

The Effect of Deposit Insurance on Risk Taking in Asian Banks

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Abstract

This paper uses a panel database of 401 banks in 31 Asian countries over the period from 2000 to 2010 to examine the effects of deposit insurance on banks' risk-taking incentives. We find that risk-taking incentives vary with bank size and risks. In addition, differentiated premiums may not accurately reflect the level of risk that a bank poses. In the presence of a deposit insurance scheme, the pattern of the non-linear relationship between bank size and risk-taking significantly changes. Our results suggest that market discipline exercised by banks is stronger in the presence of mandatory deposit insurance scheme. Government-funded deposit insurance funds allow Asian banks to take a higher risk. A risk-based deposit insurance scheme functions more effectively in the countries with good regulatory framework and institutional quality.

Keywords: deposit insurance, Asia, Emerging markets, Bank risk

JEL classification codes: G21, G22, G28

1. Introduction

The deposit insurance system has proliferated around the world in the last two decades and the relationship between deposit insurance, and bank risk-taking has been extensively studied in the banking literature. There are currently 104 countries with explicit or implicit deposit insurance scheme in operation worldwide and twenty years ago, it was only less than twenty countries adopted a deposit insurance scheme, according to the International Association of Deposit Insurers (IADI). In spite of its widespread use, empirical studies provide conflicting results on the impact of (explicit) deposit insurance schemes on the risk-taking of banks.

The regulators can prevent bank runs with a generous deposit insurance scheme (Morrisons & White, 2006). Explicit or implicit deposit potentially reduce the likelihood and severity of bank runs during a financial crisis and thus can be an effective financial tool for governments to ensure the safety and soundness of the financial system and to protect depositors from losses by insolvent banks during crisis times. Further deposit insurance can help to restore depositors' confidence and thus promote financial intermediary development.

In spite of the positive effects of deposit insurance, there is a widespread consensus that guarantees of depositors and creditors induce banks to take excessive risks. The voluminous literature indicates adverse consequences of deposit insurance related to moral hazard and adverse selection. According to the moral hazard theory, the insurant tends to be less careful about risk behavior since the potential loss is protected by the deposit insurer. The moral hazard problem associated with deposit insurance is usually interpreted in terms of an incentive for a bank to increase the risk in search for higher profits (Forssbäck, 2011). Martin (2006) argues that complete deposit insurance weakens market discipline and increases the chance of banking failures. Depositors and banks protected from the negative consequence of risk-taking will not hesitate to engage in risky banking practices. On the other hand, a handful of contrasting studies find no significant relationship between deposit insurance and bank risk taking.

The aim of this study is to assess the impact of deposit insurance on bank riskiness in Asian countries – it extends the current analyses into the Asian context. In the literature, there are a number of tests for the impact of deposit insurance on bank risk-taking in the US and Europe but very few in Asia. Several studies include the data of Asian banks in their sample set, but their primary research focus was not on the continent (Angkinand & Wihlborg, 2007; Demirguc-Kunt & Detragiache, 2000). The institutional background of the Asian banking system is special for several reasons. Firstly, emerging markets dominate the Asian economy. Secondly, Asian governments heavily regulate the financial sector, though several countries attempt to liberalize their economies. Finally, non-listed banks outnumber listed banks in Asia, and comparably weak transparency is likely to generate a moral hazard and contribute to bank runs.

To examine the impact of deposit insurance, we test for bank characteristic measures on the risk-taking behavior of 401 depository banks in 31 Asian nations of which 20 have explicit deposit insurance. The data set covers the period from 2000 to 2010. Different proxies are used for overall default risk, credit risk and liquidity risk. We also investigate the effects of a state-funded deposit insurance scheme, deposit premium and types of membership of the

insurance fund on banks' risk-taking.

The key findings are as follows: Firstly, risk-taking differs across bank size and the pattern of non-linear relationship between risk-taking and bank size changes across bank risks in the presence of explicit deposit insurance. Secondly, a mandatory deposit insurance scheme disciplines banks to monitor one another's risk-taking. The findings suggest that the increase in government funding of deposit insurance incentivizes banks' risk-taking and existing risk-based premium systems functions better in countries with stronger institutional environments.

The paper is organized as follows: Section II reviews the empirical literature on deposit insurance and bank risk. Section III introduces the data and methodology, hypotheses and variables in detail. Section IV discusses the empirical findings of this study, and section V presents the conclusion.

2. Previous Empirical Evidence

Most research indicates that deposit insurance is responsible for excessive risk-taking in the financial sector. Several studies identified a positive relationship between deposit insurance and banking instability. Wheelock (1992) finds that deposit insurance is more likely to exacerbate bank failures. He also finds that despite strict regulation lessened risk-taking, a high proportion of insured banks resulted in higher bank failure rates in Kansas during the 1920's. He noted deposit insurance has been one of the important causes of bank failures during the 1920's (Alston et al., 1994). Chernykh and Cole (2011) analyze bank-level data for 800 institutions in the Russian Federation over the period 2004-2006 and used several types of accounting information. They find that the ratio of equity to total assets ratio declined while the ratio of loans to total assets increased after the implementation of deposit insurance and conclude that deposit insurance created a moral hazard problem in the form of increased risk-taking.

Furthermore, Grossman (1992) pointed out that the combination of deposit insurance and deregulation leads banks to undertake more risk. He adds that flat rate insurance creates a moral hazard problem since banks do not bear costs associated with engaging in their risky behavior. Wheelock and Kumbhakar (1995) conclude that insured banks are prone to increase risk-taking in order to avoid subsidizing other insured banks. They argue that a voluntary deposit insurance scheme in which premiums are not sufficiently sensitive to differing **risk** levels attracts risk-prone banks; however, they find no evidence that deposit insurance encourages depository institutions to hold smaller reserves. Using panel data for 61 countries over the period 1980-1997, Demirgüç-Kunt and Detragiache (2000) conclude that the explicit deposit insurance increases the likelihood of bank failures where the institutional environment is weak. According to their study, the adverse impact of deposit insurance on financial stability is more likely to be stronger when the insurance coverage offered to depositors is more extensive, and where the system is funded and managed by the government.

Hovakimian, Kane and Laeven (2002) likewise find that in poor institutional environments

that are low in political conditions and high in corruption, explicit deposit insurance has adverse effects. Laeven (2002a) stretches further to acknowledge that existing insurance schemes create moral hazard for banks but the magnitude of incentive problems differs due to variation in governance structures and institutional environments. He (2002 a, b) investigates the effect of deposit insurance on risk-taking measured by implicit value of deposit insurance services and suggests that a deposit premium has some power in forecasting bank failures because the cost of insurance reflects the riskiness of deposit-taking institutions. Analyzing bank-level data for 100 countries including 41 emerging markets, Angkinand and Wihlborg (2006) find a robust estimation for a non-linear relationship between deposit insurance coverage and bank risk-taking. They note that effects of ownership structure on risk-taking differ through market discipline and optimal deposit insurance coverage varies in countries in Asia and Eastern Europe.

Davis and Obasi (2009) test the impact of a design package of deposit insurance and bank risk taking activity and report that design features have different effects on the different financial soundness ratios. They emphasize the impact of a deposit insurance system on bank asset-side risk. Banks with a high share of large depositors undertook relatively less risk before the insurance system established in the context of Bolivia, but banks appear to take higher risk and do not seem to compensate increasing risk by adjusting requirements for collateral and maturity after the introduction of deposit insurance (Ioannidou & Penas, 2010). This is consistent with the fact that large depositors have greater ability to monitor banks in unguaranteed circumstance as proposed by England (1988). Distinguin et al. (2011) showed that the adoption of the formal deposit insurance encouraged risk taking incentives for European banks in the 1990s. Their study also supports the view that explicit deposit insurance favors market discipline when some creditors are excluded from deposit insurance coverage.

By contrast, some studies failed to find negative or positive relationship between deposit insurance and bank risks. Karels and McClatchey (1999) show that the introduction of deposit insurance has not led to increased risk-taking in the US credit union industry. Gueyie and Lai (2003) find no empirical support for the hypothesis that the adoption of official deposit insurance creates moral hazard. They conclude that the risk-based deposit insurance is unlikely to have an effect on bank risk. Areta and Eichengreen (2002) find explicit deposit insurance reduced the likelihood of a banking crisis in their extensive analysis of developing countries. Hoggarth et al. (2004) added that insurance systems with limited coverage have a smaller probability of a banking crisis. Gropp and Vesala (2001) find that explicit deposit insurance in the banking system may significantly reduce banks' incentive to take risks if non-deposit creditors are left out in the European case. They used different proxies including charter value. In their sequel paper, Gropp and Vesala (2004) showed that the implementation of explicit deposit insurance significantly decreases bank risk-taking in their study on the large homogeneous sample of 73 European Union bank level data using Tobin's Q as a proxy to bank charter value. According to Hamada (2011), depositors' behavior varies with regard to the regulatory and economic circumstances. He finds that depositors became much more cautious after the introduction of explicit deposit insurance in Indonesia.

3. Data and Methodology

3.1. Methodology

Deposit insurance can weaken the market discipline and encourage banks' incentives to take on too much risk in search for higher profits. Depending on country's institutional circumstances and economic development, banks operate in environments with different design features of deposit insurance scheme. Consequently, we focus on measures of banks' risks: overall default risk, asset (credit) risk and liquidity risk.

Hypothesis 1: *The presence of a deposit insurance scheme generates incentives that lead banks to take on excessive risk.*

Hypothesis 2: *A deposit insurance scheme with a mandatory membership encourages market discipline exercised by banks.*

Hypothesis 3: *Combined with good regulatory framework and institutional quality, a risk-based premium system eliminates the free-rider problem and discourages banks' risk-taking.*

To test these hypotheses, we employ information on asset and liability structure, sources of income, along with information on country specific variables. The specification used here follows Forssbäck (2011). This paper uses three measures of bank risks - overall default risk, liquidity risk and credit risk. The main model of this study is as follows:

$$R_{ijt} = \alpha_0 + \alpha_1 X_{jt-1} + \alpha_2 M_{it-1} + \alpha_3 D_{it} + \varepsilon_{it} \quad (1)$$

where R_{ijt} represents a set of dependent variable of risks (or risk-taking) of individual banks, X_{j-1} represents a vector of control variables unique to bank j at the period $t-1$, M_{it-1} stands for a vector of country-specific variables in country i at the period $t-1$ and D_{it} represents a vector of indicators describing the deposit insurance system in country i at the period t .

At the bank-level, in line with Cebenoyan et al. (1999), we include bank size. To account for the non-linear relation between banks' risk-taking and asset size, the square of asset size is used in the analysis. The choice of control variables at the country level is largely made on the basis of Angkinand and Wihlborg's (2010) study. Thus, real GDP growth, the real interest rate and the inflation rate are included. An additional country-level control is the index of legal enforcement. Definitions of all variables used in this paper are presented in Table 1. A more detailed description of the variables is presented in the data section.

Table 1. Definition of variables

Variables	Definition	
Dependent variables:		
Risk variables = R_{ijt}	Proxy to:	
Z	Overall default risk	$Z-score = \frac{k + \mu_{ROA}}{\sigma_{ROA}}$ where k is a percent of equity to total assets, μ_{ROA} is the ratio of net profit over average total assets, σ_{ROA} represents the standard deviation of return on assets on the considered period. The natural logarithm of it is used in regression analysis.
NPL	Credit risk	Ratio of non-performing loans to gross loans
$Liquid$	Liquidity risk	Ratio of liquid asset to total deposits and short-term borrowing
Independent variables:		
Bank variables = X_{jt}		
Ta		Natural logarithm of total assets
$Ta2$		The square of Ta
NII		Ratio of non-interest income to gross income
$Depba$		Ratio of deposits due to banks to total deposits
Td		Ratio of total customer deposits to total assets
$Tier1$		Ratio of Tier 1 capital to risk-weighted assets
Country-specific variables = M_{it}		
$Rint$		Average nominal interest rates on deposits by country minus inflation rates
GDP		Annual percent changes of real GDP
Inf		Annual inflation rate
Law		The index of law enforcement from the Worldwide Governance
Deposit insurance variables = D_{it}		
Di		= 1 if deposits are protected by an official deposit insurance
$Diprem$		= 1 if a country adopted the differential premium system, and = 0
$Fund$		= 1 if public sector provides funding, = 0 otherwise
$Dimem$		= 1 if the membership is mandatory, = 0 otherwise
Cov		= 1 if the coverage of deposits insurance is higher than four times 22,382.8 (the sample mean) or full, = 0 otherwise

We interact our deposit insurance variables with some of bank variables. These interaction variables allow us to account for the effects of deposit insurance's features on banks' characteristics and risk-taking. Similar to other studies on risk-taking, we expect that the deposit insurance dummy is positively related to banks' risk taking. On the other hand, increasing bank size will positively affect overall risk and other risk measures in the presence of a deposit insurance scheme.

If the mandatory membership encourages banks' risk-shifting to one another at the expense of a deposit protection system, the coefficients on the interaction variable, deposit insurance membership dummy multiplied by deposits due from banks over total assets, shall be significant. If this holds true, banks will witness an increase in interbank deposits over total assets.

To test the third hypothesis, we run regressions using the interaction variables associated with risk-based deposit insurance premium, law enforcement and the tier 1 capital ratio. If an increase in the tier 1 capital ratio interacted with risk-based premium dummy positively affects bank risks, we may conclude that risk-based deposit insurance premiums do not properly reflect risks posed by banks. We also expect that higher law enforcement index strengthens risk-based deposit insurance systems.

We investigate the effects of a deposit insurance system on bank risks by employing generalized least squares. The feasible generalized least square model (FGLS) allows us to estimate the equation (1) using the unequally spaced panel data where the unbalance is due to random attrition.¹ As described in the data section, our panel is unbalanced and consists of 2,940 bank-year observations.

3.2. Data and empirical design

In examining the impact of deposit insurance on banks' risk-taking, the panel data of Asian banks are used. This data set contains the annual information about 401 banks from 2000 to 2010. There are very few prior studies that solely focus on Asia, and most of those prior studies analyzed the data mainly of developed and high income countries. Some important economies, including China and India, are left out of the research due to their relatively late liberalization in financial markets (e.g. Demirgüç-Kunt & Detragiache, 2000). The number of banks studied is presented in Table 2.

¹ See Baltagi and Wu (1999) and Biørn (2004) for details

Table 2. Number of banks per country used in this study

Countries	Number of banks	The year deposit insurance was introduced/revised	Coverage
Bangladesh	19	1984	BDT 100,000
Cambodia	14		
China	15		
Hong Kong	16	2006	HKD 100,000
India	5	1962	INR 100,000
Indonesia	19	2005/2008	IDR 2,000,000,000
Iran	13		
Japan	10	1971	JPY 10,000,000
Kazakhstan	18	1999/2003	KZT 5,000,000
Korea, Republic of	11	1996	KRW 50,000,000
Kyrgyzstan	6	2008	Full
Laos	5		Full
Malaysia	15	2005	MYR 60,000
Maldives	1		
Mongolia	15		Full
Nepal	21		
Oman	5	1995	OMR 20,000
Pakistan	21		
Qatar	11		
Saudi Arabia	11		
Singapore	11	2005	SGD 20,000
Sri-Lanka	12	1987	LKR 100,000
Syria	13		
Taiwan	12	1985	TWD 1,000,000
Tajikistan	4	2003	Full
Thailand	16	1997	Full
The Philippines	18	1963	PHP 500,000
United Arab Emirates	22		
Uzbekistan	14	2007	UZS 1,552,500
Vietnam	19	1999/2000	VND 30,000,000
Yemen	9	2008	YER 2,000,000
Total	401		

Note: The data are from the IADI database and the Worldwide Deposit Insurance Database (Demirgüç-Kunt et al., 2005)

Accounting data for individual banks are from Bankscope Fitch IBCA. First, 25 top banks from each country were selected based on total assets size (625 banks). In addition to data from twenty countries with a deposit insurance scheme, the data of eleven countries with no deposit insurance scheme are included to compare risk-taking behavior under different conditions. Although Lao DPR does not have an official deposit insurance system, the IADI includes it in the list of the countries with effective deposit protection systems worldwide, and thus Laos is included in the eleven countries in this study. The number of banks available in the Bankscope database varies. For Kyrgyzstan, Laos, Oman, Sri-Lanka, Tajikistan, Uzbekistan, Yemen, Iran, Syria, Saudi Arabia, Qatar, Maldives and Cambodia, each individual sample contains less than 25 banks in the Bankscope database. The data used for commercial banks of Mongolia in this study were obtained from the Bank of Mongolia.

Central Banks, governmental financial institutions, development banks, micro-finance institutions and investment banks were excluded from the sample due to their differing nature of business and risk-taking behavior. All accounting data are converted from local currency to U.S. Dollars. Banks with available time series less than two consecutive years and Turkmenistan and Myanmar, where only state-owned bank data were available, were eliminated in this study. Hence, our final sample consists of an unbalanced panel containing 401 banks from 31 countries in Asia, comprising 2,940 observations and spanning eleven years, as presented in table 2.²

In addition, we used the macroeconomic and country-specific variables that might affect bank risk. We retrieve the information about deposit insurance across countries from the World Bank deposit insurance database developed by Demircuc-Kunt et al. (2005) and the website of the IADI. Due to incompleteness and the limitation of data availability in the Bankscope database, we avoid using the ownership data of banks in this study. However, the previous research finds that corporate governance and ownership structure have an impact on bank risk-taking, and family- or company-owned banks were more apt to take higher risk while foreign-owned bank took less risk during the 1997 East Asian Crisis (Laeven, 1999). The data on a number of country-specific variables, associated with legal systems, are collected from the World Bank Governance Indicators (Kaufmann et al., 2010). A detailed discussion of our dependent and independent variables are as follows:

Risk variables:

This study particularly focuses on the effect of deposit insurance on bank risk-taking incentives. The dependent variables are proxies to bank risks – overall default risk, credit risk and liquidity risk. Most of deposit-taking banks in Asia are privately-held and for those publicly listed banks, the historical daily stock price in the Bankscope database covers a period of less than three years. Therefore, we did not use the deposit insurance premium which is derived from the option pricing model and indicators of systematic and unsystematic bank risks, calculated from asset pricing models.

Instead, a standard z-score was used as a proxy for the distance to default. It has been one of the most **commonly used** measures of bank default risk in the literature (e.g. Roy, 1952, Hannan et al., 1988). Unlike the distance to default developed Moody's KMV, the z-score can be easily obtained from the accounting data and is estimated as follows:

$$Z - score = \frac{k + \mu_{ROA}}{\sigma_{ROA}} \quad (2)$$

where k is a percent of equity to total assets, μ_{ROA} is the ratio of net profit over average total assets, and σ_{ROA} represents the standard deviation of return on assets. A higher value of z-score indicates a low default risk of a bank. Due to the higher dispersion of z-score obtained from the equation (2), a log transformation of this variable is used in all specifications.

² Descriptive statistics and correlation matrix of the data are available from the authors upon request

NPL ratio, *NPL*, defined as the ratio of non-performing loans to gross loans is a proxy for credit risk. A NPL ratio shows the asset quality of a bank and how much proportion of total loans is classified as being in or close to default. For liquidity risk, the ratio of liquid assets to total deposits and short-term borrowing is used and denoted as *Liquid*. When banks hold more reserves and liquid assets, they are safer to meet financial obligations. Increases in z-score and *Liquid*, and decreases in *NPL* indicate a reduction in the riskiness of banks.

Bank variables

Natural logarithm of total assets, *Ta*, is included as a proxy of bank size. Larger banks are assumed to have a greater capability to diversify their risks and stabilize the cash flow from their business. However, they may be incentivized to take higher risk due to their systematic importance (i.e. *too-big-too-fail*). The square of the log of total assets, *Ta2*, is used to test a non-linear relationship between risk-taking and bank size. We also control for the diversification of banks' sources of income defined as the ratio of non-interest income to gross income (*NII*). Diversification of income sources eliminates a bank's risk exposure (Smith et al., 2003). This is a proxy to a bank's business model. A negative relationship exists between bank risk and diversification of income sources.

A share of deposits due to banks in total assets, *Depba*, is considered the market discipline variable. In many countries, interbank deposits and subordinated debt are excluded from deposit insurance and government guarantee. Uninsured depositors are more incentivized to discipline banks. Due to missing data on subordinated debt for several Asian countries, we limited market discipline variables to interbank deposits. A share of total customer deposits in total assets, *Td*, is a proxy to the capital structure of a bank, and it represents how much of assets are financed through customer deposits.

Tier 1 capital ratio (*Tier1*), defined as the ratio of tier 1 capital to risk-weighted assets, is a measure of the capital adequacy of a bank. Most countries follow the Basel capital accord to estimate the capital adequacy ratio. Tier 1 capital, consisting of core equity capital instruments, absorbs losses before all other equity capital instruments.

Country-specific variables

In the regression analysis, country-level variables are included. The real interest rates (*Rint*), real GDP growth (*GDP*) and the inflation rates (*Inf*) are deployed to control the differences among the countries and to minimize the omitted variables bias. Due to missing data on real GDP growth, real interest rates and inflation rates for some countries in the World Bank database, we use the real discount rates for India, Saudi Arabia, and Taiwan as proxy to the real interest rates.

As a proxy to the quality and enforcement for a country's legal system, the index of legal enforcement (*Law*), from the Worldwide Governance Indicators, developed by Kaufmann et al. (2010), is used. The index has a scale of -2.5 to 2.5 and higher value indicates better outcome.

Deposit insurance variables

A dummy variable, Di , was constructed to define the status of a deposit insurance scheme (except for a government guarantee). For the year deposits are protected by an official deposit insurance scheme, this variable takes the value of 1 and is 0 otherwise. During the sample period covered in this study, Asian countries adopted mandatory insurance system except for Sri Lanka and Tajikistan. Thus, an endogeneity problem between Di variable and risk proxies does not exist in the regression analysis.

In many Asian countries, a flat-rate premium is paid by the insured banks. Among countries covered in this sample, six countries have adopted the risk-based differential premium system. We use the second dummy variable, $Diprem$, which takes the value of 1 if a country adopted the differential premium system and the value of 0 otherwise. As pointed out by Demirgüç-Kunt and Huizinga (1999), funding of deposit insurance has an effect on bank risk-taking incentives. Thus we created another dummy variable, $Fund$, that takes 0 if the private sector provides the source of the deposit insurance fund and 1 otherwise (if the government or both public and private sectors fund the deposit insurance scheme).

To examine the effect of deposit insurance membership on risk-taking incentives, a dummy variable, $Dimem$, is included in the regression analysis. This dummy variable takes the value of 1 if the membership of a deposit insurance system is mandatory and 0 otherwise. The insurance coverage provided to depositors has an effect on bank risk-taking incentives. Cov is a dummy variable that takes the value of 1 if the coverage of deposit insurance is higher than four times the sample mean of deposit insurance coverage (USD 22,382.8) or full. Countries offering full guarantee on deposits are treated as they have full insurance coverage.

4. Empirical Results

Table 3 presents the estimation results of the equation (1) where independent variables include interaction terms between the deposit insurance dummy and bank variables. In all specifications Woolridge's test rejects the null hypothesis implying that the autocorrelation exists in the residuals. Thus, each equation is estimated using FGLS method with White type standard errors robust to time-varying residual variance and correlation over time within cross-section units. Columns (1)-(3) of Table 4 report the results of our main model with interaction variables between Di and Ta , and Di and $Ta2$. Columns (4)-(6) of Table 4 show the results of the same model with the interaction term between Di and $Depba$.

The results of the main regressions essentially support the prediction of a non-linear relationship between bank size and risk-taking incentives. The influence of Ta in each specification is consistent with too-big-to-fail argument where larger banks have more incentives to undertake risky investments because they become recipients of beneficial policies from the governments. When bank risks are measured by z-score and NPL , the pattern of relationship between bank size and risk is concave-shaped (R1), as illustrated in graph 1. In all specifications, the signs of the coefficients on Ta are different from those of the coefficients on $Ta2$ and they are all statistically significant. In specifications 3 and 6, the negative coefficient on $Ta2$ suggests that largest banks are more leveraged but hold less

liquid assets. As financial intermediaries between investors and economic agents, banks have to attract more deposits, thereby increasing their leverage and have to allocate their funding into income-bearing assets to make profits. Given that the $Ta2$ coefficients tend to be positive when risk is measured as z-score and significantly negative in NPL estimations, larger banks have a greater potential to reduce risks by exploiting economies of scale.

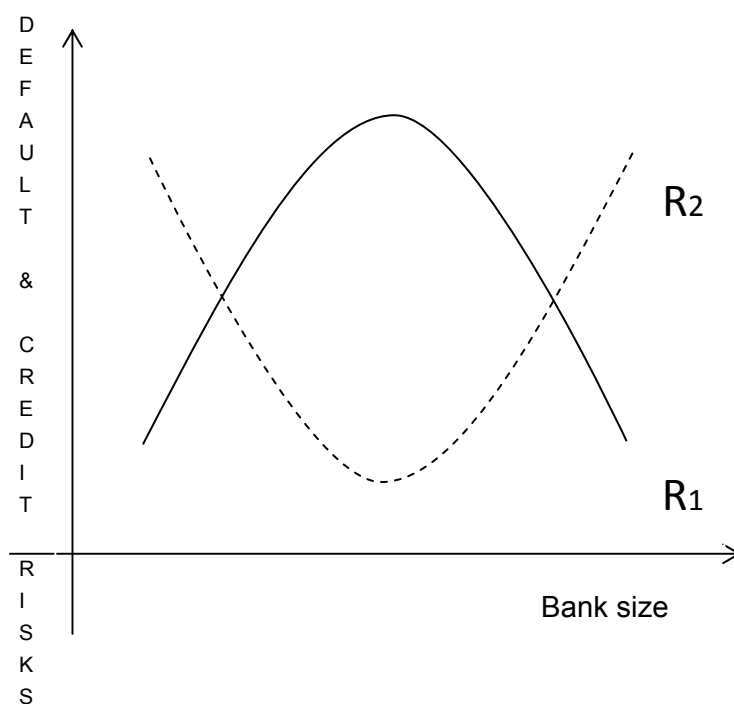


Figure 1. Relationship between risks and bank size

In the interaction terms used in main regressions, we find that the pattern of non-linear relationship between bank size and risks is likely to change, as illustrated in graph 1. The signs of the Ta and $Ta2$ coefficients are opposite to those of the coefficients on the interaction terms, $Di \times Ta$ and $Di \times Ta2$. On the other hand, the relationship between risk-taking and bank size becomes convex ($R2$) in terms of z-score and NPL when a country adopts explicit deposit insurance. For instance, the effect of bank size is positive and the effect of the square of bank size is negative in countries with a deposit insurance scheme. The negative effect of $Di \times Ta$ is significant but the positive effect of $Di \times Ta2$ is statistically insignificant in NPL estimation. The coefficient on the interaction term, $Di \times Ta2$, is significantly positive for liquidity risk estimation.

Table 3. Results from estimation with deposit insurance variables

VARIABLES	(1) Z	(2) NPL	(3) Liquid	(4) Z	(5) NPL	(6) Liquid
<i>Ta</i>	-0.736*** (0.231)	0.020** (0.010)	0.111*** (0.040)	-0.691*** (0.229)	0.019* (0.010)	0.097*** (0.035)
<i>Ta2</i>	0.025*** (0.008)	-0.001*** (0.000)	-0.005*** (0.002)	0.023*** (0.008)	-0.001*** (0.000)	-0.005*** (0.002)
<i>Td</i>	-0.697 (0.457)	-0.075 (0.080)	-0.294 (0.559)	-0.675 (0.459)	-0.080 (0.081)	-0.318 (0.567)
<i>Depba</i>	-0.745* (0.413)	-0.033 (0.077)	0.196 (0.196)	-0.658 (0.449)	-0.010 (0.083)	0.733* (0.378)
<i>NII</i>	-0.081 (0.112)	0.019 (0.021)	0.110** (0.053)	-0.080 (0.112)	0.020 (0.021)	0.117** (0.054)
<i>Di</i>				0.073 (0.055)	-0.023*** (0.009)	0.122* (0.066)
<i>Di x Ta</i>	0.057** (0.028)	-0.009* (0.005)	-0.024 (0.016)			
<i>Di x Ta2</i>	-0.003** (0.002)	0.000 (0.000)	0.002* (0.001)			
<i>Di x Depba</i>				-0.150 (0.327)	-0.058 (0.063)	-0.984 (0.663)
<i>GDP</i>	0.416 (0.331)	-0.431*** (0.103)	-0.365 (0.819)	0.538 (0.333)	-0.449*** (0.104)	-0.505 (0.849)
<i>Inf</i>	0.258 (0.552)	0.257* (0.135)	0.109 (0.312)	0.148 (0.551)	0.277** (0.134)	0.245 (0.278)
<i>Rint</i>	0.008 (0.565)	0.186 (0.135)	-0.084 (0.855)	-0.094 (0.562)	0.207 (0.132)	0.074 (0.801)
<i>Law</i>	0.135* (0.072)	0.009 (0.011)	-0.107 (0.079)	0.112 (0.070)	0.012 (0.010)	-0.100 (0.083)
<i>Intercept</i>	8.407*** (1.479)	0.176*** (0.056)	0.112 (0.351)	8.206*** (1.476)	0.177*** (0.057)	0.110 (0.359)
Wald Chi2	41.12	112.92	33.42	40.46	97.63	31.72
Wald p-stat	0.00	0.00	0.00	0.00	0.00	0.00
No. of obs.	1,899	1,702	1,789	1,899	1,702	1,789
Number of banks	327	294	301	327	294	301

The table reports coefficient estimates from Panel FGLS. Standard errors in parentheses are based on White type standard errors robust to time-varying residuals and correlation over time within cross-section units. See Table 1 for variable definitions.

*, **, *** indicate statistical significance at the 10%, 5% and 1% percent, respectively.

In column (4)-(6) of Table 3, the coefficients on the deposit insurance dummy are mostly significant. The *Di* coefficient becomes negative at 10% level when risk is measured by *NPL*. In contrast, it has a significant positive effect on banks' liquidity. Given the theoretical argument that the introduction of deposit insurance helps stabilize the financial market in the short run, this positive effect of explicit deposit insurance is not necessarily surprising. There are a number of cases in Asia where the deposit insurance helped prevent bank runs in the short term (i.e., Asian financial crisis in 1997 and Mongolia in 2008).

In liquidity risk estimations, the statistically significant positive coefficients of *NII* explain that revenue diversification increase bank liquidity; thus decrease liquidity risk. This finding is in line with what the modern portfolio theory suggests. It implies that banks liquidity risk can be reduced through diversifying their income sources.

In z-score regressions, *Depba* is negatively correlated with z-score. It implies that an increase in interbank deposits may have a negative effect on overall default risk because of the contagion risk involved. In the case of blanket guarantee, we observe that interbank deposits tend to increase because the guarantee encourages banks to increase investments in the protected assets. The coefficients are statistically insignificant in other estimations (except in specification 6 where the dependent variable is *Liquid*). However, the empirical results on the interaction term, *Di x Depba*, are mixed and additional test results are discussed below. These

conflicting results may be due to the weakened market discipline exercised by banks when deposit insurance is adopted.

The negative correlation of economic growth with *NPL* suggests that credit risk is significantly lower in years and countries with relatively high economic growth. The results obtained from specifications 1 and 4 indicate that the higher economic growth is positively correlated with overall risk-taking by banks, measured by z-score. A possible explanation for this correlation is that banks in faster-growing economies have a greater incentive to assume higher risks. On the other hand, risk-taking is a well-spring of the economic growth and continuously higher economic growth also encourages banks' risk-taking in return. However, the coefficient on *GDP* is negative but statistically insignificant in liquidity risk estimations. The significant positive coefficients on *Inf* indicate that an increase in inflation leads to higher credit risk. Hence higher inflation may result in lower payment capacity of borrowers. In line with our expectation, banks' risk-taking is lower in countries with higher legal enforcement (*Law*).

The results of estimations of the equation (1) with interaction terms between deposit insurance features and bank variables are presented in Table 4. The results are largely consistent with those presented in Table 3. The coefficients on *Cov* appear negative and significant in all specifications. An increase in deposit insurance coverage leads to increased credit and liquidity risks undertaken by banks. The negative coefficient on *Cov* in *NPL* specification indicates that higher coverage is negatively related to credit risk. A possible explanation for this correlation might be that regulators require a significant improvement in their risk management and a reduction in asset risks in return for providing higher deposit insurance coverage.

Table 4. Results from estimation with deposit insurance features

VARIABLES	(1) Z	(2) NPL	(3) Liquid
<i>Ta</i>	-0.025 (0.033)	-0.014*** (0.004)	-0.005 (0.010)
<i>Td</i>	-0.981*** (0.308)	0.033 (0.030)	0.011 (0.082)
<i>Depba</i>	-0.881 (1.397)	0.332*** (0.051)	-1.032*** (0.196)
<i>Nll</i>	0.084 (0.138)	0.000 (0.027)	0.028 (0.018)
<i>Dimem x Depba</i>	-0.104 (1.360)	-0.267*** (0.075)	0.892*** (0.194)
<i>Cov</i>	-0.146** (0.064)	-0.008** (0.004)	-0.022** (0.011)
<i>Fund</i>	-0.086 (0.073)	0.050*** (0.010)	-0.049*** (0.018)
<i>GDP</i>	-0.922 (0.698)	-0.130 (0.117)	0.198 (0.126)
<i>Inf</i>	0.507 (0.631)	0.256** (0.104)	0.188 (0.148)
<i>Rint</i>	0.022 (0.788)	0.254** (0.100)	0.212 (0.172)
<i>Law</i>	0.023 (0.111)	0.026** (0.011)	0.022 (0.033)
<i>Intercept</i>	4.036*** (0.611)	0.204*** (0.069)	0.483** (0.214)
Wald Chi2	24.11	288.28	97.94
Wald p-value	0.01	0.00	0.00
No. of obs.	979	874	992
No. of banks	198	180	187

The table reports coefficient estimates from Panel FGLS. Standard errors in parentheses are based on White type standard errors robust to time-varying residuals and correlation over time within cross-section units. See Table 1 for variable definitions.

*, **, *** indicate statistical significance at the 10%, 5% and 1% percent, respectively.

When we consider the interaction term, *Dimem x Depba*, the mandatory membership of a deposit insurance scheme has a significant positive effect on bank risks. The negative coefficient on *Dimem x Depba* in *NPL* estimation and the negative coefficient in *Liquid* estimation indicate that market discipline exercised by banks is stronger when the membership is mandatory for all banks. Since banks are able to obtain better information about other banks where they allocate funds as opposed to retail depositors, they have a greater ability to monitor and discipline other deposit-taking financial institutions.

The negative effect of government-funded deposit insurance schemes is confirmed by the statistically significant positive coefficient in *NPL* estimation and the statistically negative coefficient in *Liquid* estimation. The coefficient on *Fund* is insignificant but negative in terms of z-score. Since higher value of this variable from 0 to 2 represents the rising share of the government financing, this may indicate that risk-taking rises with the increasing share of the government financing in a deposit insurance scheme. Thus, the results indicate that government-funded deposit insurance funds allow banks to take a higher risk. This is

consistent with the findings by Demirgüç-Kunt and Detragiache (2000). If the fund amount that consists of premiums paid by member banks is not sufficient to cover losses caused by bank failures, the shortfall is made up by taxpayers.

Table 5 presents the estimation results using risk-based premium interaction variables. A risk-based deposit insurance scheme has negative effects on *z*-score and *Liquid* when we consider the effect of *Diprem*. It implies that differentiated premiums do not accurately reflect the level of risk that a bank poses. In practice, risk-based deposit insurance is technically difficult to be managed and administratively demanding. However, we find that the coefficient on *Diprem* is negative but statistically insignificant when risk is measured by NPL ratio. The coefficients on *Diprem x Tier1* indicate that risk-based deposit insurance tied to the regulatory capital ratio (or prudential norms) can reduce banks' risk-taking. The coefficients on *Diprem x Tier1* in *z*-score and *Liquid* specifications are significant positive. When risk is measured by NPL ratio, the effect of *Diprem x Tier1* is negative and statistically significant. The positive significant effect of *Diprem x Law* is supportive of the Hypothesis 3. A risk-based deposit insurance scheme works more effectively in countries with high judicial quality and legal enforcement.

Table 5. Results from estimation with risk-based premium interactions

VARIABLES	(1) <i>Z</i>	(2) <i>NPL</i>	(3) <i>Liquid</i>
<i>Ta</i>	-0.087*** (0.009)	-0.004*** (0.001)	-0.023*** (0.003)
<i>Td</i>	0.034 (0.084)	0.037*** (0.008)	0.184*** (0.024)
<i>NII</i>	0.180** (0.086)	0.001 (0.003)	0.115*** (0.023)
<i>Depba</i>	-1.743*** (0.230)	-0.002 (0.012)	0.429*** (0.062)
<i>Diprem</i>	-0.550*** (0.065)	-0.005 (0.004)	-0.058* (0.033)
<i>Diprem x Tier1</i>	2.082*** (0.325)	-0.037*** (0.014)	1.098*** (0.187)
<i>Diprem x Law</i>	0.510*** (0.040)	-0.016*** (0.003)	0.019 (0.018)
<i>GDP</i>	-1.608*** (0.303)	-0.006 (0.023)	0.318*** (0.115)
<i>Rint</i>	3.982*** (0.574)	0.032 (0.041)	0.515*** (0.149)
<i>Inf</i>	5.751*** (0.517)	-0.038 (0.045)	0.023 (0.161)
<i>Law</i>	0.244*** (0.035)	-0.004* (0.002)	-0.020** (0.009)
<i>Intercept</i>	3.917*** (0.162)	0.090*** (0.015)	0.399*** (0.050)
Wald chi2	1682.47	665.58	554.17
Wald p-value	0.000	0.000	0.000
No. of obs.	747	716	757
Number of banks	156	150	151

The table reports coefficient estimates from Panel FGLS. Standard errors in parentheses are based on White type standard errors robust to time-varying residuals and correlation over time within cross-section units. See Table 1 for variable definitions.

*, **, *** indicate statistical significance at the 10%, 5% and 1% percent, respectively.

Our robustness checks are based on three variations to the estimation process. Firstly, we estimate all specifications presented in Tables 3-5 with time dummies. These regressions show no significant qualitative differences in the results. Hence we do not report the results here (available upon request from the authors). Secondly, we replace NPL ratio as a credit risk proxy with the ratio of loan loss reserves to total loans denoted as *LLP*. This variation is suggested by the fact that loans loss provision ratio may be more accurate to measure asset risk in terms of bank's preparedness to writing-off bad loans. The results are presented in Table 6. The coefficients of the deposit insurance variables are basically similar to those obtained in the previous specifications. Thirdly, we apply a feasible two-stage least square model to analyze the influence of tier 1 capital ratio interacted with the deposit premium dummy, *Diprem*. Tier 1 capital ratio can be endogenous because bank assets and capital structure determines the capital adequacy.

In the first stage, tier 1 capital ratio is defined as a function of the bank variables and the macroeconomic and country-specific variables. In the second stage, we incorporate the tier 1 capital ratio, *Tier1hat*, predicted by the first stage as explanatory variables together with the macroeconomic and country-specific variables, bank variables and deposit insurance variables. Table 7 presents the results obtained from the feasible two-stage least squares. The results are largely consistent with those presented in Table 4. However, we find that the most coefficients become insignificant in liquidity risk estimation. The significantly positive effect of *Diprem* $\times$ *Tier1hat* on z-score confirms that the twin effects of a risk-based deposit insurance scheme and the regulatory prudential norms discourage banks' risk-taking. Since a risk-based premium system eliminates the free-rider problem and discourages banks' risk-taking in countries with higher institutional quality, the empirical results on *Diprem* $\times$ *Law* are consistent with the hypothesis 3.

Table 6. The relationship between loan loss reserves and deposit insurance

VARIABLES	(1) <i>LLP</i>	(2) <i>LLP</i>	(3) <i>LLP</i>	(4) <i>LLP</i>
<i>Ta</i>	0.006 (0.006)	0.005 (0.006)	-0.004* (0.002)	-0.005*** (0.002)
<i>Ta2</i>	-0.000** (0.000)	-0.000* (0.000)		
<i>Td</i>	-0.014 (0.037)	-0.016 (0.037)	0.011 (0.028)	0.013 (0.015)
<i>Depba</i>	0.002 (0.055)	-0.008 (0.053)	-0.076 (0.052)	-0.012 (0.024)
<i>NII</i>	0.022 (0.014)	0.023* (0.014)	0.025 (0.016)	0.007 (0.005)
<i>Di</i>		-0.012** (0.006)		
<i>Dita</i>	-0.004* (0.002)			
<i>Dita2</i>	0.000* (0.000)			
<i>Didepba</i>		0.010 (0.059)		
<i>Dimem x Depba</i>			0.153* (0.081)	
<i>Cov</i>			-0.002 (0.004)	
<i>Fund</i>			0.035*** (0.009)	
<i>Diprem</i>				0.006 (0.008)
<i>Diprem x Tier1</i>				0.023 (0.034)
<i>Diprem x Law</i>				-0.018*** (0.005)
<i>GDP</i>	-0.212*** (0.061)	-0.225*** (0.062)	-0.132 (0.108)	0.018 (0.032)
<i>Inf</i>	0.155** (0.076)	0.165** (0.077)	0.136* (0.082)	0.030 (0.048)
<i>Rint</i>	0.212*** (0.070)	0.224*** (0.070)	0.169** (0.073)	0.120** (0.057)
<i>Law</i>	-0.007 (0.004)	-0.005 (0.004)	0.001 (0.006)	-0.003 (0.006)
Constant	0.058* (0.035)	0.061* (0.037)	0.057 (0.051)	0.100*** (0.025)
Wald Chi2	83.1	75.2	105.06	82.93
Wald p-value	0.00	0.00	0.00	0.00
No. of obs.	1,938	1,938	1,009	770
Number of banks	317	317	195	156

The table reports coefficient estimates from Panel FGLS. Standard errors in parentheses are based on White type standard errors robust to time-varying residuals and correlation over time within cross-section units. See Table 1 for variable definitions.

*, **, *** indicate statistical significance at the 10%, 5% and 1% percent, respectively.

Table 7. Endogenous tier 1 capital ratio and banks' risk-taking

VARIABLES	1st stage	VARIABLES	Z	2nd stage	
	<i>Tier1hat</i>			<i>NPL</i>	Liquid
<i>Ta</i>	-0.017*** (0.006)	<i>Ta</i>	-0.024 (0.033)	-0.017*** (0.005)	-0.005 (0.010)
<i>Td</i>	-0.166** (0.070)	<i>Td</i>	-0.955*** (0.326)	0.044 (0.031)	0.002 (0.080)
<i>NII</i>	0.033 (0.032)	<i>NII</i>	0.048 (0.147)	-0.001 (0.023)	0.027 (0.017)
<i>GDP</i>	0.189 (0.149)	<i>Depba</i>	-0.867*** (0.329)	0.029 (0.057)	-0.142 (0.091)
<i>Inf</i>	-0.298 (0.227)	<i>Diprem</i>	-0.441* (0.243)	0.003 (0.084)	-0.047 (0.089)
<i>Rint</i>	0.061 (0.210)	<i>Diprem x Tier1hat</i>	3.209* (1.723)	0.079 (0.619)	0.149 (0.594)
<i>Law</i>	0.008 (0.011)	<i>Diprem x Law</i>	0.173** (0.069)	-0.044*** (0.015)	0.015 (0.027)
<i>Constant</i>	0.516*** (0.124)	<i>GDP</i>	-0.518 (0.596)	-0.083 (0.119)	0.241* (0.132)
		<i>Inf</i>	0.603 (0.738)	0.241** (0.114)	0.148 (0.147)
		<i>Rint</i>	-0.037 (0.858)	0.222** (0.095)	0.176 (0.155)
		<i>Law</i>	-0.019 (0.121)	0.036** (0.015)	-0.006 (0.031)
		<i>Constant</i>	3.860*** (0.621)	0.286*** (0.078)	0.452** (0.218)
Wald Chi2	36.59	Wald Chi2	27.83	36.59	17.5
Wald p-value	0.00	Wald p-value	0.00	0.00	0.09
Observations	1,755	Observations	979	874	992
Number of id	316	Number of id	198	180	187

The table reports coefficient estimates from Panel FGLS. Standard errors in parentheses are based on White type standard errors robust to time-varying residuals and correlation over time within cross-section units. See Table 1 for variable definitions.

*, **, *** indicate statistical significance at the 10%, 5% and 1% percent, respectively.

5. Conclusions

This paper examines whether implicit or explicit deposit insurance encourages bank risk-taking in emerging markets dominated Asia. Testing the data set of 401 banks in 31 Asian countries over the period from 2000 to 2010 with three risk proxies for bank risk-taking- credit, liquidity, and overall default risks, we find that the implementation of deposit insurance helps to stabilize the banking system but also leads banks to undertake excessive risk. Risk-taking incentives vary with bank size and risks. Differentiated premiums may not accurately reflect the level of risk that a bank poses. We also find that higher deposit insurance coverage significantly encourages banks' risk-taking. During the presence of a deposit insurance scheme, the pattern of the non-linear relationship between bank size and risk-taking becomes convex. In addition, our results suggest that market discipline exercised by banks is stronger in the presence of mandatory deposit insurance scheme. Government-funded deposit insurance funds allow Asian banks to take a higher risk.

The policy implication of this study suggests that Asian governments should encourage private sector involvement in deposit insurance schemes and define optimal levels of the insurance coverage and risk-adjusted premium. When regulators assess bank risks inaccurately, the insurance premium does not help mitigating risk-taking. A country should have strong banking supervision and design high quality regulations to adopt the risk-based deposit insurance. The finding is supportive of our hypothesis that good institutional background and legal environment mitigates banks' risk-taking. In the case of a blanket guarantee, banks should be left out of implicit insurance coverage immediately after stabilizing a turbulent situation in the market at times of distress. This helps to prevent banks shifting risks to the government, insurers, or other banks.

For many of the Asian banks, the important data such as market value, ownership structure, banks executive compensation have not been publicly available or sufficiently collected for quantitative analyses. This is mainly because such information is legally private or has recently been allowed for public access. It is worth further studying the effect of deposit insurance on risk taking in Asian banks using those data when they become sufficiently available.

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