, divided by the risk-weighted assets. LDI is a dummy variable, being 1 for limited deposit insurance and 0 otherwise. LLP is the loan loss provision divided by the net interest revenue. Log(Asset) is the natural logarithm of total assets. Deposit represent is the percentage of the bank's deposits to the total deposits in each country. Equity/Total Assets is the ratio of equity to total assets. Revenue growth represents the growth in total revenues (EBIT) of the bank over the past year. Loan measures the net loans to the total assets. Log(GDP Per Capita) is the natural logarithm of the gross domestic product divided by midyear population. Trade/GDP is the sum of the exports and imports of goods and services measured as a share of the gross domestic product. Log(Population) is the natural logarithm of the total population of each country. Stock Market capitalization/GDP is the ratio of stock market capitalization to GDP. GDP Growth Volatility measures the variance of GDP growth for the previous five years. Firm-level data are collected from Bankscope, while country-level data are sourced from World Bank. N represents the number of observations, while μ and σ are the mean and standard deviation, respectively. The sample period for each country is as stated in Table 1.

To deal with potential omitted variables, we also control for a number of country-level variables, as both bank risk and deposit insurance can be affected by the economic conditions in a country. We draw these measures of economic development from the World Bank's World Development Indicator (WDI) database. We use the natural logarithm of GDP per capita as the proxy for the economic development of a country, the variance of the GDP growth rate for economic stability, the natural logarithm of the population for country size, and imports plus exports of goods and service divided by GDP for global integration (see Karolyi et al. 2012) and finally, the stock market capitalization divided by the GDP (Beck et al. (2010) for differences in financial development). Finally, to capture the effect of the global financial crisis (GFC), we also include the GFC dummy variable, taking a value of 1 for the years of 2007 to 2009, and zero otherwise.

Table 2 reports the summary statistics of all the variables included in this study for the full sample, both the developed and emerging markets. The two proxies for bank risk appear to measure different aspects of bank risk, as we find contrasting results for the developed and emerging markets. That is, for the Log(Z-score) variable, we find higher means and volatility in the emerging markets than those in the developed markets. The higher mean of Log(Z-score) implies a lower bank risk in the emerging markets, and longer distant to default (less likely to be bankrupt). However, for the earnings' volatility

[2] Revenue growth is the total revenue in the current year minus the total revue in the previous year, all divided by the total revenue in the previous year.

variable, we find that, on average, banks in the emerging markets experience higher earnings volatility, indicating a higher bank risk in the emerging markets. It should be noted that higher earnings volatility in the emerging markets, nonetheless, reflects unstable revenue growth, rather than a more direct measure of the probability of default.

Almost all bank-level variables, except for the ratio of net loans to total assets, have higher means in the emerging markets than in the developed markets. This implies that banks in the emerging markets are larger in size, have higher loan loss provisions, higher percentage of the bank's deposits to total deposits, higher equity-to-total assets ratio, and higher revenue growth, than banks in the developed markets. For the country control variables, we find that emerging markets have smaller stock markets and lower GDP, but higher GDP growth volatility, trades, and population. Further, dispersions of all independent variables in the emerging markets are larger than those in the developed markets.

3.2. Empirical Modelling

To investigate the relationship between deposit insurance and bank risk, we estimate the following panel regression model:

$$Risk_{ijt} = \beta_0 + \beta_1 LDI_{ijt} + \beta_2 GFC + \beta_3 \times GFC \times LDI_{ijt} + \sum_{k=1}^{N} \beta_k Control_{ijkt} + \sum_{z=1}^{N} \beta_z Country_{izt} + \varepsilon_{ijt} \quad (1)$$

where $Risk_{ijt}$ is bank risk measured by the log of the z-score at the end of year t. β_1, β_2, β_3 are the coefficients to be estimated. LDI_{ijt} is the type of deposit insurance, 0 for blanket deposit insurance and 1 for limited deposit insurance. GFC stands for global financial crisis, and it equals 1 for the years of the global financial crisis (2007–2009), and 0 otherwise.

We include a number of control variables that are consistent with prior studies (Laeven and Levine 2009; Ashraf et al. 2016; and Ashraf et al. 2017; Ashraf 2018). $Control_{ijkt}$ is a matrix of bank-level control variables, which include LLP (loan loss provision), log(assets), Deposit (the percentage of the bank's deposits to total deposits in each country), Equity (equity to total assets), Revenue Growth (growth in EBIT of the bank over the past year) and Loan (net loan to total assets), and $\sum_{k=1}^{N} \beta_k$ are their coefficients to be estimated. $Country_{izt}$ is a matrix of country-level control variables, which includes log(GDP per capita), Trade/GDP (the sum of exports and imports of goods and services divided by GDP), log(population), stock market capitalization/GDP, and GDP growth volatility (the variance of GDP growth for the previous five years).[3] $Risk_{ijt}$ is also measured by the earning volatility as an alternative to bank risk. $GFC \times LDI_{ijt}$ is the interaction term that represents the impact of type of deposit insurance and its role on bank risk during the global financial crisis. Finally, ε_{ijt} is a disturbance term.

In testing the relationship between bank risk and capital adequacy, we estimate the following panel regression model:

$$Risk_{ijt} = \beta_0 + \beta_1 CAR_{ijt} + \beta_2 GFC + \beta_3 \times GFC \times CAR_{ijt} + \sum_{k=1}^{N} \beta_k Control_{ijkt} + \sum_{z=1}^{N} \beta_z Country_{izt} + \varepsilon_{ijt} \quad (2)$$

where CAR_{ijt} is the Capital Adequacy Ratio, computed as Tier I capital plus Tier II capital, divided by the risk-weighted assets. $GFC \times CAR_{ijt}$ is the interaction term, which represents the impact of the

[3] Ashraf et al. (2017), using a sample of 291 banks from 37 emerging countries, report that stronger trade openness diminishes bank risk-taking. Trade openness provides diversification opportunities to banks in lending activities, which decreases the overall bank risk. In addition, Ashraf (2018) finds that higher trade openness promotes bank development by increasing the volume and decreasing the cost and risk of bank credit.

Capital Adequacy Ratio and its role on bank risk during the global financial crisis. The others are the same as in (1).

Next, to investigate the interplay between deposition insurance and capital adequacy on bank risk, we fit the following panel regression models:

$$Risk_{ijt} = \beta_0 + \beta_1 LDI_{ijt} + \beta_2 CAR_{ijt} + \beta_3 GFC + \beta_4 CAR_{ijt} \times LDI_{ijt} + \beta_5 \times GFC \times CAR_{ijt} + \sum_{k=1}^{N} \beta_k Control_{ijkt} + \sum_{z=1}^{N} \beta_z Country_{izt} + \varepsilon_{ijt} \quad (3)$$

$$Risk_{ijt} = \beta_0 + \beta_1 LDI_{ijt} + \beta_2 CAR_{ijt} + \beta_3 GFC + \beta_4 CAR_{ijt} \times LDI_{ijt} + \beta_5 \times GFC \times CAR_{ijt} + \beta_6 \times LDI_{ijt} \times GFC \times CAR_{ijt} + \sum_{k=1}^{N} \beta_k Control_{ijkt} + \sum_{z=1}^{N} \beta_z Country_{izt} + \varepsilon_{ijt} \quad (4)$$

The variables in (3) and (4) are the same as in (1) and (2). Additionally, $CAR_{ijt} \times LDI_{ijt}$ is the interaction term, which represents the interplay between the Capital Adequacy Ratio and the type of deposit insurance and their interplaying effect on bank risk. $GFC \times CAR_{ijt} \times LDI_{ijt}$ is the interaction term, which represents the impact on bank risk of both Capital Adequacy Ratio and type of deposit insurance and their interplaying role during the global financial crisis.

We divide the whole sample into two sub samples, one for the developed markets and the other for the emerging markets and repeat the testing for Models 1 to 4.

4. Empirical Results

4.1. Deposit Insurance, Capital Adequacy, and Bank Risk

Table 3 reports the panel regression results for Models 1 to 5, where, using the log of z-score, we investigate the relation between overall deposit insurance, capital adequacy, and bank risk. Model 1 focuses on bank risk when deposit insurance is the only tool that is adopted by the authorities. As shown in Model 1, we find a positive and significant relation between the log of the z-score and limited deposit insurance, a negative and significant relation between the log of the z-score and the GFC dummy, and between the log of the z-score and the interaction term of LDI and GFC. Taken together, we argue that (i) a reduction in the deposit insurance, or limited deposit insurance, reduces bank risk; (ii) bank risk increases during the GFC period; and (iii) a reduction in insurance or limited deposit insurance intensifies bank risk during the GFC period. When deposit insurance is the only tool that is adopted by the authorities, our findings are evidence of the moral hazard problem during the normal time, while a panic-driven period may warrant the need for blanket deposit insurance, as documented by Anginer et al. (2013). Further, we find evidence that is consistent with Demirgüç-Kunt and Kane (2002), who argues that deposit insurance could lead to the moral hazard problem, and that limited coverage is an important way to mitigate such excess risk-taking by banks.

The coefficients of the control variables are generally consistent with the expectations, and with the results from prior research. For instance, larger banks with more total assets experience lower risk. Banks with larger deposits experience less risk. Banks in more wealthy countries (higher GDP per capita) sustain lower risk. Banks in countries with more GDP volatility exhibit higher risk.

Table 3. Effect of deposit insurance and capital adequacy on bank risk.

Model	(1)	(2)	(3)	(4)
LDI	0.174 ***		0.293 ***	0.314 ***
	(0.00924)		(0.0504)	(0.0504)
CAR		−0.300 *	0.0861	−0.0438
		(0.154)	(0.344)	(0.325)
PREM				
GFC	−0.494 ***	−0.642 ***	−0.592 ***	−0.686 ***
	(0.00596)	(0.0388)	(0.0379)	(0.0583)
LDI × CAR			−0.593 *	−0.415
			(0.311)	(0.307)
LDI × GFC	−0.170 ***			0.0523
	(0.0173)			(0.0764)
CAR × GFC		0.0973	0.136	1.139 ***
		(0.253)	(0.252)	(0.379)
LDI × CAR × GFC				−1.349 ***
				(0.519)
LLP	−0.147 ***	−0.197 ***	−0.175 ***	−0.176 ***
	(0.0201)	(0.0263)	(0.0263)	(0.0263)
Log(Assets)	−0.0384 ***	−0.0329 ***	−0.0337 ***	−0.0319 ***
	(0.00401)	(0.00487)	(0.00491)	(0.00471)
Deposit	5.381 **	5.862 **	5.891 ***	5.912 ***
	(2.647)	(2.381)	(2.230)	(2.229)
Equity/Total Assets	6.193 ***	6.755 ***	6.699 ***	6.711 ***
	(0.372)	(0.610)	(0.585)	(0.581)
Revenue growth	0.00119	0.00175	0.00151	0.00162
	(0.00199)	(0.00252)	(0.00253)	(0.00253)
Loan	0.238 ***	0.110 *	0.101	0.116 *
	(0.0386)	(0.0626)	(0.0649)	(0.0626)
Log(GDP Per Capita)	0.138 ***	0.470 ***	0.212 ***	0.148 **
	(0.0270)	(0.0522)	(0.0625)	(0.0646)
Trade/GDP	1.157 ***	0.238 ***	−0.234 **	−0.268 **
	(0.0445)	(0.0850)	(0.111)	(0.112)
Log(Population)	1.485 ***	−0.817 **	−0.122	−0.0967
	(0.246)	(0.336)	(0.354)	(0.352)
Stock Market Cap/GDP	−0.446 ***	0.253 ***	0.142 ***	0.128 ***
	(0.0304)	(0.0297)	(0.0319)	(0.0325)
GDP Growth Volatility	−0.000944	0.00155 **	8.97×10^{-5}	-3.08×10^{-5}
	(0.000591)	(0.000693)	(0.000776)	(0.000777)
Constant	−24.85 ***	10.25 **	1.489	1.735
	(3.972)	(5.215)	(5.449)	(5.391)
Country dummies	Yes	Yes	Yes	Yes
Year dummies	No	No	No	No
Observations	30,025	14,709	14,709	14,709
R-squared	0.590	0.714	0.724	0.726

The sample consists of 2129 banks from 14 countries. The dependent variable is the log of the z-score, computed as the natural logarithm of the bank's return on assets, plus the capital asset ratio divided by the standard deviation of asset returns. The LDI is set to 0 for blanket deposit insurance, and 1 for limited deposit insurance. CAR is the Capital Adequacy Ratio computed as Tier I capital plus Tier II capital, divided by risk-weighted assets. GFC is 1 for the years of the global financial crisis (2007–2009), and 0 otherwise. LLP is the loan loss provision divided by the net interest revenue. Log(Assets) is the natural logarithm of the total assets. Deposit Representation is the percentage of the bank's deposits to the total deposits in each country. Equity is equity-to-total assets. Revenue growth is the growth in total revenues (EBIT) of the bank over the past year. Loan is the net loans to total assets. Log(GDP Per Capita) is the natural logarithm of GDP divided by the midyear population. Trade/GDP is the sum of exports and imports of goods and services, measured as a share of the GDP. Population is the total population of each country. Stock Market capitalization/GDP is the stock market capitalization divided by GDP. GDP growth volatility is the variance of GDP growth for the previous five years. Panels A and B report full sample and subsamples, respectively. The *p*-values shown in Panel B are based on the Chi-square tests for the equality of coefficients on interaction terms in two subsamples with developed and emerging countries. Robust standard errors are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Model 2 considers the effect of capital adequacy on bank risk using the log of the z-score, when capital adequacy is the only tool that is adopted by the authorities. We find a negative and statistically significant relation between CAR and the log of z-score, and between the GFC dummy variable and the log of z-score. Taking these together, we argue that (i) a higher capital adequacy induces a higher bank risk, (ii) bank risk increases during the GFC period, (iii) during the GFC period, higher capital adequacy has no impacts on bank risk. This evidence suggests that capital adequacy does not perform an effective monitoring role. Our findings confirm a positive relation between capital adequacy and bank risk, as documented by Calem and Rob (1999), Blum (1999), and Lin et al. (2005). Hao and Zheng (2015) also show that, with the competition in the banking industry represented by the number of interstate branches, there is a positive relationship between capital adequacy and bank risk. Moreover, Zhang et al. (2015) find that all three regulations, Tier I leverage ratio, Tier I Capital ratio, and Tier I risked-based capital ratio are very important for controlling bank risk, especially in the post-crisis period. Bornemann et al. (2014) also conclude that capital reserves, within the financial accounting framework, are effective in controlling bank risk.

We argue that this positive relation between capital adequacy and bank risk implies that capital adequacy alone may not be an effective tool for monitoring bank risk, as it leads to the asset substitution problem. The asset substitution problem refers to an agency conflict where shareholders prompt the firm to take riskier investments, which in turn causes an adverse effect on the bondholder. Higher capital or equity exacerbates such an agency problem. Generally, the asset substitution problem becomes more severe during a stressful period. In our case, with a high level of capital adequacy, banks act on shareholders' (owners of the banks) interests by taking on more risky loans to increase the bank's profit, resulting in an adverse effect to depositors with limited deposit insurance. This implication for the asset substitution problem is in line with Blum (1999), who shows that, in a dynamic framework under the binding capital requirements of bank, the additional value of banks will be created with an additional unit of equity. The reason for this is that raising equity is excessively costly. The only way to compensate for such a cost is to engage in risk-taking activities.

Model 3 considers the effect of both deposit insurance and capital adequacy on bank risk, when both tools are adopted by the authorities. Overall, we find largely consistent results as in Model 1. The bank risk is heightened during the GFC period and a reduction in deposit insurance reduces bank risk. Similar to Model 2, capital adequacy has no relation with bank risk. However, the combined effect of both a reduction in the deposit insurance and the use of capital adequacy intensifies bank risk.

Model 4 considers the influence of the GFC on the effect of both deposit insurance and capital adequacy on bank risk, when both tools are adopted by the authorities. We find a positive and statistically significant relation between LDI and the log of the z-score, and also between the log of the z-score and the interaction term between capital adequacy and the GFC dummy variable. We find a negative and statistically significant relation between the GFC dummy and the log of z-score, and between the log of the z-score and the interaction term among LDI, capital adequacy, and the GFC dummy variable. These findings imply that bank risk heightens during the GFC period, but that an increase in capital adequacy during that period reduces bank risk. As such, capital adequacy appears to perform its monitoring role well during the GFC period. On the contrary, a reduction in deposit insurance, together with an increase in capital adequacy during the GFC period, intensifies bank risk. The combination of capital adequacy and limited deposit insurance heightens the asset substitution problem during the time of turmoil. Further, this is also consistent with the findings from Model 1 stating that during the stressful time, there might be a need for blanket insurance.

Furthermore, we partition the sample into the developed versus the emerging markets (results not shown, but available upon request). We find stronger results in the developed markets. When deposit insurance is the only tool that is adopted by the authorities, we find that for both the developed and the emerging markets, a reduction in deposit insurance reduces bank risk during the normal time. This is evidence of the moral hazard problem due to deposit insurance during the normal time, but not

during the stressful period (Anginer et al. 2013). When capital adequacy is the only tool that is used by regulators, we find no relation between capital adequacy and bank risk in the emerging markets, but capital adequacy increases bank risk in the developed markets. This implies that capital adequacy may not be effectively used or enforced in the emerging markets. (Calem and Rob 1999; Blum 1999; Lin et al. 2005; Hao and Zheng 2015). The combined tools show an adverse effect during the normal time for the developed markets. However, the combined tools do not show any significant impact during the stressful time in either the developed or emerging markets. During the global financial crisis, a reduction in deposit insurance and an increase in capital adequacy does not significantly affect bank risk.

Table 4 reports the results when earnings volatility is used as a proxy for bank risk. We find that limited insurance coverage reduces risk significantly. This result supports the argument that the moral hazard problem is associated with the use of blanket deposit insurance. However, this relationship is not significant in the emerging markets. An increase in capital adequacy significantly reduces bank risk, as shown in Models 3 and 4. Interestingly, when these two regulatory tools are simultaneously used, limited deposit insurance and increased capital adequacy ratio significantly intensifies bank risk.

Table 4. Effect of deposit insurance and capital adequacy on bank risk—earning volatility.

	(1)	(2)	(3)	(4)
LDI	−0.000908 ***		−0.00502 ***	−0.00440 ***
	(0.000244)		(0.00140)	(0.00154)
CAR		−0.00465	−0.0218 **	−0.0235 **
		(0.00388)	(0.00855)	(0.00925)
GFC	0.00142 ***	0.000966	0.00112	2.89×10^{-6}
	(0.000252)	(0.00106)	(0.00106)	(0.00113)
LDI × CAR			0.0238 ***	0.0261 ***
			(0.00848)	(0.00953)
LDI × GFC	−0.00238 ***			-7.55×10^{-5}
	(0.000696)			(0.00177)
CAR × GFC		0.000967	−0.00140	0.0139 *
		(0.00692)	(0.00718)	(0.00732)
LLP	0.000578	2.04×10^{-5}	9.01×10^{-5}	0.000109
	(0.000563)	(0.000552)	(0.000532)	(0.000534)
Log(Assets)	−0.000470 ***	−0.000393 ***	−0.000390 ***	−0.000366 ***
	(8.00×10^{-5})	(8.86×10^{-5})	(8.24×10^{-5})	(8.07×10^{-5})
Deposit	−0.0625 *	−0.0728 **	−0.0566	−0.0585
	(0.0378)	(0.0358)	(0.0374)	(0.0378)
Equity/Total Assets	0.0286 **	0.0270 *	0.0321 **	0.0331 **
	(0.0127)	(0.0154)	(0.0149)	(0.0150)
Revenue growth	2.43×10^{-5}	2.81×10^{-5}	3.01×10^{-5}	3.27×10^{-5}
	(5.11×10^{-5})	(6.05×10^{-5})	(5.99×10^{-5})	(5.92×10^{-5})
Loan	−0.00305 ***	−0.00335 ***	−0.00327 ***	−0.00299 **
	(0.00106)	(0.00124)	(0.00122)	(0.00122)
Log(GDP Per Capita)	−0.00864 ***	−0.0105 ***	−0.00876 ***	−0.0100 ***
	(0.00174)	(0.00186)	(0.00180)	(0.00201)
Trade/GDP	0.00394 *	0.00389	0.00744 **	0.00667 *
	(0.00225)	(0.00319)	(0.00352)	(0.00343)
Log(Population)	−0.0112	−0.0225 *	−0.0320 **	−0.0318 **
	(0.0186)	(0.0134)	(0.0134)	(0.0134)
Stock Market Cap/GDP	−0.00173 ***	−0.00358 ***	−0.00285 ***	−0.00308 ***
	(0.000509)	(0.000882)	(0.000953)	(0.000968)
GDP Growth Volatility	0.000204 ***	0.000182 ***	0.000191 ***	0.000185 ***
	(3.95×10^{-5})	(3.90×10^{-5})	(3.94×10^{-5})	(3.86×10^{-5})

Table 4. *Cont.*

	(1)	(2)	(3)	(4)
Constant	0.298	0.511 **	0.653 ***	0.663 ***
	(0.305)	(0.218)	(0.218)	(0.217)
Country dummies	Yes	Yes	Yes	Yes
Year dummies	No	No	No	No
Observations	24,069	12,411	12,411	12,411
R-squared	0.298	0.339	0.353	0.357

The sample consists of 2129 banks from 14 countries. The dependent variable is the earning volatility, computed as the standard deviation of the bank's earnings over the past five years. LDI is set to 0 for blanket deposit insurance, and 1 for limited deposit insurance. CAR is the Capital Adequacy Ratio computed as Tier I capital plus Tier II capital, divided by the risk-weighted assets. GFC is set to 1 for years of the global financial crisis (2007–2009) and 0 otherwise. PREM is set to 0 for countries that use a fixed premium, and 1 for a risk-adjusted premium of deposit insurance. LLP is the loan loss provision divided by the net interest revenue. Log(Assets) is the natural logarithm of total assets. Deposit Represent is the percentage of the bank's deposits to the total deposits in each country. Equity is the equity to total assets. Revenue growth is the growth in total revenues (EBIT) of the bank over the past year. Loan is the net loans to total assets. Log(GDP Per Capita) is the natural logarithm of GDP divided by the midyear population. Trade/GDP is the sum of exports and imports of goods and services, measured as a share of GDP. Population is the total population of each country. Stock Market capitalization/GDP is the stock market capitalization divided by the GDP. GDP growth volatility is the variance of GDP growth for the previous five years. Panels A and B report full samples and subsamples, respectively. The *p*-values shown in Panel B are based on the Chi-square tests for the equality of coefficients on the interaction terms in two subsamples with developed and emerging countries.

4.2. The Immediate Effect of Deposit Insurance Reduction on Capital Adequacy and Bank Risk

In this section, we further investigate in Tables 5 and 6 how the timing of deposit insurance reduction, together with capital adequacy, affects bank risk. Table 5 uses the log of the z-score as the proxy for bank risk. Model 5 indicates that blanket insurance, limited insurance, and capital adequacy, each used by itself, are not an effective tool in bank risk reduction. Consistent with the findings in Table 3, we also find that the GFC period intensifies bank risk. However, when deposit insurance (blanket or limited) is used together with capital adequacy, these tools become effective, as evidenced by the bank risk reduction. Further, findings from Model 5 also highlight that blanket insurance during the GFC period lowers bank risk. This warrants blanket insurance during the stressful time. The findings from Model 6 are largely consistent with those from Model 5, with additional evidence supporting the benefit of blanket insurance and capital adequacy during GFC. Overall, we find that deposit insurance (blanket or limited) by itself leads to the moral hazard problem, while capital adequacy by itself does not perform the monitoring role well (Demirgüç-Kunt and Kane 2002; Davis and Obasi 2009; Schotter and Yorulmazer 2009). However, when capital adequacy and deposit insurance are both adopted, capital adequacy does the monitoring job well, and it alleviates the moral hazard problem of the deposit insurance scheme (Cooper and Ross 2002). Finally, during the stressful period, with capital adequacy serving as a monitoring tool, it may be beneficial to implement blanket deposit insurance rather than a reduction in deposit insurance (Madiès 2006).

Partitioning the sample into the developed versus emerging markets, we again find stronger results in the developed markets. The results from the developed markets are consistent with those that are reported for the full sample. Table 6 uses earnings volatility as the proxy for bank risk. The results from this table are in line with those in Table 5. Overall, the evidence on the immediate effect supports our main findings, as reported in Appendix A.

Table 5. The immediate effect of reduction in deposit insurance, capital adequacy and bank risk.

Model	(5)	(5a)	(5b)	(6)	(6a)	(6b)
		Developed	Emerging		Developed	Emerging
Pre	−0.326 ***	−0.543 ***	0.118 *	−0.298 ***	−0.564 ***	0.125 *
	(0.0542)	(0.0799)	(0.0659)	(0.0525)	(0.0704)	(0.0672)
During	−0.0781 *	−0.116 **	0.0709	−0.0902 **	−0.114 **	0.106
	(0.0416)	(0.0453)	(0.0778)	(0.0449)	(0.0445)	(0.120)
CAR	−0.551 ***	−0.670 ***	−0.110	−0.497 ***	−0.677 ***	−0.0740
	(0.189)	(0.163)	(0.202)	(0.175)	(0.161)	(0.212)
GFC	−0.677 ***	−0.587 ***	−0.596 ***	−0.613 ***	−0.619 ***	−0.577 ***
	(0.0337)	(0.0587)	(0.0493)	(0.0509)	(0.119)	(0.0556)
CAR × Pre	0.651 **	2.096 ***	0.236	0.471	2.234 ***	0.193
	(0.330)	(0.438)	(0.221)	(0.320)	(0.385)	(0.230)
p-value for Chi-Square		0.5991			0.9940	
CAR × During	1.009 ***	1.327 ***	0.386	1.090 ***	1.315 ***	0.197
	(0.249)	(0.263)	(0.247)	(0.271)	(0.259)	(0.566)
p-value for Chi-Square		0.0134			0.0008	
Pre × GFC	0.152 ***	0.160 ***	0.0373	−0.0743	0.237 *	−0.0864
	(0.0239)	(0.0471)	(0.0512)	(0.0804)	(0.129)	(0.145)
p-value for Chi-Square		0.0005			0.0347	
During × GFC	−0.110 *	−0.630 ***	0.0147	−0.0847	−1.118 ***	−0.0525
	(0.0669)	(0.206)	(0.0647)	(0.116)	(0.311)	(0.128)
p-value for Chi-Square		0.0021			0.0025	
CAR × GFC	0.0915	−0.596	0.125	−0.311	−0.363	0.0325
	(0.255)	(0.607)	(0.234)	(0.369)	(1.073)	(0.266)
p-value for Chi-Square						
Pre × CAR × GFC				1.460 ***	−0.532	0.653
				(0.553)	(1.109)	(0.766)
p-value for Chi-Square					0.0116	
During × CAR × GFC				−0.0672	3.575 *	0.322
				(0.496)	(1.867)	(0.626)
p-value for Chi-Square						–
LLP	−0.170 ***	−0.149 ***	−0.142 *	−0.171 ***	−0.149 ***	−0.143 *
	(0.0262)	(0.0202)	(0.0750)	(0.0262)	(0.0201)	(0.0751)
Log(Assets)	−0.0322 ***	−0.0257 ***	0.00876	−0.0307 ***	−0.0259 ***	0.00895
	(0.00489)	(0.00512)	(0.0103)	(0.00470)	(0.00505)	(0.0103)
Deposit	5.972 ***	8.172 ***	1.400	5.946 ***	8.248 ***	1.430
	(2.232)	(3.002)	(2.072)	(2.224)	(3.021)	(2.079)
Equity/Total Assets	6.722 ***	9.795 ***	4.712 ***	6.733 ***	9.790 ***	4.694 ***
	(0.582)	(0.996)	(0.491)	(0.578)	(1.000)	(0.497)
Revenue growth	0.00164	0.00439 ***	−0.00138	0.00162	0.00439 ***	−0.00138
	(0.00258)	(0.00166)	(0.00220)	(0.00256)	(0.00166)	(0.00220)
Loan	0.110 *	0.118 ***	0.248 **	0.124 *	0.121 ***	0.254 **
	(0.0657)	(0.0456)	(0.120)	(0.0633)	(0.0457)	(0.121)
Log(GDP Per Capita)	0.191 ***	0.576 ***	0.144 *	0.185 ***	0.571 ***	0.141 *
	(0.0648)	(0.115)	(0.0837)	(0.0655)	(0.116)	(0.0839)
Trade/GDP	−0.245 **	−1.054 ***	−0.221	−0.244 **	−1.057 ***	−0.225
	(0.110)	(0.182)	(0.194)	(0.110)	(0.181)	(0.195)
Log(Population)	−0.281	1.199 **	0.924 **	−0.311	1.224 **	0.933 **
	(0.358)	(0.584)	(0.421)	(0.356)	(0.582)	(0.422)
Stock Market Cap/GDP	0.171 ***	0.257 ***	0.307 **	0.177 ***	0.251 ***	0.307 **
	(0.0342)	(0.0525)	(0.133)	(0.0347)	(0.0522)	(0.133)
GDP Growth Volatility	−0.000424	−0.000145	−0.00293 **	−0.000330	−0.000254	−0.00291 **
	(0.000777)	(0.000925)	(0.00115)	(0.000773)	(0.000888)	(0.00116)
Constant	4.624	−24.66 ***	−14.77 **	5.165	−25.03 ***	−14.91 **
	(5.477)	(8.874)	(6.403)	(5.428)	(8.844)	(6.418)

Table 5. *Cont.*

Model	(5)	(5a)	(5b)	(6)	(6a)	(6b)
		Developed	Emerging		Developed	Emerging
Country Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	14,709	12,704	2005	14,709	12,704	2005
R-squared	0.727	0.757	0.687	0.728	0.757	0.687

The sample consists of 2129 banks from 14 countries. Dependent variable is log of z-score, computed as the natural logarithm of the bank's return on assets plus the capital asset ratio divided by the standard deviation of asset returns. Pre is set to 1 for the year preceding the year of transition to limited deposit insurance, and zero otherwise. During is set to 1 for the year of transition to limited deposit insurance and zero otherwise. CAR is the Capital Adequacy Ratio computed as Tier I capital plus Tier I capital, divided by the risk-weighted assets. GFC is 1 for years of global financial crisis (2007–2009), and 0 otherwise. LLP is the loan loss provision divided by the net interest revenue. Log(Assets) is the natural logarithm of the total assets. Deposit Represent is the percentage of the bank's deposits to total deposits in each country. Equity is the equity to total assets. Revenue growth is the growth in total revenues (EBIT) of the bank over the past year. Loan is net loans to total assets. Log(GDP Per Capita) is the natural logarithm of GDP divided by the midyear population. Trade/GDP is the sum of exports and imports of goods and services, measured as a share of GDP. Population is the total population of each country. Stock Market capitalization/GDP is the stock market capitalization divided by GDP. GDP growth volatility is the variance of GDP growth for the previous five years. Country dummies are included. The *p*-values shown in the table are based on the Chi-square tests for the equality of coefficients on interaction terms in two subsamples with developed and emerging countries. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 6. The immediate effect of reduction in deposit insurance, capital adequacy, and bank risk—earning volatility.

Model	(5)	(5a)	(5b)	(6)	(6a)	(6b)
		Developed	Emerging		Developed	Emerging
Pre	0.00403 ***	0.00170	0.00891 **	0.00447 ***	0.00226	0.00887 **
	(0.00142)	(0.00113)	(0.00406)	(0.00161)	(0.00138)	(0.00415)
During	0.00132	0.00164 *	0.00323	0.00273 ***	0.00172 *	0.0113
	(0.00137)	(0.000872)	(0.00547)	(0.000943)	(0.000906)	(0.00855)
CAR	0.00240	−0.000358	0.0189	0.00317	−0.000262	0.0187
	(0.00465)	(0.00255)	(0.0191)	(0.00502)	(0.00263)	(0.0197)
GFC	−0.000938	0.00111	−0.00163	0.000427	0.00227 *	−0.00157
	(0.000985)	(0.000672)	(0.00338)	(0.00126)	(0.00136)	(0.00359)
CAR × Pre	−0.0243 ***	−0.00322	−0.0416 **	−0.0269 ***	−0.00663	−0.0415 **
	(0.00860)	(0.00541)	(0.0182)	(0.00974)	(0.00692)	(0.0188)
p-value for Chi-Square		0.0011			0.9029	
CAR × During	−0.00938	−0.00683	0.00726	−0.0178 ***	−0.00714	−0.0473
	(0.00835)	(0.00526)	(0.0262)	(0.00567)	(0.00539)	(0.0463)
p-value for Chi-Square		0.7906			−	
Pre × GFC	0.00317 ***	-2.93×10^{-6}	0.00302	−0.000415	−0.00222	0.00592
	(0.000765)	(0.000590)	(0.00233)	(0.00177)	(0.00158)	(0.00495)
p-value for Chi-Square		0.1952			0.0459	
During × GFC	−0.000326	0.000743	−0.00194	−0.00754 *	0.000129	−0.0112
	(0.00278)	(0.00243)	(0.00326)	(0.00419)	(0.00399)	(0.00906)
p-value for Chi-Square		−			−	
CAR × GFC	−0.000698	−0.00306	−0.0155	−0.00948	−0.0120	−0.0158
	(0.00687)	(0.00424)	(0.0183)	(0.00898)	(0.00930)	(0.0194)
p-value for Chi-Square						
Pre × CAR × GFC				0.0231 *	0.0159	−0.0179
				(0.0123)	(0.00999)	(0.0251)
p-value for Chi-Square					0.1307	
During × CAR × GFC				0.0364	0.00373	0.0590
				(0.0285)	(0.0264)	(0.0542)
p-value for Chi-Square					−	
LLP	7.67×10^{-5}	0.000388 ***	−0.000728	7.42×10^{-5}	0.000375 ***	−0.000809
	(0.000540)	(0.000125)	(0.00136)	(0.000541)	(0.000124)	(0.00138)
Log(Assets)	−0.000391 ***	−0.000136 ***	−0.00226 ***	−0.000374 ***	−0.000131 ***	−0.00226 ***
	(8.16×10^{-5})	(4.86×10^{-5})	(0.000856)	(8.02×10^{-5})	(4.93×10^{-5})	(0.000861)
Deposit	−0.0567	−0.0179	0.0825	−0.0572	−0.0194	0.0829
	(0.0378)	(0.0279)	(0.118)	(0.0377)	(0.0273)	(0.119)
Equity/Total Assets	0.0323 **	0.0350 **	0.0219	0.0332 **	0.0353 **	0.0224
	(0.0148)	(0.0147)	(0.0227)	(0.0150)	(0.0148)	(0.0228)

Table 6. *Cont.*

Model	(5)	(5a)	(5b)	(6)	(6a)	(6b)
		Developed	Emerging		Developed	Emerging
Revenue growth	3.32×10^{-5}	-9.59×10^{-5}	8.33×10^{-5}	3.39×10^{-5}	-9.86×10^{-5}	8.38×10^{-5}
	(5.93×10^{-5})	(0.000122)	(7.89×10^{-5})	(5.93×10^{-5})	(0.000124)	(7.91×10^{-5})
Loan	−0.00326 ***	−0.00196 **	−0.00489	−0.00321 **	−0.00202 **	−0.00493
	(0.00124)	(0.000830)	(0.00638)	(0.00125)	(0.000856)	(0.00638)
Log(GDP Per Capita)	−0.0101 ***	−0.000455	−0.00426	−0.0100 ***	−0.000171	−0.00430
	(0.00214)	(0.00268)	(0.00347)	(0.00213)	(0.00270)	(0.00347)
Trade/GDP	0.00657 *	−0.00147	−0.0128	0.00639 *	−0.00149	−0.0129
	(0.00337)	(0.00237)	(0.00849)	(0.00336)	(0.00237)	(0.00855)
Log(Population)	−0.0297 **	−0.0249 **	−0.0432	−0.0313 **	−0.0260 **	−0.0434
	(0.0144)	(0.0114)	(0.0264)	(0.0142)	(0.0115)	(0.0264)
Stock Market Cap/GDP	−0.00337 ***	−0.000684	−0.00706	−0.00346 ***	−0.000495	−0.00696
	(0.00107)	(0.00149)	(0.00515)	(0.00106)	(0.00151)	(0.00517)
GDP Growth Volatility	0.000187 ***	2.69×10^{-5} **	0.000327 ***	0.000187 ***	2.94×10^{-5} **	0.000327 ***
	(3.88×10^{-5})	(1.25×10^{-5})	(8.44×10^{-5})	(3.88×10^{-5})	(1.35×10^{-5})	(8.45×10^{-5})
Constant	0.626 ***	0.432 ***	0.792 *	0.651 ***	0.448 ***	0.795 *
	(0.231)	(0.167)	(0.417)	(0.229)	(0.168)	(0.417)
Country Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	12,411	10,987	1424	12,411	10,987	1424
R-squared	0.356	0.238	0.267	0.358	0.239	0.267

The sample consists of 2129 banks from 14 countries. The dependent variable is earning volatility, computed as the standard deviation of the bank's earnings over the past five years. Pre is set to 1 for the year preceding the year of transition to limited deposit insurance, and zero otherwise. During is set to 1 for the year of transition to limited deposit insurance, and zero otherwise. CAR is the Capital Adequacy Ratio computed, as Tier I capital plus Tier II capital, divided by risk weighted assets. GFC is 1 for the years of global financial crisis (2007–2009), and 0 otherwise. LLP is the loan loss provision divided by the net interest revenue. Log(Assets) is the natural logarithm of the total assets. Deposit Represent is the percentage of the bank's deposits to total deposits in each country. Equity is the equity to total assets. Revenue growth is the growth in total revenues (EBIT) of the bank over the past year. Loan is net loans to total assets. Log(GDP Per Capita) is the natural logarithm of the GDP divided by the midyear population. Trade/GDP is the sum of exports and imports of goods and services, measured as a share of GDP. Population is the total population of each country. Stock Market capitalization/GDP is stock market capitalization divided by GDP. GDP growth volatility is the variance of GDP growth for the previous five years. Country dummies are included. The *p*-values shown in the table are based on the Chi-square tests for the equality of coefficients on interaction terms in two subsamples, with developed and emerging countries. Robust standard errors are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

5. Conclusions

Given the recent fragility of the financial market, due to its exposure to various risks, it is important to thoroughly investigate the effectiveness of regulatory tools in curbing potential disastrous events. Our paper focuses on how regulatory tools (deposit insurance and capital adequacy) impact bank risks. To test the effectiveness of these regulatory tools in risk reduction, we conduct empirical tests for countries that introduce limited deposit insurance policies, and test its interaction with capital adequacy requirements. We further investigate how the timing of deposit insurance reduction, together with capital adequacy affects bank risk. Overall, we find that these tools used separately are not effective in curbing bank risk. In particular, capital adequacy leads to the asset substitution problem, while blanket insurance could lead to the moral hazard problem. However, the interplay between these two regulatory tools demonstrate their abilities to reduce bank risk.

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Appendix A

Table A1. Variable Definitions.

Variable Definition		
Variable	**Definition**	**Source/Note**
Z-Score	The average return on assets (ROA) plus equity–asset ratio, divided by the standard deviation of ROA	Bankscope
CAR	Capital Adequacy Ratio: Tier I capital plus Tier II capital, divided by risk-weighted assets	Bankscope
LDI	Set to 0 for blanket deposit insurance, and 1 for limited deposit insurance	Dummy variable
GFC	Set to 1 for the years of global financial crisis (2007–2009), and 0 otherwise.	Dummy variable
pre	Set to 1 for years before transition date, and 0 otherwise	Dummy variable
during	Set to 1 for year of transition date, and 0 otherwise	Dummy variable
post	Set to 1 for years after transition date, and 0 otherwise	Dummy variable
LLP	Loan loss provision divided by the net interest revenue	Bankscope
Log(Assets)	Natural logarithm of the total assets	Bankscope
Deposit	The percentage of the bank's deposits to total deposits in each country	Bankscope
Equity/Total Assets	Equity to total assets	Bankscope
Revenue growth	Growth in total revenues (EBIT) of the bank over the past year	Bankscope
Loan	Net loans to total assets	Bankscope
GDP per capita	GDP per capita is the gross domestic product divided by the midyear population.	World Bank
Trade/GDP	Trade is the sum of exports and imports of goods and services measured as a share of the gross domestic product.	World Bank
Population	Total population of each country	World Bank
Stock Market capitalization/GDP	Stock market capitalization divided by GDP	World Bank
GDP growth volatility	The variance of GDP growth for the previous five years	World Bank

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