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Impact of Financial Market Development, Financial Crises and Deposit Insurance on Bank Risk*

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Abstract

This paper examines the impact of financial market development, financial crises and deposit insurance on bank risk based on macro data of 86 countries during the period 1998–2014. The results show that banking sector development and stock market development have

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opposing effects on bank risk measured as bank non-performing loan ratio. The introduction of an explicit deposit insurance system plays a significant role in reducing banks' risk. However, the bank market development after the introduction of this system also increases banks' risk. The impact of financial market development and deposit insurance system on banks' risk was more significant before the 2008 financial crisis. It is found that there is a nonlinear relationship between financial market development, deposit insurance, financial crises and banks' risk. The stock market development has an asymmetric effect on banks' risk.

Keywords: Financial market development, financial crisis, deposit insurance, bank risk, non-linear relationship

JEL Classification: G21, G22, G32

Introduction

Financial market development not only can promote economic activities by increasing the efficiency of capital allocation, financial services, risk management and resource mobilization (Levine, 1997; Merton, 1995), but can also pose threats to the health of the financial system (Vithessonthi, 2014a). Banks are major participants in financial markets, and financial market development may affect bank capitalization by increasing the demand for bank loans from the private sector (Abdul Hamid *et al.*, 2020), and bank revenue diversification by contributing to the growth of non-traditional activities (Vithessonthi, 2014b). High capitalization is associated with bank stability (Pak, 2019), more capital enables banks to survive and avoid financial distress (Anginer *et al.*, 2018), whereas bank revenue diversification is expected to increase bank risk (Baele *et al.*, 2007; Bikker and Metzemakers, 2005; Sanya and Wolfe, 2011; Shim, 2013).

Based on these arguments, whether financial market development plays any role in influencing bank risk deserves to be investigated. However, prior studies focus on the linkage between financial market development and economic growth or stability (Bumann *et al.*, 2013; Galindo *et al.*, 2007; Ranciere *et al.*, 2006), bank performance, efficiency and risk (Abdul Hamid *et al.*, 2020; Vithessonthi, 2014a) and innovation-related activity (Tee *et al.*, 2014). Emerging literature has attempted to estimate the effect of financial market development on bank risk using panel data models and has not reached consistent conclusions. A study based on 52 listed banks in five Southeast Asian countries shows that bank capitalization is negatively associated with financial market development and bank revenue diversification is insensitive to financial market development (Vithessonthi, 2014a). In contrast, a study based on 37 listed banks from seven South American countries finds that financial

market development has a positive effect on bank capitalization and a negative effect on bank revenue diversification (Vithessonthi and Tongurai, 2016). Vithessonthi (2014b) indicates that stock market development enhances the banking system's stability and banking sector development appears to induce the banking system's instability in Thailand, whereas Abdul Hamid *et al.* (2020) reveal that banking sector development lowers bank risk, measured by bank capitalization and bank revenue diversification, while stock market development has no effect on bank risk.

Financial or banking crises have serious adverse effects on financial systems and economic growth (Adrian and Shin, 2009; Khan *et al.*, 2017). Crisis experience usually leads to a tightening of banking regulations and induces banks to be more conservative in future (Vithessonthi and Tongurai, 2016), which may bring a substantial change in the linkage between financial market development and bank risk (Abdul Hamid *et al.*, 2020; Nee and Opper, 2009). Vithessonthi (2014a) finds that the negative effect of banking sector development on bank capitalization in Southeast Asia has been weaker after the Asian financial crisis. Vithessonthi and Tongurai (2016) show that a country-level banking crisis moderates the linkage between financial market development and bank risk. Furthermore, to better protect the depositors' interests and enhance the banking sector's stability, many countries have implemented explicit deposit insurance systems. The introduction of explicit deposit insurance schemes weakens market discipline (Angkinand and Wihlborg, 2010; Chang *et al.*, 2018; Ioannidou and de Dreu, 2019), and may lead banks to take on excessive risk. However, the existing literature on the linkage between financial market development and bank risk fails to analyse the impact of deposit insurance.

This paper uses an unbalanced panel data sample of 86 countries during the period 1998–2014 to investigate the effects of financial market development, financial crises and deposit insurance on bank risk, and contributes to the literature in three ways. Firstly, this paper examines the impact of an explicit deposit insurance system and its interaction terms with financial market development on bank risk. Secondly, it investigates the nonlinear relationship between financial market development and bank risk using panel data at the national level. Last but not the least, our study explores whether banks have learned from the 2008 financial crisis and the role of explicit deposit insurance systems after the financial crisis.

The rest of this paper is organized as follows. Section 2 introduces the data source, variable selection and econometric methods. Section 3 provides statistical description, empirical results and analyses. Section 4 concludes the paper.

2. Data and Methodology

2.1 Data source and variable selection

According to the aim of this paper and data availability, we restrict the study sample to 86 countries and collect an unbalanced panel data set during the period 1998–2014. The data come from the World Development Indicators (WDI), EIU Country Data of the BVD (EIU), Global Financial Development (GFDD), the Polity IV of Centre for Systemic Peace (Polity IV) and the International Association of Deposit Insurers (IADI).

(1) Bank risk

The leverage ratio and non-core banking activities are positively associated with the likelihood of bank failures (Abdul Hamid *et al.*, 2020; Ayadi, 2019; Stiroh, 2006; Vazquez and Federico, 2015; Vithessonthi, 2014a). Consistent with the literature (Angkinand and Wihlborg, 2010), we use bank non-performing loans to gross loans (%) as proxies for bank risk. Data for this variable are from the GFDD.

(2) Financial market development

Developed financial markets can provide banks with growth opportunities by increasing credit demand from the private sector and with more opportunities for engaging in non-traditional banking activities. To measure the degree of financial market development, many examples in the literature have employed banking sector development and stock market development (Cave *et al.*, 2020; Law and Habibullah, 2009; Nyasha and Odhiambo, 2017; Pradhan *et al.*, 2014). Based on the existing studies, we proxy financial market development by banking sector development (*BSD*) and stock market development (*SMD*) simultaneously, measured as the ratio of private credit provided by deposit money banks to GDP and the ratio of stock market capitalization to GDP, respectively. Data for these two variables are from the GFDD.

(3) Financial crisis

To test whether there has been a substantial change in the effects of financial market development and deposit insurance on bank risk after the 2008 global financial crisis, this paper defines a dummy variable *CRISIS*, which equals 1 during the sample period 2008–2014, and 0 otherwise.

(4) Explicit deposit insurance

The implementation of explicit deposit insurance schemes may weaken the influence of bank regulation or market discipline (Angkinand and Wihlborg, 2010; Cubillas *et al.*, 2012), encouraging banks' risk-taking behaviours. Thus, the current study defines a dummy variable *Explicit*, which equals 1 if the country has implemented an explicit deposit insurance scheme, to investigate the direct and indirect effects of explicit deposit insurance on bank risk. We also

introduce the variable *CONTAGION*, which indicates the proportion of countries that have adopted explicit deposit insurance systems in all these country samples every year. The data are the authors' calculation based on the WDI and EIU.

(5) Bank level control variables

The study also controls for variables affecting bank risk (Demirgüç-Kunt *et al.*, 2013; Pak, 2019; Vazquez and Federico, 2015; Vithessonthi, 2014a, 2014b). Bank revenue diversification (BRD) is measured as the ratio of bank non-interest income to total income. *BCIR* indicates bank cost-to-income ratio (%). *BOCTA* indicates bank overhead costs to total assets (%). *BROAT* indicates bank return on assets (%, after tax). *BCBD* indicates bank credit to bank deposits (%). *BEIM* indicates bank net interest margin (%). *BROEBT* indicates bank return on equity (%, before tax). *LATDASTF* and *BRCTRWA* both are proxies for the bank's liquidity, measured as the ratio of liquid assets to deposits and short-term funding and the ratio of bank regulatory capital to risk-weighted assets, respectively. Bank capitalization (*CAPTA*) is measured by the ratio of bank capital to total assets. *CFBBTG* indicates consolidated foreign claims of BIS-reporting banks to GDP (%). *CGSETG* indicates credit to government and state-owned enterprises to GDP (%). *DEP* indicates deposit interest rate (%). *DEP2GDP* is measured as the ratio of bank deposits to GDP. *EDBAS* indicates external loans and deposits of reporting banks vis-à-vis all sectors (% of domestic bank deposits). Bank size (*LnASSET*) is measured as the natural logarithm of bank assets, and bank assets are calculated as the product of GDP and the ratio of deposit money banks' assets to GDP. Bank performance (*ROAbt*) is the ratio of EBIT to total assets. SPR indicates the interest rate spread (%). Data for these variables are from the GFDD.

(6) Macroeconomic control variables

This paper also includes nine variables to control for the macroeconomic conditions of the sample countries. *EXC* indicates official exchange rate; the data are from the WDI and EIU. *FS* indicates the fiscal surplus (%); the data are from the WDI. The growth of GDP (*GDPGann*) is measured as year-on-year growth in GDP, the data are from the WDI. *NIPVG* indicates non-life insurance premium volume to GDP (%). *SAV* indicates household saving rate, it is defined as the subtraction of household consumption expenditure from household disposable income, divided by the disposable income, the data are the authors' calculation based on the WDI and EIU. Trade openness (*TRADE*) is defined as the ratio of the sum of total exports and imports to GDP. *POP65* is the proportion of people over 65 in a country; the data are from the WDI.

(7) Institutional control variables

DEMOC indicates the democracy score, *POLITY* indicates the polity score, data of *DEMOC* and *POLITY* is from Polity IV.

2.2 Econometric models and methods

2.2.1 Response of bank risk to financial market development and deposit insurance

According to the previous research (Angkinand and Wihlborg, 2010; Chang *et al.*, 2022; Chang *et al.*, 2018), all the independent variables in this paper are lagged one period in order to reduce a potential simultaneity problem caused by introducing explicit deposit insurance schemes or to altering the deposit insurance coverage limits in response to credit losses. Following Vithessonthi (2014a), this paper constructs panel data models to assess the effects of financial market development and explicit deposit insurance on bank risk:

$$BR_{i,t} = \alpha + \beta_1 FD_{i,t-1} + \beta_2 Explicit_{i,t-1} + \delta CCON_{i,t-1} + \gamma BCON_{i,t-1} + \eta MAC_{i,t-1} + \lambda INS_{i,t-1} + \theta_i + \varepsilon_{i,t} \quad (1)$$

where $BR_{i,t}$ denotes the bank risk indicator of the country i at the time t, bank non-performing loans to gross loans ($NPL_{i,t}$ in %); $FD_{i,t-1}$ denotes financial market development, including banking sector development ($BSD_{i,t-1}$) and stock market development ($SMD_{i,t-1}$); β_1 is the impact of financial market development on bank risk; $Explicit_{i,t-1}$ is a dummy variable, indicating whether the country has implemented an explicit deposit insurance scheme; β_2 indicates the impact of explicit deposit insurance systems on bank risk; $BCON_{i,t-1}$ represents the bank level variables affecting bank risk; $MAC_{i,t-1}$ represents the macroeconomic variables; $INS_{i,t-1}$ represents the institutional variables; θ_i denotes the individual effect at the country level; and $\varepsilon_{i,t}$ is the error term.

2.2.2 Impact of financial crisis on response of bank risk to financial market development and deposit insurance

First, this paper interacts the financial crisis dummy variable and the explicit deposit insurance dummy variable with each of the measures of financial market development, respectively. Then we introduce them into Equation (1) to examine the effects of financial crises and explicit deposit insurance on the relationship between financial market development and bank risk over the whole sample period. The model is specified as Equation (2):

$$BR_{i,t} = \alpha + \beta_1 FD_{i,t-1} + \beta_2 Explicit_{i,t-1} + \beta_3 FD_{i,t-1} CRISIS_{i,t-1} + \beta_4 FD_{i,t-1} Explicit_{i,t-1} + \gamma BCON_{i,t-1} + \eta MAC_{i,t-1} + \lambda INS_{i,t-1} + \theta_i + \varepsilon_{i,t} \quad (2)$$

where $FD_{i,t-1}$ $CRISIS_{i,t-1}$ denotes the interaction of the financial market development variable and the financial crisis dummy variable; β_3 denotes the impact of financial market development on bank risk after the onset of the 2008 financial crisis; $FD_{i,t-1}$ $Explicit_{i,t-1}$ is the interaction

term of the financial market development variable and the explicit deposit insurance dummy variable; and β_4 represents the impact of financial market development on bank risk after the introduction of an explicit deposit insurance system.

Then, this research divides the whole sample period 1998–2014 into two stages, namely 1998–2007 and 2008–2014, and uses Equation (2) to estimate the impact of financial market development and explicit deposit insurance on bank risk during the two sub-periods, respectively. We then analyse the differential effects of financial market development and explicit deposit insurance schemes on bank risk after the onset of the 2008 global financial crisis.

2.2.3 Non-linear effect of financial market development on bank risk

Angkinand and Wihlborg (2010) find that there is a U-shaped quadratic function relationship between bank risk and deposit insurance coverage. Further, Zhao *et al.* (2017) study the impact of household savings rate and deposit-loan spread on this U-shaped relationship. From the macro point of view, deposit insurance coverage, household savings rate, deposit-loan spread and other factors are part of financial market development. Finally, Vithessonthi (2014a) shows that more advanced financial markets may exert a more substantial effect on bank risk than less developed financial markets; thus, financial market development may pose non-linear effects on bank risk. This paper introduces the squared term of financial market development and its intersection terms into Equation (3) to test whether the effect of financial market development on bank risk is non-linear. The model is specified as Equation (3):

$$\begin{aligned} BR_{i,t} = {} & \alpha + \beta_1 FD_{i,t-1} + \beta_2 FD^2{}_{i,t-1} + \beta_3 Explicit_{i,t-1} + \beta_4 FD_{i,t-1} CRISIS_{i,t-1} + \beta_5 FD_{i,t-1} Explicit_{i,t-1} \\ & + \gamma BCON_{i,t-1} + \eta MAC_{i,t-1} + \lambda INS_{i,t-1} + \theta_i + \varepsilon_{i,t} \end{aligned} \quad (3)$$

where $FD^2{}_{i,t-1}$ denotes the squared term of financial market development measures; and the coefficients β_2, β_3 represent the non-linear effect of financial market development on bank risk.

In addition, to further investigate whether financial market development has an asymmetric effect on bank risk, we define a conditioning dummy variable $FDDUM_{i,t-1}$, which equals 1 if the value of $FD_{i,t-1}$ is larger than its median value and replaces the squared term in Equation (3) with the interaction of $FD_{i,t-1}$ and $FDDUM_{i,t-1}$.

2.2.4 Model verification

We take some measures to deal with the potential problems of panel data with long time dimensions. Considering the unbalanced panel data, the difference of autoregressive coefficients between panels and the asymptotic theory of time dimension and section dimension, we introduce

the panel unit root test to verify the stationarity of each variable and find that the common variables and instrumental variable selected in this paper are stationary. We use a modified Wald test to identify the group-wise heteroscedasticity in the regression model, as shown in Table 1. The statistics in Table 1 reject the original hypothesis of homoscedasticity and lead us to believe that there is heteroscedasticity between groups. We use the Wooldridge test to identify the intra--group autocorrelation problem in the regression model. The specific results are shown in Table 2. The statistics in Table 2 reject the original hypothesis that there is no first-order intra-group autocorrelation.

Table 1: Modified Wald test for group-wise heteroscedasticity in regression model

Equation	H_0: $\sigma^2(i) = \sigma^2$ for all i	
Column (1), Table 4	chi2 (99) = 1.3e + 33	Prob > chi2 = 0.0000
Column (2), Table 4	chi2 (77) = 4.4e + 31	Prob > chi2 = 0.0000
Column (1), Table 5	chi2 (77) = 7.9e + 31	Prob > chi2 = 0.0000
Column (2), Table 5	chi2 (69) = 4.0e + 33	Prob > chi2 = 0.0000
Column (3), Table 5	chi2 (63) = 6.3e + 31	Prob > chi2 = 0.0000
Column (1), Table 6	chi2 (77) = 1.7e + 31	Prob > chi2 = 0.0000
Column (2), Table 6	chi2 (77) = 6.0e + 31	Prob > chi2 = 0.0000

Source: Authors' calculations using Stata SE 15.1 based on Section 2. Data and Methodology

Table 2: Wooldridge test for intra-group autocorrelation in regression model

Equation	H_0: no first-order autocorrelation	
Column (1), Table 4	F(1, 91) = 158.490	Prob > F = 0.0000
Column (2), Table 4	F(1, 69) = 122.106	Prob > F = 0.0000
Column (1), Table 5	F(1, 69) = 123.412	Prob > F = 0.0000
Column (2), Table 5	F(1, 58) = 108.383	Prob > F = 0.0000
Column (3), Table 5	F(1, 52) = 78.265	Prob > F = 0.0000
Column (1), Table 6	F(1, 69) = 119.156	Prob > F = 0.0000
Column (2), Table 6	F(1, 69) = 119.294	Prob > F = 0.0000

Source: Authors' calculations using Stata SE 15.1 based on Section 2. Data and Methodology

Countries may be affected by the contagion effect in establishing explicit deposit insurance systems, and there may be endogenous problems, which leads to biased estimates. This paper adopts the Davidson-MacKinnon test to test the endogeneity of *CONTAGION*. Research shows that setting up a deposit insurance system is highly correlated with the proportion of people over 65 years of age (hereafter, *POP65*) (Chang *et al.*, 2018; Demirgüç-Kunt *et al.*, 2008), and *POP65* is not directly related to bank risk-taking behaviour. Therefore, if the *CONTAGION* is an endogenous variable, this paper takes *POP65* as the instrumental variable for *CONTAGION*. The results of the endogeneity test in Table 3 show that the panel regression equations in columns (2)–(3) of Table 5 do not have an endogeneity problem.

The fixed-effect model and the random-effect model are fundamental in the panel data models. In the fixed-effect model, explanatory variables are allowed to be correlated with the individual effect θ_i and not allowed to correlate with the error term $\varepsilon_{i,t}$, whereas the individual effect θ_i is purely random and uncorrelated with the regressors in the random-effect model. This paper uses the Hausman test to select the more appropriate model to estimate the effects of financial market development and deposit insurance on bank risk. The results are shown in Table 4.

To solve the group-wise heteroscedasticity and intra-group autocorrelation problems in the regressions, we consider using fits panel data linear models by using feasible generalized least squares and instrumental variable methods.

Table 3: Davidson-MacKinnon test of exogeneity in regression model

Equation	Instrumented	Instrument	IV Regression	Davidson-MacKinnon test of exogeneity
Column (1), Table 4	*CONTAGION*	*POP65*	F(98,869) = 10.22 Prob > F = 0.0000	F(1,868) = 24.77362 *p*-value = 7.8e-07
Column (2), Table 4	*CONTAGION*	*POP65*	F(76,667) = 9.95 Prob > F = 0.0000	F(1,666) = 11.71616 *p*-value = 6.6e-04
Column (1), Table 5	*CONTAGION*	*POP65*	F(76,663) = 9.55 Prob > F = 0.0000	F(1,662) = 13.21911 *p*-value = 3.0e-04
Column (2), Table 5	*CONTAGION*	*POP65*	F(68,335) = 10.18 Prob > F = 0.0000	F(1,334) = 0. 2925778 *p*-value = 0.5889
Column (3), Table 5	*CONTAGION*	*POP65*	F(62,243) = 8.19 Prob > F = 0.0000	F(1,242) = 0.2854978 *p*-value = 0.5936
Column (1), Table 6	*CONTAGION*	*POP65*	F(76,661) = 10.34 Prob > F = 0.0000	F(1,660) = 8.618395 *p*-value = 0.0034
Column (2), Table 6	*CONTAGION*	*POP65*	F(76,659) = 10.40 Prob > F = 0.0000	F(1,658) = 8.618395 *p*-value = 0.0049

Source: Authors' calculations using Stata SE 15.1 based on Section 2. Data and Methodology

Table 4: Hausmann test in regression model

Equation	H_0: difference in coefficients not systematic		Model selection
Column (1), Table 4	chi2(28) = 93.68	Prob > chi2 = 0.0000	Fixed effects
Column (2), Table 4	chi2(30) = 110.26	Prob > chi2 = 0.0000	Fixed effects
Column (1), Table 5	chi2(33) = 106.30	Prob > chi2 = 0.0000	Fixed effects
Column (2), Table 5	chi2(31) = 67.65	Prob > chi2 = 0.0002	Fixed effects
Column (3), Table 5	chi2(30) = 46.51	Prob > chi2 = 0.0278	Fixed effects
Column (1), Table 6	chi2(33) = 105.49	Prob > chi2 = 0.0000	Fixed effects
Column (2), Table 6	chi2(35) = 106.09	Prob > chi2 = 0.0000	Fixed effects

Source: Authors' calculations using Stata SE 15.1 based on Section 2. Data and Methodology

3. Results and Discussion

3.1 Statistical description

Table 5 reports summary statistics of the critical variables for the complete sample. Tables 6 and 7 report summary statistics of the key variables for the two sub-periods (1998–2007 and 2008–2014). According to Tables 6 and 7, in the post-crisis period, the mean of *NPL* is lower than that before the crisis. The mean of the bank capitalization ratio is similar in size, 9.212% for the period 1998–2007 and 10.46% for the period 2008–2014.

Table 5: Summary statistics of key variables

	Mean	Median	Std. dev.	Min	Max
NPL	7.302	4.501	7.594	0	74.1
BSD	37.376	25.842	34.743	0.073	385.885
SMD	45.533	28.907	49.989	0.01	464.721
CONTAGION	0.215	0.142	0.192	0.00526	0.574
BRD	37.788	35.932	13.521	1.425	92.858
BCIR	56.95	56.52	15	19.99	218.1
BOCTA	3.839	3.037	3.397	0.00147	81.9
BROAT	1.402	1.201	1.536	−8.824	9.908
BCBD	103.3	92.27	79.12	1.138	2861
BEIM	4.808	4.053	3.126	0.125	21.29
BROEBT	18.08	16.5	17.54	−275.6	169
BRCTRWA	16.46	15.5	5.376	1.755	48.6
CAPTA	9.936	9.3	4.036	1.49	30.6
DEP	25.01	6.777	357.2	0.01	17236
CFBBTG	42.81	16.12	111.3	0.000541	3547
CGSETG	10.34	6.392	11.52	4.70E-05	74.82
DEP2GDP	40.27	29.335	42.049	0.263	883.404
EDBAS	95.89	44.44	264	1.975	5 506
LnASSET	1.559	1.605	2.934	−7.840	9.63
LATDASTF	35.653	31.506	19.981	1.422	233.333
ROAbt	1.827	1.546	2.478	−24.117	66.262
SPR	8.718	5.4	49.15	−731.6	2 335
EXC	351.5	4.862	1 541	1.00E-06	21 909
FS	−2.209	−2.011	5.678	−203.7	39.91
GPGann	3.979	3.962	5.952	−50.248	149.973
NIPVG	1.264	1.152	0.84	0.00233	13.62
SAV	31.03	31.84	24.97	−88.60	89.83
POP65	6.915	5.036	4.501	0.697	25.71
TRADE	77.048	65.105	53.549	0	442.62
DEMOC	4.954	6	5.242	−61	37
POLITY	2.562	6	10.67	−127	122

Source: Authors' calculations based on WDI, GFDD, EIU, Polity IV and IAD

Table 6: Summary statistics of key variables: 1998–2007

	Mean	Median	Std. dev.	Min	Max
NPL	8.013	5.05	8.466	0.1	74.1
BSD	32.93	22.79	30.76	0.0729	385.9
SMD	42.1	25.46	49.29	0.0124	464.7
CONTAGION	0.16	0.0895	0.146	0.00526	0.479
BRD	38.35	36.92	14.09	1.425	87.88
BCIR	57.62	57.38	16	19.99	218.1
BOCTA	4.098	3.33	3.157	0.0409	27.48
BROAT	1.561	1.268	1.668	−7.736	9.908
BCBD	102.6	91.39	80.59	1.138	2861
BEIM	5.085	4.231	3.449	0.181	21.29
BROEBT	20.1	17.87	19.66	−275.6	169
BRCTRWA	15.31	13.7	5.346	2.9	48.6
CAPTA	9.212	8.6	4.01	2	30.6
DEP	29.45	7.387	395.2	0.01	17236
CFBBTG	36.43	14.34	106.2	0.00908	3547
CGSETG	9.853	5.863	11.65	4.70e−05	74.82
DEP2GDP	35.98	24.68	37.74	0.263	883.4
EDBAS	98.32	56.83	154.9	3.46	2490
LnASSET	1.127	1.089	2.874	−7.840	9.282
LATDASTF	38.69	34.97	21.37	1.422	233.3
ROAbt	1.984	1.62	2.222	−17.59	18.74
SPR	9.652	5.65	57.83	−731.6	2335
EXC	269.8	3.75	1211	1.00e−06	16078
FS	−2.202	−1.993	5.632	−203.7	31.85
GPGann	4.26	4.237	6.437	−50.25	150
NIPVG	1.293	1.166	0.888	0.00233	13.62
SAV	30.89	31.55	25.98	−88.60	89.83
POP65	6.619	4.793	4.207	0.756	20.96
TRADE	71.34	59.79	49.5	0	425.4
DEMOC	4.719	5.9	5.434	−61	37
POLITY	2.13	5	11.24	−127	122

Source: Authors' calculations based on WDI, GFDD, EIU, Polity IV and IADI

Table 7: Summary statistics of key variables: 2008–2014

	Mean	Median	Std. dev.	Min	Max
NPL	6.797	4.3	6.867	0	54.541
BSD	55.97	45.01	43.25	2.638	260.7
SMD	53.85	38.63	50.72	0.00951	333.9
CONTAGION	0.549	0.566	0.0287	0.505	0.574
BRD	36.87	34.68	12.49	8.624	92.86
BCIR	55.85	55.29	13.12	19.99	150
BOCTA	3.51	2.753	3.656	0.00147	81.9
BROAT	1.201	1.161	1.324	−8.824	7.558
BCBD	106.3	95.27	72.49	20.39	879.7
BEIM	4.46	3.901	2.627	0.125	13.16
BROEBT	15.53	14.94	14.04	−59.89	81.37
BRCTRWA	17.37	16.39	5.225	1.755	44.48
CAPTA	10.46	9.931	3.975	1.49	24.85
DEP	5.303	4.051	3.939	0.01	22.91
CFBBTG	57.9	22.88	121.2	0.000541	1238
CGSETG	11.67	8.31	11.04	0.0154	73.59
DEP2GDP	58.19	45.86	53	3.791	472
EDBAS	92.38	33.98	368.7	1.975	5506
LnASSET	3.291	3.222	2.504	−2.088	9.63
LATDASTF	31.74	27.78	17.27	5.266	233.3
ROAbt	1.628	1.507	2.755	−24.12	66.26
SPR	6.326	4.9	5.713	−2.808	49.5
EXC	618.8	7.752	2294	0.269	21909
FS	−2.251	−2.140	5.948	−40.55	39.91
GPGann	3.034	3.137	3.757	−36.04	25.12
NIPVG	1.212	1.125	0.747	0.00513	4.992
SAV	31.69	33.15	19.75	−64.88	86.34
POP65	8.932	6.762	5.754	0.697	25.71
TRADE	96.51	82.62	61.67	20.72	442.6
DEMOC	6.361	8	3.591	0	10
POLITY	5.155	8	5.526	−10	10

Source: Authors' calculations based on WDI, GFDD, EIU, Polity IV and IADI

However, banks appear to decrease their engagement in non-traditional activities after the global financial crisis. The mean of bank revenue diversification for the period 2008–2014 is 36.87%, which is relatively smaller than that for the period 1998–2007. For financial market development, the ratio of private credit to GDP rises and the depth of stock markets increases, as the mean of banking sector development for 2008–2014 is 55.97%, larger than 32.93% for 1998–2007, while the mean of stock market development for 2008–2014 is 53.85%, bigger than 42.10% for 1998–2007. Furthermore, after the global financial crisis, banks are better capitalized, the ratio of bank deposits to GDP is higher, the growth of GDP declines and the degree of trade openness rises.

3.2 Impact of financial market development and deposit insurance on bank risk

The Hausman test is used to explore whether the individual effect at the country level is fixed or random for the entire sample. Fits panel-data linear models by using feasible generalized least squares and instrumental variable methods are considered in estimation equations. The results are shown in Table 8. We report the results of regressions without financial market development variables simultaneously.

According to column (2) of Table 8, the impact of *BSD* on *NPL* is positive and significant at the statistical level of 1%, and that of *SMD* is negative and significant at the statistical level of 1%. Therefore, banking sector development significantly increases bank risk, whereas stock market development significantly decreases bank risk. The coefficient of *Explicit* in columns (1) and (2) is negative and significant as expected, implying that the introduction of an explicit deposit insurance scheme significantly lowers bank risk. However, previous studies have shown that the introduction of an explicit deposit insurance system may increase banks' moral hazard and banks' risk-taking behaviour (Angkinand and Wihlborg, 2010; Cooper and Ross, 2002; Demirgüç-Kunt and Detragiache, 2002; Demirgüç-Kunt and Huizinga, 2004; Demirgüç-Kunt *et al.*, 2008; Diamond and Dybvig, 1983; Dreyfus *et al.*, 1994). The positive and significant coefficient of *CONTAGION* in columns (1) and (2) also verifies this point; that is, the transmission effect of explicit deposit insurance systems around the world may lead to high risk in the banking industry. It can be seen that the explicit deposit insurance system is still controversial in restraining bank risk.

Table 8: Response of bank risk to financial market development and deposit insurance

	Fixed effects		Fixed effects	
	(1)	*p*-value	(2)	*p*-value
BSD	–	–	0.079***	(0.007)
SMD	–	–	−0.021***	(0.009)
CONTAGION	35.909***	(0.003)	19.896*	(0.088)
Explicit	−2.110***	(0.008)	−1.439*	(0.084)
BRD	0.042*	(0.050)	0.040*	(0.057)
BCIR	−0.011	(0.567)	−0.012	(0.553)
BOCTA	−0.014	(0.809)	0.052	(0.314)
BROAT	0.749	(0.275)	0.428	(0.558)
BCBD	0.026***	(0.000)	0.041***	(0.001)
BEIM	−0.209	(0.182)	−0.283*	(0.092)
BROEBT	0.043*	(0.092)	0.007	(0.788)
BRCTRWA	−0.047	(0.450)	0.097	(0.135)
CAPTA	0.057	(0.547)	0.177*	(0.078)
DEP	0.287***	(0.000)	0.251***	(0.000)
CFBBTG	0.023**	(0.024)	0.013	(0.167)
CGSETG	−0.087**	(0.039)	−0.007	(0.849)
DEP2GDP	0.132***	(0.000)	0.028	(0.417)
EDBAS	−0.014**	(0.023)	−0.013**	(0.022)
LnASSET	−7.191***	(0.000)	−5.810***	(0.000)
LATDASTF	−0.059***	(0.000)	−0.024	(0.152)
ROAbt	−1.828***	(0.006)	−1.426**	(0.050)
SPR	−0.054	(0.323)	0.047	(0.383)
EXC	−0.000	(0.536)	−0.002**	(0.032)
FS	−0.037	(0.546)	0.011	(0.868)
GPGann	−0.160***	(0.001)	−0.071	(0.168)
NIPVG	−2.277***	(0.000)	−1.436***	(0.009)
SAV	−0.053***	(0.006)	−0.057***	(0.003)
TRADE	−0.043***	(0.008)	0.012	(0.498)
DEMOC	0.984*	(0.080)	1.677***	(0.004)
POLITY	−0.506	(0.177)	−0.776**	(0.046)
Constant	13.797***	(0.000)	5.598	(0.136)
R^2	0.272		0.421	
N	996		774	

Notes: ***, **, and * denote significance at the statistical level of 1%, 5%, and 10% respectively.

Source: Authors' calculations using Stata SE 15.1 based on Section 2. Data and Methodology

For other control variables, *BRD* has a positive and significant impact on *NPL* in columns (1) and (2), which indicates that the non-performing loan ratio of the banks is positively correlated with the diversity of bank income. Since an increase in non-interest related income, such as net gains on trading and derivatives, tends to increase the income diversity of banks and increase the instability of banks (Mashamba and Magweva, 2019; Polizzi *et al.*, 2020), *LnASSET* has a negative and significant impact on *NPL* and a positive one in columns (1) and (2). The impact of *BCBD* on *NPL* is significantly positive, which is observed because the higher the bank credit contributes to decreasing bank stability. The higher the return on bank assets, the stronger the profitability, the better the stability of the bank can effectively reduce the bank risk (Xu *et al.*, 2019); thus, *ROAbt* has a statistically significant negative impact on *NPL*. Countries with higher household saving rates may have more prudent capital supervision requirements, and can increase bank supervision levels (Demirgüç-Kunt *et al.*, 2008; El-Hadj, 1997).

3.3 Impact of financial market development and deposit insurance on bank risk

This section first examines whether financial crises and deposit insurance affect the relationship between financial market development and bank risk, and the results are reported in column (1) of Table 9. By dividing the total sample into two sub-periods, we further assess the differential effects of financial market development and deposit insurance on bank risk, and the results are reported in columns (2) and (3) of Table 9. We use fits panel-data linear models by using feasible generalized least squares and instrumental variable methods. We also introduce the Hausman test to select the more appropriate model, and the results show that the fixed-effect models should be used in columns (1), (2) and (3).

In column (1) of Table 9, the coefficient of *CONTAGION* is positive and significant at the statistical level of 10%, indicating the spread effect of deposit insurance systems around the world increases bank risk. The coefficient of *Explicit* in column (1) of Table 9 is negative and significant, which shows that the introduction of explicit deposit insurance systems inhibits bank risk. The results in column (2) of Table 9 show that the effect of *Explicit* on *NPL* is significantly negative for the pre-crisis period, while the coefficient of the cross terms of *BSD* and *Explicit* is significantly positive. This shows that before the 2008 financial crisis, the introduction of an explicit deposit insurance system played a role in reducing bank risk; however, the introduction of this scheme also increases bank risk with the development of banking industry, which once again proves the positive and negative effects of explicit deposit insurance systems on bank stability (Angkinand and Wihlborg, 2010; Chang *et al.*, 2019; Chang *et al.*, 2018; Demirgüç-Kunt *et al.*, 2008).

Table 9: Response of bank risk to financial development and deposit insurance: sub-periods

	NPL		NPL		NPL	
	1998–2014		1998–2007		2008–2014	
	Fixed effects		Fixed effects		Fixed effects	
	(1)	*p*-value	(2)	*p*-value	(3)	*p*-value
BSD	0.036	(0.354)	−0.067	(0.173)	0.075	(0.201)
SMD	−0.002	(0.875)	0.009	(0.674)	0.029	(0.191)
SMD_CRISIS	−0.001	(0.958)	–	–	–	–
BSD_CRISIS	0.007	(0.680)	–	–	–	–
CONTAGION	21.691*	(0.067)	−9.918	(0.942)	14.539	(0.386)
Explicit	−2.291*	(0.071)	−4.454***	(0.004)	2.095	(0.342)
BSD_Explicit	0.040	(0.100)	0.079**	(0.029)	0.007	(0.839)
SMD_Explicit	−0.022	(0.137)	−0.034	(0.101)	−0.031	(0.157)
BRD	0.037*	(0.089)	0.071**	(0.013)	0.004	(0.901)
BCIR	−0.012	(0.535)	−0.018	(0.461)	−0.019	(0.552)
BOCTA	0.057	(0.267)	0.367*	(0.093)	−0.049	(0.219)
BROAT	0.397	(0.594)	0.774	(0.391)	−2.537**	(0.029)
BCBD	0.043***	(0.001)	0.067***	(0.005)	0.001	(0.956)
BEIM	−0.293*	(0.084)	0.100	(0.690)	−0.585**	(0.022)
BROEBT	0.010	(0.735)	0.020	(0.566)	−0.037	(0.334)
BRCTRWA	0.085	(0.197)	0.157*	(0.055)	−0.054	(0.624)
CAPTA	0.180*	(0.076)	0.093	(0.456)	0.586***	(0.000)
CFBBTG	0.014	(0.138)	0.010	(0.421)	0.002	(0.911)
CGSETG	−0.004	(0.915)	0.040	(0.503)	0.027	(0.695)
DEP	0.254***	(0.000)	0.040	(0.534)	0.405***	(0.000)
DEP2GDP	0.033	(0.351)	0.071	(0.163)	0.010	(0.848)
EDBAS	−0.015**	(0.014)	−0.013	(0.208)	−0.009	(0.175)
LnASSET	−6.043***	(0.000)	−3.302***	(0.009)	−3.790**	(0.043)
LATDASTF	−0.025	(0.148)	−0.015	(0.501)	0.073**	(0.016)
ROAbt	−1.442*	(0.055)	−1.863**	(0.043)	2.149**	(0.046)
SPR	0.044	(0.419)	−0.040	(0.535)	−0.142	(0.173)
EXC	−0.002**	(0.030)	−0.000	(0.930)	0.000	(0.838)
FS	0.008	(0.899)	0.029	(0.709)	−0.112	(0.185)
GPGann	−0.068	(0.193)	−0.070	(0.351)	−0.082	(0.204)
NIPVG	−1.449***	(0.010)	−1.937**	(0.012)	−2.259**	(0.045)
SAV	−0.048**	(0.017)	−0.058**	(0.024)	0.066*	(0.056)
TRADE	0.006	(0.744)	0.003	(0.906)	−0.000	(0.991)
DEMOC	1.854***	(0.002)	0.965	(0.332)	1.482*	(0.079)
POLITY	−0.873**	(0.027)	−0.102	(0.878)	−0.974	(0.136)
POP65	–	–	0.463	(0.482)	0.433	(0.440)
Constant	6.335*	(0.096)	5.020	(0.936)	−7.048	(0.375)
R^2	0.420		0.523	–	0.421	–
N	774		436	–	338	–

Notes: ***, **, and * denote significance at the statistical level of 1%, 5%, and 10% respectively.

Source: Authors' calculations using Stata SE 15.1 based on Section 2. Data and Methodology

3.4 Is the impact of financial market development on bank risk nonlinear?

We estimate Equation (3) to test for the presence of the non-linear effect of financial market development on bank risk, and the results are presented in Table 10. According to the results of the Hausman test, columns (1) and (2) report the results using fixed-effect regression. The individual effect and year effect of a country are also considered in each equation.

In columns (1) and (2) of Table 10, the coefficients of the squared term of *BSD* are negative and significant at the level of 1%, the coefficients of *BSD* are statistically significant and positive, providing evidence for the nonlinear effect of banking sector development on bank risk. The squared term of *SMD* is positive and significant at the level of 1%, the coefficient of *SMD* is negative and significant at the level of 1%, also indicating a U-shaped relationship between *NPL* and *SMD*. Therefore, an appropriate development level of the stock market would make the banking industry relatively stable. This finding occurs because a gradual shift form direct financing to indirect financing promotes the development of stock market (Tang and Yao, 2018); however, banks are financial intermediaries with interest rate as the operation core, which are closely related to the stock market and other economic sectors, providing a way for spreading systemic risk across different sectors (Acharya *et al.*, 2017).

The coefficient of *SMD_SMDDUM* in column (2) of Table 10 is positive and significant at the level of 10%, which indicates that a relatively high level of stock market development may increase bank risk, which also proves that the financial market development has an asymmetric effect on bank risk (Vithessonthi, 2014a).

In columns (1) and (2) of Table 10, the coefficient of *Explicit* is significantly negative, the coefficient of *BSD_Explicit* is positive and significant at the level of 5%, and the coefficient of *SMD_Explicit* is significantly negative at the level of 5%. This shows that the introduction of an explicit deposit insurance system increases banks' stability. However, this scheme also increases banks' moral hazard, which may weaken the stable operation of banks. With the stock market development, the introduction of an explicit deposit insurance system has a positive effect on improving the stability of banks.

Table 10: Response of bank risk to financial development: nonlinear effects

	NPL		NPL	
	Fixed effects		Fixed effects	
	(1)	*p*-value	(2)	*p*-value
BSD²	−0.001***	(0.000)	−0.001***	(0.000)
SMD²	0.000***	(0.000)	0.000***	(0.000)
BSD	0.198***	(0.001)	0.218***	(0.002)
SMD	−0.061***	(0.004)	−0.105***	(0.002)
SMD_CRISIS	0.001	(0.974)	0.001	(0.940)
BSD_CRISIS	0.013	(0.427)	0.013	(0.455)
BSD_BSDDUM	–	–	−0.020	(0.502)
SMD_SMDDUM	–	–	0.037*	(0.096)
CONTAGION	13.429	(0.207)	12.185	(0.250)
Explicit	−2.481**	(0.043)	−2.614**	(0.034)
BSD_Explicit	0.047**	(0.046)	0.049**	(0.036)
SMD_Explicit	−0.028**	(0.049)	−0.029**	(0.038)
BRD	0.035*	(0.092)	0.036*	(0.082)
BCIR	−0.008	(0.690)	−0.008	(0.682)
BOCTA	0.049	(0.323)	0.049	(0.327)
BROAT	0.346	(0.629)	0.391	(0.585)
BCBD	0.019	(0.192)	0.021	(0.161)
BEIM	−0.232	(0.155)	−0.217	(0.187)
BROEBT	0.004	(0.899)	0.003	(0.922)
BRCTRWA	0.099	(0.117)	0.092	(0.147)
CAPTA	0.273***	(0.006)	0.269***	(0.007)
DEP	0.215***	(0.000)	0.214***	(0.000)
CFBBTG	0.009	(0.347)	0.009	(0.327)
CGSETG	−0.028	(0.476)	−0.018	(0.638)
DEP2GDP	0.016	(0.654)	0.013	(0.702)
EDBAS	−0.014**	(0.016)	−0.015**	(0.011)
LnASSET	−5.585***	(0.000)	−5.486***	(0.000)
LATDASTF	−0.015	(0.358)	−0.018	(0.277)
ROAbt	−1.195*	(0.097)	−1.227*	(0.088)
SPR	0.015	(0.777)	0.017	(0.741)
EXC	−0.001	(0.313)	−0.001	(0.306)
FS	0.035	(0.572)	0.028	(0.648)
GPGann	−0.048	(0.346)	−0.049	(0.340)
NIPVG	−1.563***	(0.004)	−1.564***	(0.004)
SAV	−0.050**	(0.010)	−0.052***	(0.007)
TRADE	0.010	(0.530)	0.014	(0.406)
DEMOC	1.887***	(0.001)	1.773***	(0.002)
POLITY	−0.837**	(0.027)	−0.752**	(0.049)
Constant	5.901	(0.108)	6.615*	(0.081)
R²	0.463		0.525	
N	1 050		1 050	

Notes: ***, **, and * denote significance at the statistical level of 1%, 5%, and 10% respectively. *BSD_BSDDUM* (*SMD_SMDDUM*) is the interaction of *BSD* (*SMD*) and *BSDDUM* (*SMDDUM*). If the value of *BSD*(*SMD*) is greater than its median value, *BSDDUM* (*SMDDUM*) equals 1, and 0 otherwise.

Source: Authors' calculations using Stata SE 15.1 based on Section 2. Data and Methodology

3.5 Subregional discussion

To explore the regional impact of financial market development, financial crises and deposit insurance on bank risk, we divide the total sample into four subsamples according to geographical location: Africa, the Americas, Europe and Asia-Pacific. For Africa, the coefficient of *SMD* is significantly negative, indicating that the stock market development can effectively reduce bank risk. The coefficients of *BSD_ BSDDUM* and *SMD_SUMDUM* are significantly positive, which indicates that the rapid development of the banking and stock market in Africa has an asymmetric effect on bank risk, and the effect is mainly reflected in an increase in bank risk. For the Americas, the coefficient of *SMD* is significantly positive. The coefficients of *Explicit* and *SMD_Explicit* are significantly negative. The coefficient of *BSD_CRISIS* is significantly positive, which indicates that after the 2008 financial crisis, the banking industry development has increased the bank risk, and the American banking industry may not have learned from the financial crisis. For Europe, the coefficients of BSD^2 and *BSD_Explicit* are significantly negative, while the coefficients of *BSD* and *BSD_BSDDUM* are significantly positive. The coefficients of SMD^2, *Explicit* and *SMD_Explicit* are significantly positive, and the coefficient of *SMD* is significantly negative. This shows that there is a significant nonlinear and asymmetric relationship between the European financial market development and bank risk. For Asia-Pacific, the coefficients of SMD^2 and *Explicit* are positive and significant, while the coefficients of *SMD*, *BSD_CRISIS* and *BSD_Explicit* are significantly negative, which shows that the countries in the Asia-Pacific region have learned a lesson from the global financial crisis of 2008, and the banking industry development in the post-crisis period has decreased banking risks. There is also a significant nonlinear and asymmetric relationship between financial market development and bank risk in the region.

Conclusion

Using macro data from 86 countries over a 17-year period between 1998 and 2014, this paper estimated the effects of two measures of financial market development – stock market development and banking sector development – on bank risk measured by bank non-performing loans to gross loans, taking into consideration the impact of the 2008 global financial crisis and the explicit deposit insurance scheme on bank risk and on the linkage between financial market development and bank risk.

The quadratic term of banking market development was found to be significantly negative, and the coefficient of *BSD* is significantly positive. In theory, there is an inverted U-shaped relationship between bank market development and bank risk. The quadratic term of stock market development is significantly positive, while the coefficient of *SMD* is significantly negative.

In theory, there is a U-shaped relationship between bank risk and stock market development. The coefficient of *Explicit* is significantly negative. From the perspective of introducing an explicit deposit insurance system, it can effectively curb bank risk. However, the cross-term between *Explicit* and *BSD* has a significant positive effect on bank risk, which indicates that the introduction of an explicit deposit insurance system may increase banks' moral hazard (Diamond and Dybvig, 1983; Keeley, 1990), reduce public supervision and restraint on banks (Cooper and Ross, 2002; Demirgüç-Kunt and Detragiache, 2002), resulting in incentives for banks to engage in high-risk activities. The cross-term between *Explicit* and *SMD* has a significant negative impact on bank risk, which indicates that the stock market development after the introduction of an explicit deposit insurance system will reduce bank risk. This may be due to the promotion of financial liberalization in the world. On the one hand, the diversification of financing channels reduces the profitability of banks with deposit loan interest margin, and banks may be involved in more non-interest income fields in order to maintain their own profits. This may lead to an increase in the overall risk level of the banking industry. On the other hand, the abundance of financing channels also promotes a gradual shift from bank-centred to indirect financing.

During the pre-crisis period 1998–2007, the introduction of an explicit deposit insurance system reduced the risk of the banking industry. However, the banking industry development after the introduction of this system increases the banks' risk. In addition, the diversification of bank income and the high proportion of credit to deposits also increase the banks' risk. For the post-crisis period 2008–2014, the relevant variables of financial market development and explicit deposit insurance systems do not have a significant impact on bank risk. However, many bank-level control variables have an impact on banks' risk. For example, higher levels of bank overhead costs to total assets, bank net interest margin and bank assets can inhibit banks' risk. There is a positive correlation between banks' risk and bank capital asset ratio, deposit interest rate, the ratio of liquid assets to deposits and short-term funding and the ratio of EBIT to total assets.

The present study finds that the impact of financial market development, deposit insurance and bank crises on bank risk is heterogeneous in different time dimensions and regions. Different samples prove that there is a nonlinear relationship between financial market development, deposit insurance, financial crises and banks' risk. The financial market development has an asymmetric effect on banks' risk. Financial crises promote the development of financial markets and lead to financial reforms. The process also produces many uncertain factors which affect bank risk, and bank risk breeds potential crises. Therefore, regulatory authorities should also be vigilant about the transmission of adverse effects of financial market development to financial intermediaries, including banks (Noman *et al.*, 2018; Tennant and Tracey, 2014). Furthermore, regulatory authorities should formulate corresponding prudent policies according to the characteristics of different financial sectors to limit the risk to a controllable range while promoting the development of the sector.

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