Macro-financial linkages and bank behaviour: evidence from the second-round effects of the global financial crisis on East Asia

Chau H.A. Le[1]

Abstract

This paper studies the link between macro-financial variability and bank behaviour, which justifies the second-round effects of the global financial crisis on East Asia. Following Gallego et al. (The impact of the global economic and financial crisis on Central Eastern and South Eastern Europe (CESEE) and Latin America, 2010), the second round effects are defined as the adverse feedback loop from the slumps in economic activities and sharp financial market deterioration, which may influence the financial performance of bank, inter alia via deteriorating credit quality, declining profitability and increasing problems in retaining necessary capitalization. Differentiating itself from other research, this study stresses adjustments in four dimensions of bank performance and behaviour: asset quality, profitability, capital adequacy, and lending behaviour, assuming that any change in a bank-specific characteristic is induced by endogenous adjustments of the others. The empirical results based on partial adjustment models and two-step system GMM estimation show that bank's adjustment behaviour is subject to the variation in the macro-financial environment and the stress condition in the global financial market. There is no convincing evidence to support the effectiveness of policy rate cut to boots bank lending and to avoid a financial accelerator effect.

Keywords: Bank behaviour, Financial contagion, Global financial crisis, Macro-financial linkages, The second round effect

JEL Classification: G21, F61, F62, F65

[1] Chau H. A. Le (email: chaulha@buh.edu.vn), Institute of Research and Technology, Banking University HCMC, 39 Ham Nghi, District 1, Ho Chi Minh City, Vietnam

1. Introduction

Problems in banking sectors have been at the epicenter of the historical economic and financial crises in both emerging markets and advanced economies during the past decades. Experiencing an expensive lesson from the financial distress of 1997-1998, East Asia has focused on building a resilient banking system to withstand negative shocks and stimulate macro-financial stability. Therefore, East Asian banks entered the global financial crisis in a relatively sound condition thanks to the remarkable reforms and conservative regulatory regime developed in the 2000s. Despite the healthy pre-crisis condition and limited direct exposure to US subprime mortgage credit products, following the mounting pressures of the global financial markets during 2007-2008, the short-term outlook of the Asian banking sector assessed by leading credit agencies was negative (Pomerleano, 2009). Table 1 summaries Moody's average bank financial strength ratings, which reflect several downgrades and downward changes in outlook for major banking systems in 2008 and 2009. Some countries, such as Hong Kong and Indonesia, were considered to have a stable outlook. However, according to a report from the Hong Kong Monetary Authority (HKMA) in 2008, the outlook of banks in Hong Kong was uncertain and less promising. Similarly, despite their stable outlook, Indonesian banks were assessed to be very vulnerable to credit risk, especially mid-sized and large banks, according to the stress tests conducted by the IMF in 2010[2]. Pressure in the banking sector works through feedback loops from a slump in economic activities, along with a tailspin in asset prices, which may cause bank performance to deteriorate. Rating agencies expected the biggest threat to be the substantial pressure on loan quality and the potential rising non-performing loans (NPL). This would therefore lead to higher provisions, lower profitability and considerable erosion in bank capital, which may have negative implications for further lending.

This study empirically examines how the variability in macro-financial conditions can influence banks' financial soundness and behaviour, which justifies the second-round effects of the global financial crisis of 2007-2008 on East Asian economies. The analysis is based on a panel of 196 commercial banks from eight East Asian countries over the time period of 2005 to 2014. This paper contributes to the existing literature by stressing the simultaneous effects in four dimensions of bank performance: asset quality, profitability, capital adequacy, and loan portfolio. The assumption is that any change in bank performance is caused by either endogenous bank-specific factors or exogenous factors of

[2] See IMF Country Report No.10/288. Indonesia: Financial System Stability Assessment.

macro-financial variables. Therefore, a multi-equation instead of a single-equation framework is employed, taking into account partial adjustment models and the dynamic interactions between instruments of bank performance. This research also differentiates itself from previous studies by allowing the global financial stress factors, amongst the main drivers of bank behaviour, to control for the contagion effect from external shocks to East Asia. Additionally, in response to the contagion effect, central banks in Asia announced numerous policy interventions during the period 2008 to 2009. Although the scale of interventions and their impacts varied across markets, they contributed in various ways to stabilize the regional financial system in conditions of stress[3]. The effectiveness of policy rate cut will be revised in the empirical tests. The findings should have several implications for bank managers and policy makers for forecasting and stress testing purposes to detect problems arising in the banking system.

Table 1 - Moody's Average Bank Financial Strength Ratings

Country	Date	Average Strength Ratings	Outlook changes
Japan	Dec.2008	C-	Negative
Singapore	May.2008	B	Negative
HongKong	Dec.2007	B	Stable. (But according to a HKMA publication in 2008, the outlook was less promising and uncertain).
Korea	Oct.2008	C-	Negative, primarily due to its dependence on international capital and money markets for funding.
Thailand	Sep.2008	D	Negative
Indonesia	Dec.2008	D	Stable
Philippines	Feb.2008	D	Stable
Malaysia	2009	C-D	Stable

Source: Pomerleano (2009)

The outline of this paper is presented as follows. Section 2 reviews the theoretical framework and empirical evidence of macro-financial linkages and bank behaviour. Section 3 describes the empirical models, methodologies and data sample. The analysis of the empirical results will be discussed in Sect. 4. Section 5 provides conclusions.

[3] See BIS paper No.52: "The international financial crisis: timeline, impact and policy responses in Asia and the Pacific" by the staff at The BIS Asian Programme.

2. Literature review

2.1. The theoretical framework of macro-financial linkages and bank behaviour

The theoretical literature that explains macro-financial linkages and bank behaviour is linked to the credit channel via borrower and bank balance sheet effects. The borrower balance sheet channel relates to borrowers' equity position (or net worth, NW), which influences their access to credit. This is also known as the financial accelerator effect, explaining bank lending behaviour and its relationship with the cyclical fluctuations in the economy. The channel works through a so called external finance premium (EFP), the wedge reflecting the difference in the cost of externally and internally raised funds (Bernanke et al., 1994; Kiyotaki & Moore, 1995). Bernanke et al. (1994) argue for an inverse relationship between the borrowers' NW and EFP. During business upturn, a firm's NW is improved and the greater it is, the lower the EFP, as lenders assume less risk when lending to high NW agents. An adverse shock that lowers borrowers' current cash flows leads to a decline in their NW and raises EFP. The increase in borrowers' cost of financing will discourage their desires to undertake more investment projects and consequently affect the demand for credit, propagating and amplifying the effect of the initial shocks. Kiyotaki and Moore (1995) develop a dynamic equilibrium model to demonstrate that borrowers' NW is not only sensitive to the variation in cash flow, but also the changes in the valuation of the real and financial assets they hold. In this model, assets play a dual role in an economy: (i) to produce goods and services and (ii) to provide collateral for loans. When asset values are hit by a temporary shock, a direct effect occurs because the changes in collateral values cause changes in obtained credit. In addition, the reduction in production and spending as a result of the shocks to real economies may also depress asset prices further, causing shock propagation over time.

The bank balance sheet channel refers to the traditional bank lending and bank capital channels. The traditional bank lending channel focuses on the reserve-deposit constraints on the supply of bank loans. However, the traditional bank lending model has largely ignored the role of bank capital and endogenous credit risk by assuming that all loans are paid back. Holmstrom and Tirole (1997) point out the important role of bank capital to finance bank lending because this will provide the incentives for banks to monitor borrowers and overcome the moral hazard problem. Therefore, a shrinkage in bank capital due to a fall in loan pay-offs following a shock that weakens firms' NW will reduce the volume of loan supply. Blum and Hellwig (1995), Borio et al. (2010) and Goodhart et al. (2004) study the bank capital channel in terms of regulatory requirements. Increases in

credit risk during recession cause a deterioration in the bank capital ratio and hence banks face much higher capital needs to fulfil regulatory requirements. However, raising fresh capital is more difficult and costly because banks' profit and capacity to build up reserves diminishes, and they are likely to de-lever their assets and reduce certain types of them. In this sense, the amount of credit extended to firms and households will fall, which in turn will restrain borrowers' expenditure and lower aggregate demand.

2.2. Empirical evidence for bank behaviour

There is a general consensus in the empirical literature that bank behaviour is likely to vary according to the stage of the business cycle and the bank's specific characteristics.

2.2.1. Economic Condition and Pro-cyclical Bank Behaviour

Extensive research has linked bank credit risk, profitability, capital adequacy and credit supply to the overall condition of the economy. A large amount of work has applied macro-stress testing (Du¨llmann and Erdelmeier 2009; Segoviano Basurto and Padilla 2007; Sorge and Virolainen 2006) and VAR framework (Alves 2005; Castre´n et al. 2008; Jacobson et al. 2005) to analyse the relationships between macroeconomic condition and bank credit risk. The empirical results suggest the importance of GDP, inflation, interest rate, and exchange rates in determining the variation in NPL, loan loss provision (LLP), and probability of defaults (PDs).

The effect of macro-financial variables on bank profitability is mixed in the empirical findings. On one hand, the work of Athanasoglou et al. (2008); Demirgüç-Kunt and Huizinga (1999); and Molyneux and Thornton (1992) shows a significant positive relationship between macroeconomic factors (GDP, inflation and policy rate) and bank profitability. On the other hand, some studies find little direct significant relationship. However, credit quality is one of the key drivers of a bank's profits, hence when macro-financial conditions weaken a bank's credit quality by increasing NPL and LLP, this also indirectly affects its profits (Davydenko, 2010; Pangestu, 2003; Vong & Chan, 2009).

In terms of bank capital, the empirical studies focus on the procyclical feature of capital requirements in partial adjustment models. Ayuso et al. (2004), Lindquist (2004), Stolz and Wedow (2005) and Jokipii and Milne (2008) examine the relationship between capital ratios and various measures of the business cycle such as real GDP growth and the real output gap. Their findings show that this relationship is statistically significant and negative, which suggests that banks raise capital during downturns as a buffer to negative

shocks. However, the main concern of cyclical influences is the banks' inability to raise capital during economic contractions; they therefore try to reduce lending.

Credit supply response is also sensitive to business cycle phases because the state of the economy affects the ability of bank managers to predict returns from lending opportunities. If banks perceive a stable macro environment, they may expect a higher probability that borrowers will pay back loans. Therefore, banks adjust their lending in response to these expectations, both in terms of stability and level of economic performance (Somoye & Ilo, 2009). Talavera et al. (2006) also mention that banks decrease their supply of credit when the volatility of macroeconomic variables increases. Macroeconomic volatility is captured by the conditional variance of monetary aggregates, CPI and the production price index. A related strand of empirical literature on bank lending to EMEs during global financial crises confirms the hypothesis of contraction in bank credit expansion in recession and general economic uncertainty following external financial shock (Aisen & Franken, 2010; Guo & Stepanyan, 2011; Ivashina & Scharfstein, 2010).

2.2.2. Bank-Specific Characteristics

While macroeconomic factors are considered as exogenous forces driving bank performance, the distinctive features of each particular bank are expected to exert a decisive influence on their behaviour. The empirical papers have provided considerable evidence to support the following hypotheses relating to bank-specific characteristics:

Asset size effect hypothesis: Bank size may affect bank behaviour for a variety of reasons such as economies of scale, diversification benefits, accessibility to capital and systematic effect (too big to fail). In the presence of economies of scale, larger banks benefit from lower costs and can undertake more screening and monitoring. This helps banks to reduce unexpected losses arising from asymmetric information between lenders and borrowers. Larger banks may also have better investment and diversification opportunities, as well as more access to capital markets and are therefore subject to a lower probability of negative capital shock. During financial stress, big banks may benefit from government protection due to systematic effects. In general, bank size is shown to yield a positive effect on asset quality (Louzis et al., 2012) and profitability (Demirgüç-Kunt & Huizinga, 1999; Goddard et al., 2011). However, bank size may also negatively affect capital management, which means that larger banks hold less capital buffer (Alfon et al., 2005; Jokipii & Milne, 2008; Stolz & Wedow, 2005).

Moral hazard hypothesis: The moral hazard hypothesis refers to the relationship between capital and risk-taking. Accordingly, banks with relatively low capital have more incentives to increase the riskiness of their portfolio in the form of excess lending, which results in a higher NPL in the future. On the contrary, a higher level of capital reduces risk-taking, which in turn reduces credit risk (Furlong & Keeley, 1989). Berger and DeYoung (1997) study the causality between loan quality and capital in US banks and confirm the significant moral hazard incentives, suggesting an increase in the level of NPL for poorly-capitalised banks. In complete contrast, Shrieves and Dahl (1992), Hellmann et al. (2000), and Stolz and Wedow (2005) argue that there is a positive relationship between portfolio risk and regulatory capital since banks raise capital to keep up their buffer when portfolio risk rises. Although the empirical evidence on the risk-capital relationship is inconclusive, these findings generally indicate that assets, asset risk and capital are endogenously determined.

Inefficiency hypothesis: The inefficiency hypothesis mentions the effect of bank cost management on asset quality and profitability. Berger and DeYoung (1997) and Louzis et al. (2012) provide evidence of a significant positive relationship between cost management and NPL ratio, which confirms that bad management goes hand in hand with poor skills in screening and monitoring borrowers. In terms of profitability, there is a consensus from the literature to confirm that cost inefficiency has a negative effect on bank profitability, since banks pass a part of the increased costs on to customers and the remaining part reduces profits (Athanasoglou et al., 2008; Pasiouras & Kosmidou, 2007).

Credit risk effect hypothesis: Credit risk is the main source of risk in banking and may simultaneously affect many aspects of bank performance. According to Athanasoglou et al. (2008), the relationship between credit risk and bank profitability is negative due to the fact that poor quality of loans reduces interest revenue. However, Flamini et al. (2009) find a positive and significant effect of credit risk on profitability, which may suggest that risk-averse shareholders target risk-adjusted returns and seek larger earnings to compensate for higher credit risk. Credit risk may also either directly or indirectly impact loan supply by its influence on profitability and capital. In Berger and Udell (2004), banks tend to tighten credit standards in response to deterioration in credit quality. Dumičić and Ridžak (2012) add more evidence for the negative relationship between loan quality and earnings, capitalisation and loan supply in their study of Croatian banks during the global financial crisis. Their findings indicate that a rise in NPL will increase the future costs of banks, and consequently diminish credit supply. Nevertheless, Peek and Rosengren (2000) find

contradictory behaviour amongst Japanese banks, who have incentives to roll over loans for severely impaired firms to limit the growth of bad loans, although this loan extension behaviour may create additional losses.

Earning effect hypothesis: As one of the key components representing financial soundness in the CAMEL system, earnings play an important role in banks' financial decisions. The theoretical and empirical literature suggests that changes in profit have a positive effect on bank capital. Since raising capital through capital markets is costly, retained earnings are frequently used to increase capital (Jokipii & Milne, 2008; Myers, 1984; Rime, 2001; Schaeck & Cihak, 2012). However, the negative effect of ROA on bank capital is also significant in Stolz and Wedow (2005). These authors suggest that highly profitable banks are able to permanently generate high profits and retain earnings to increase capital; they therefore need to hold a lower level of capital buffers as insurance against a probable violation of the regulatory minimum.

In conclusion, the literature survey of macro-financial linkages and bank behaviour reveals some gaps that motivate the development of the empirical strategy of this research. First, the existing literature focuses on investigating each aspect of bank behaviour (i.e. asset quality, profitability, capital buffer or lending behaviour) separately. Study of the simultaneous adjustment of all four of these dimensions of bank performance appears to be very limited. Furthermore, although the empirical evidence mostly shows the relationships between bank-specific characteristics in pairs, the literature suggests that specific behavioural factors are endogenously determined. Second, the empirical research measures bank behaviour which is mostly determined by macroeconomic variables and bank-specific characteristics. It seems to ignore the effects of common global shocks. Regarding the studies of shock transmission across countries, the main focus is on asset price and capital flow channels with less attention paid to microeconomic conditions and institutional factors. Last, in accordance with the study on one specific dimension of bank performance, current research tend to apply a single-equation framework and the most common econometric techniques are the VAR model and/or fixed effect regression in panel data. However, the fixed effects may encounter dynamic panel bias and fail to capture reverse causality. These problems have been addressed in some empirical works using instrumental variables estimation (e.g. 2SLS), but 2SLS is only efficient under homoscedasticity (Roodman, 2009). This study attempts to bridge the literature gaps by examining the simultaneous adjustment in asset quality, profitability, capital adequacy and lending behaviour, in response to the changes in the macro-financial environment and

global shocks. The partial adjustment models and two-step system GMM estimation are applied to deal with dynamic panel data, fixed effects, endogeneity, omitted variables and persistent series.

3. Methodologies and Data Sample

3.1. Methodologies

Bank behaviour is examined using partial adjustment model, which has the following specifications:

$$\boldsymbol{Y_t - Y_{t-1} = \beta(Y_t^* - Y_{t-1})} \quad \textbf{(1)}$$

$$\boldsymbol{Y_t^* = \sum_{k=1}^{K} \alpha_k X_{kt} + \mu_t} \quad \textbf{(2)}$$

where Y_t represents the proxy variables for bank performance at time t;

Y_t^* is an optimal target level, hence, in the long run Y_t will tend to converge toward Y_t^*. The optimal target level is not readily observable, but it depends on a set of internal and external factors, denoted by X_{kt};

β measures the speed of adjustment and lies between 0 and 1. The closer it approaches to 1, the faster the speed of adjustment;

μ_t is an error term.

Combining (1) and (2) give the following model:

$$\boldsymbol{Y_t = (1-\beta)Y_{t-1} + \beta Y_t^* = (1-\beta)Y_{t-1} + \sum_{k=1}^{K} \beta\alpha_k X_{kt} + \mu_t} \quad \textbf{(3)}$$

Equation (3) implies that bank behaviour is a function of the dynamic partial adjustment process and the desired target level, which may depend on the state of the economy and a bank's financial situation. Four dimensions of bank behaviour are proxied with the following variables: (i) the ratio of NPL over gross loan (denoted by NPL) to measure asset quality (also credit risk), (ii) return on assets (ROA) to represent bank profitability, (iii) capital adequacy ratio (CAR), which is measured by the amount of a bank's core capital as a percentage of its risk-weighted assets, (iv) lending behaviour is proxied by the percentage difference in total gross loan to non-bank customers (LOAN). The vector of explanatory variables, X_{kt} includes macroeconomic factors (ME), financial market variables (FM), global stress indices (GF) and bank-specific variables (Z). Applying the partial adjustment model for each dimension of bank behaviour, the four equations are set up as follows:

$$\boldsymbol{NPL_{it} = \gamma_1 NPL_{it-1} + \delta_1 ME_{it} + \theta_1 FM_{it} + \varphi_1 GF_t + \pi_1 Z_{it} + \varepsilon_{1,it}} \quad \textbf{(4)}$$

$$\boldsymbol{ROA_{it} = \gamma_2 ROA_{it-1} + \delta_2 ME_{it} + \theta_2 FM_{it} + \varphi_2 GF_t + \pi_2 Z_{it} + \varepsilon_{2,it}} \quad \textbf{(5)}$$

$$\boldsymbol{CAR_{it} = \gamma_3 CAR_{it-1} + \delta_3 ME_{it} + \theta_3 FM_{it} + \varphi_3 GF_t + \pi_3 Z_{it} + \varepsilon_{3,it}} \quad \textbf{(6)}$$

$$\boldsymbol{LOAN_{it} = \gamma_4 LOAN_{it-1} + \delta_4 ME_{it} + \theta_4 FM_{it} + \varphi_4 GF_t + \pi_4 Z_{it} + \varepsilon_{4,it}} \quad \textbf{(7)}$$

where: $i = \{1,2, \dots, N\}$ refers to individual bank i;

$\varepsilon_{it} = \omega_i + \vartheta_{it}$, with ω_i the unobservable bank-specific effects and ϑ_{it} the idiosyncratic error, given $\omega_i \sim IID(0, \sigma_\omega^2)$ and $\vartheta_{it} \sim IID(0, \sigma_\vartheta^2)$, independent of each other and among themselves.

The estimated parameter γ helps identify the adjustment factor β in the partial adjustment model as $\gamma = 1 - \beta \Rightarrow \beta = 1 - \gamma$. All explanatory variables enter the estimation of equations 4 - 7 with the current lags based on the assumption that banks revised their targets during the estimation period.

Equations 4, 5, 6 and 7 are estimated using dynamic panel data techniques with system-GMM as proposed by Arellano and Bond (1991) and Blundell and Bond (1998). GMM is more relevant for this study given that the structure of the data panel has a limited number of years (t = 10) and a substantial number of cross-sectional observations (n = 196). Moreover, bank-specific characteristic variables are likely to be potentially endogenous (Athanasoglou et al., 2008) and some other independent variables are not strictly exogenous, which make the application of other econometric methodologies (OLS, fixed effects, 2SLS) inappropriate. GMM estimation allows for instrumenting of the endogenous variables and provides consistent estimates. It is also robust to the omitted variables problem and helps avoid bias, when the presence of the lagged dependent variable with fixed effects gives rise to autocorrelation (Nickell, 1981). The GMM estimation of Arellano and Bond (1991) is based on the first difference transformation in the initial equation to eliminate the specific-effect component. The lags of the right hand side variables in the equations are used as instruments.

However, according to Blundell and Bond (1998), first-differences estimation has a large bias and low precision in a short sample period and relatively persistent data. This is clearly a concern in the studies of bank behaviour, since some of the variables (e.g. bank assets), display high levels of persistency, even after controlling for time trends. Therefore, this paper applies system GMM, derived from the jointly estimated system of two simultaneous equations in both levels (with lagged first differences as instruments) and in

first differences (with lagged levels as instruments). The two-step estimation is used because is it asymptotically more efficient than the one-step estimator in the presence of heteroskedasticity and serial correlation (Arellano & Bond, 1991; Blundell & Bond, 1998). However, the two-step estimator imposes a severe downward bias in standard errors. Following Windmeijer (2005), finite sample correction to two-step covariance matrix is employed (Windmeijer-corrected cluster–robust errors). The Hansen J-test is performed to test the validity of instrument sets and the Arellano–Bond test is applied to check the absence of second-order serial correlation in the first differenced residuals.

3.2. Descriptions of Variables and Data Sources

Models are estimated on an annual panel dataset of 196 commercial banks in eight East Asian countries (Singapore, Malaysia, Indonesia, Philippines, Thailand, Vietnam, Hong Kong and Japan)[4] from 2005 to 2014. Banks are selected based on country location categories from Bankscope database. The process starts with all local banks that have observations available within the investigated time period and then banks with insufficient performance data are dropped from the sample. Not all banks enter the sample in every year, so the selection process results in an unbalanced panel. The set of macroeconomic, financial, global stress variables and bank-specific characteristics is decided based on the literature and the narrative of the crisis.

Macroeconomic variables: the macroeconomic variables consist of the real GDP annual growth rate (GDP); inflation calculated as the average change in the CPI (INF); and change in policy rate (ΔPR). The hypothesis is that banks respond significantly to changes in the macroeconomic condition. Specifically, a decline in GDP (as a consequence of the contagion effect from global shock) negatively affects borrowers' cash flows and reduces their loan payoff probabilities. As a result, banks may suffer increasing problems in outstanding loans and declining profits. The downward adjustments in loan portfolio quality and profitability will weaken bank capital and reduce credit supply via balance sheet effects. At the same time, the economic slowdown also directly affects lending behaviour because it makes information in the financial markets even more asymmetric and worsens the adverse selection problem (Mishkin, 1999). The effects of inflation and interest rates are challenging. In theory, increases in interest rates and unanticipated declines in inflation cause firms' NW to decrease with negative implications for the banking sector (Bernanke et

[4] The paper focuses on six ASEAN countries which were strongly affected by the 1997-1998 financial crisis and two financial centres of the region (Hong Kong and Japan) as they have played a very important role in the credit market of Asia.

al., 1994; Mishkin, 1999). However, in EMEs inflation is usually very high and variable; therefore an unanticipated decline in inflation will be more likely to have a favourable effect on firms' balance sheets. ΔPR variable is added in the model not only to control for central bank interventions to sustain contagion effect during the global financial crisis, but also to capture the effect of the traditional bank lending channel.

Table 2– Summary of explanatory variables

Categories	Variables description	
	Mnemonic	**Definition**
Macroeconomic variables (IMF-IFS)	GDP	Real GDP annual growth rate
	INF	Inflation, average consumer price (percentage change)
	ΔPR	Changes in central bank policy rates to represent policy intervention (or changes in 3-months interbank rates for Vietnam due to data limitation)
Financial market variables (Datastream)	SVOL	Stock market volatility calculated by the standard deviation of daily returns on market index
	FER	Return on nominal foreign exchange rate (local currency per US dollar)
	CRISK	Sovereign CDS spreads expressed by basis point (in logarithm)
Global variables (Datastream)	VIX	Change in Chicago Board Options Exchange S&P500 Volatility Index
	TED	Spreads between 3-month LIBOR and 3-month US Treasury bill rate
Bank-level variables (Bankscope)	TA	Logarithm of bank's total assets (in million USD)
	LTD	Ratio between customer loan to deposit
	NPL	Non-performing loan to gross loan
	CAR	Capital adequacy ratio, measured by the amount of bank's core capital as a percentage of its risk-weighted assets.
	ROA	Net income after tax to average assets
	LOAN	Percentage change in gross loan provided to non-bank sectors

Financial market variables: In order to represent the financial market perception, three variables are employed: volatilities of stock returns (SVOL); returns on nominal exchange rates (FER); and sovereign Credit Default Swap Spreads (CDS). Empirical studies strongly support the hypothesis that asset prices become highly correlated during a crisis via

deleveraging effects. After the collapse of Lehman Brothers in September 2008, global investors dramatically reduced their exposures to East Asia, resulting in sharp declines in many stock markets. An adverse adjustment in stock prices could dampen consumer spending through a negative wealth effect. Moreover, stock price devaluation promotes financial instability because it leads to a large decline in the market value of firms' NW (Calomiris & Hubbard, 1990; Mishkin, 1999). Changes in CDS may affect the default risk of banks because financial institutions often hold a significant share of sovereign debt in total assets. Unanticipated exchange rate depreciation also contributes to financial instability as it makes domestic borrowers unable to roll over foreign currency liabilities and causes a mismatch in the banks' value of foreign denominated assets and liabilities (Mishkin, 1999).

Global financial stress variables: The effect of the global financial crisis is examined with the S&P500 volatility index (VIX) and TED spreads (TED). VIX is a key measure of a market's expectation of short-term (up to 30 days) volatility, and has therefore been considered as the world's premier barometer of investor sentiment. TED is widely used as an indicator to measure liquidity and credit risk, since the interbank rate represents banks' perception of the creditworthiness of other financial institutions and the availability of funds for lending purposes, compared with risk free investment in government securities.

Table 3 – Descriptive statistics of variables

Variables	Obs	Mean	Std. dev.	Min	Max
NPL	1965	3.494	3.043	0.000	39.589
ROA	2019	0.695	0.840	-6.338	5.319
CAR	1932	14.454	5.415	0.780	63.500
LOAN	1997	4.295	18.323	-59.4	408.39
LTD	2021	65.982	34.739	0.399	463.960
TA	2025	16.243	2.311	7.636	21.668
GDP	2030	2.557	3.232	-5.520	15.240
INF	2030	2.213	2.990	-1.340	13.100
ΔPR	2030	-0.034	0.951	-3.170	4.120
SVOL	2030	21.134	9.468	7.217	113.708
FER	2030	0.175	7.618	-13.361	20.138
CDS	1958	102.912	100.451	3.758	375.562
VIX	2030	-0.130	6.293	-8.930	15.128
TED	2030	0.515	0.405	0.200	1.550

Bank-specific variables: Bank-specific variables involve: TA (logarithm of a bank's total assets) to control for the asset size effect; LTD (customer loan to deposit ratio) to capture bank liquidity and the relative dependence on wholesale funding; CAR to control for the

moral hazard effect; NPL to control for credit risk; ROA to control for the earning effect; and LOAN to control for risk-taking behaviour.

Table 4 - Correlation matrix of variables

	NPL	ROA	CAR	LOAN	LTD	TA	GDP
NPL	1.000						
ROA	-0.059	1.000					
CAR	-0.030	0.516	1.000				
LOAN	-0.144	-0.302	-0.369	1.000			
LTD	0.049	0.232	0.105	-0.271	1.000		
TA	-0.143	-0.293	-0.321	0.989	-0.338	1.000	
GDP	0.057	0.546	0.350	-0.392	0.210	-0.383	1.000
INF	0.097	0.556	0.428	-0.384	0.189	-0.380	0.570
ΔPR	0.053	0.013	0.020	-0.048	0.066	-0.054	0.107
SVOL	-0.044	-0.171	-0.045	0.226	-0.119	0.226	-0.289
FER	-0.112	0.069	0.014	0.026	-0.059	0.025	0.043
CDS	0.007	0.315	0.355	-0.234	-0.151	-0.219	0.202
VIX	0.029	-0.129	-0.038	-0.036	0.000	-0.039	-0.189
TED	0.069	-0.138	-0.040	-0.055	-0.009	-0.058	-0.120
	INF	ΔPR	SVOL	FER	CDS	VIX	TED
INF	1.000						
ΔPR	0.213	1.000					
SVOL	0.072	-0.114	1.000				
FER	0.089	0.094	-0.143	1.000			
CDS	0.475	-0.096	0.117	-0.005	1.000		
VIX	0.195	0.036	0.591	-0.165	-0.065	1.000	
TED	0.130	-0.043	0.626	-0.285	-0.068	0.883	1.000

The macro data come from IMF – IFS, financial market and global financial stress data are collected from Datastream and bank-level data are extracted from BankScope. The description of variables is provided in Table 2, while Table 3 summarises descriptive statistics, which show marked performance differences between the banks in the sample. On average, the NPL ratio between 2005 and 2014 is 3.5%, which is quite low compared with the peak in the 1997 Asian crisis. Banks' regulatory capital also varies considerably but average CAR is relatively high, well above the Basel III requirement. In terms of profitability, the mean of ROA is reported at 0.69%, which is quite small because some banks experienced losses with negative ROA and the highest ratio is 5.32%. There is also quite wide heterogeneity between banks in terms of their size, liquidity and credit growth. The statistics on macro-financial variables also evidence large dispersion both across countries and over time. The variation in VIX and TED indicates the collapse of the risk

appetite of international investors and the global liquidity shortage, causing contagion effects in Asia. Table 4 shows the correlation coefficients between variables which are relatively low. Therefore, there may be no problem to involve them all in the regressions.

4. Empirical Results and Discussion

The estimation results are reported in Tables 5, 6, 7 and 8, representing different dimensions of bank performance. Various specifications of Eqs. 4, 5, 6 and 7 are examined. Specification 1 shows estimated parameters of bank behaviour, which is subject to macroeconomic factors and bank-specific characteristics suggested by the literature. Financial market variables were added to specification 2 and the global financial stress indicators as well as policy intervention were then included to capture the vulnerability of East Asian banks to external shocks in specification 3 and 4. The macro-financial variables are treated as strictly exogenous, while bank-specific variables are considered to be endogenous, in the sense that each behavioural factor can simultaneously cause the responses of the others. The estimated models fit the panel data reasonably well. The Wald-test statistics reject the null hypothesis of jointly insignificant parameters. The Hansen test for over-identifying restrictions confirms that the structural specifications are well modeled as the null hypothesis of valid instruments cannot be rejected. The p-values associated with AR(1) and AR(2) clearly indicate that the moment conditions of the models meet the requirements. Specifically, the tests reject the null hypothesis of zero first order serial correlation but cannot reject the absence of second order autocorrelated errors. In all regressions, the lags of dependent variables are statistically significant at a level of 1%, which confirms the persistent nature of bank performance and justifies the selection of dynamic models and system GMM. The estimated coefficients of lagged dependent variables give the speed of adjustment to a target value which is medium (β is around 0.25 - 0.6) for asset quality, capital and lending but relatively faster for bank profitability. In all models, most of the macroeconomic and financial variables have statistically significant effects on bank behaviour. Generally, the empirical results seem to be fairly robust, although the significance and size of a few coefficients may vary in different specifications.

4.1. Asset Quality

Table 5 shows that most external factors influence bank's asset quality. NPL is statistically and negatively affected by economic growth, which sharpens the cyclical nature of banks' behavior. Higher than expected NPL ratios in downturns are associated with declines in borrowers' cash flows and NW, which lower their debt servicing capacity. The effect of

inflation is not consistent in all specifications. The positive coefficients of INF in (1) and (2) suggest that increases in inflation will deteriorate firms' wealth and raise banks' credit risk. However, the effect of inflation will reverse in the presence of interest rate. The deterioration in financial market perceptions represented by increased sovereign risk and stock volatility as well as local currency depreciation also signals an increase in NPL. Local currency depreciation lowers the debt-servicing capacity of export-oriented firms which borrow in foreign currencies. Increase in sovereign credit risk and market volatility signal economic uncertainties, which have negative implications for banks' risks and expected losses. The global factors of VIX and TED demonstrated significant and positive influences on domestic banks' asset quality, which indicates the transfer of credit risk and contagion effect. The positive coefficient of ΔPR appears to be consistent with theoretical consensus that increasing interest rates increase debt burdens for borrowers and reduce debt pay-off probability.

There are also significant connections between NPL and the bank-specific characteristics. The negative coefficient of ROA supports the cost efficiency hypothesis. Better managed banks tend to have better asset quality. The change in gross loans also affects NPL at a level of significance of 1%. The negative impact of credit growth and loan to deposit ratio on NPL implies the instantaneous effect of increases in gross loans, which lowers the ratio of NPL (provisionally) within that period. There is evidence to support the size effect, verified by significant coefficients on TA. The positive coefficient of CAR is consistent with Hellmann et al. (2000) and Stolz and Wedow (2005) who explained that bank raised capital to keep up their buffer when portfolio risk risen. This implies the conservative attitudes of Asian banks after a decade of crisis resolution.

4.2. Bank Profitability

Bank profitability shows a lower level of persistence comparing to those of NPL, CAR and LOAN; implying that its convergence toward equilibrium level is relatively rapid. One of the reasons could be the increasing intensity of competition in the banking industry as a result of financial integration in East Asia. Banks profits appear to be very sensitive to the state of the economy and the perception of the financial market. The positive effects of GDP are consistent with much of the previous empirical literature, confirming that bank profits improve in good economic conditions because there is higher demand for credit, as well as non-credit services, and there is less credit risk. There is also significant positive impact of inflation on profitability, suggesting that inflation in Asian countries was well managed and anticipated during the period, so the banks adjusted the profit rates accordingly (Trujillo-

Ponce, 2013). Financial market performance has conflicting effects on ROA. The coefficient on FER variable is positive and significant which seems to contradict to the hypothesis that local currency depreciation signals financial instability that may increase credit risk and deteriorate bank income. One possible explanation for this result is that a small depreciation may improve the cash flows of export-oriented firms with a positive implication for bank profitability. The positive effect of market volatility and CDS spreads on banks' profit is also surprising. However, according to Lahmann (2012), there was contagion effect between sovereign and bank default risk in Asia-Pacific during the period of global financial crisis. Then, the co-movement of the perceived risk in bank sector and profits may imply the risk-return hypothesis. The global variables (VIX and TED), have a significant and negative impact on ROA, demonstrating that funding shortages together with the corruption of international investors' risk appetite, may cause the contraction of cross-border banking flows and increase tension in the interbank market. This will lead to impaired access to funding and a drop in trading volumes.

The effects of bank-specific characteristics support the credit risk hypothesis. Rising NPL negatively relates to bank profitability, which means that a poor quality of loans reduces interest revenue and increases provisioning cost. This suggests the important implication that in order to maximise profits, banks should improve the screening and monitoring of the risk of loan default (Karminsky & Kostrov, 2014). Moreover, well-capitalized banks were more likely to earn higher profits as they were able to attract more customers and extend their services, supported by the positive coefficients on CAR.

4.3. Capital Adequacy

The estimated parameters suggest a dynamic structure for bank capital in which today's capital adequacy ratio adjusts to the previous period's level. The significant and negative coefficients on GDP suggest the counter-cyclical effects, i.e. banks increase their capital holdings during economic downturn to accommodate higher risks (Ayuso et al., 2004; Jokipii & Milne, 2008; Stolz & Wedow, 2005). There is also convincing evidence to support the hypothesis that financial volatility has a significant impact on the capital ratio. As raising capital during the financial turbulence is difficult and costly, banks tend to hold more capital buffer. This lagged effect of VIX and TED is also more likely to reflect bank attitude toward the perceived risk. However, if the shock persisted, that may deteriorate banks' asset quality and profitability with negative implication for bank capital.

Bank capital is also highly dependent on bank-specific characteristics. Coefficients on NPL, ROA, LOAN and TA are all significant at the level of either 1%. The findings support the results from Alfon et al. (2005), in that banks decide the level of capital according to internal risk assessment. The negative coefficient on NPL is consistent with the theory of bank capital channel, while the negative coefficient on LOAN indicates that the increase in risky assets will contemporaneously weaken capital ratios. ROA also shows a statistically significant and positive effect, implying that profitable banks prefer to retain their earnings to improve their capitalisation. The significantly negative coefficient of TA supports the asset size effect hypothesis. Larger banks may have better diversification opportunities and easier access to capital markets, therefore they tend to hold less capital as a buffer against negative capital shocks.

4.4. Lending Behaviour

The empirical results show that the lagged dependent variable has a positive sign and is statistically significant in all specifications, giving an adjustment parameter of around 0.26. Overall, the rate at which banks adjusts their lending depends significantly on GDP growth, stock volatility, foreign exchange rates, country risk, global financial stress and changes in their specific performance. First, a positive coefficient on GDP affirms the pro-cyclical nature of lending behaviour. Specifically, during an economic upturn, firms' cash flows are improved and banks have an incentive to extend credit to borrowers. On the contrary, a recessionary period not only increases the default risk but also lowers loan demand. Turning to financial variables, market volatility and currency devaluation is likely to increase the perceived level of uncertainty about firms' future cash flows. This discourages banks from extending credit. At the same time, increasing global investors' risk aversion (high VIX and TED indices) had negative aggregate effects of bank lending. Moreover, TED spreads is also a measure of global funding shock. The estimation results suggest that facing with global liquidity shortage; international banks tend to stop rolling over their lending to the region. In the presence of informational asymmetry, domestic banks cannot perfectly substitute wholesale funding with domestic deposits. Therefore, a sudden stop in cross-border funding will propagate shock through the same transmission mechanism as stated in the literature on bank lending channels (Bernanke and Blinder, 1989; Bernanke and Gertler, 1995; Kashyap and Stein, 2000). This finding once again cautions East Asian bank vulnerabilities to international liquidity and capital flow cycles. The positive coefficient on ΔPR appears to be inconsistent with the hypothesis about the effectiveness of policy rate cut to boost bank lending. One possible explanation is that a decrease in interest

rates with a negative effect on the supply side of loans may have offset its positive effects on lending volumes.

In all specifications, we find that credit growth is driven by bank soundness, as sounder banks have more capacity to manage risks and to expand faster than others. First, improved asset quality has a significant impact on the issuance of more private credit to businesses. On the contrary, increasing NPL in a downturn, coupled with a decline in the value of collaterals, engenders greater caution among banks and leads to a tightening of credit extension. Moreover, high NPL also has negative implications for banks' capital and limits their access to financing. Second, credit tends to grow faster in highly profitable banks, as verified by the positive coefficient on ROA. This may be because more profitable banks have fewer constraints and are less risk averse, and are therefore more likely to expand their loan portfolio. Third, bank capitalisation significantly influences the reaction of credit supply to macro-financial shocks; however, this result is likely to support banks' attitude toward risk rather than the bank capital channel. A negative effect of the CAR on LOAN indicates that well-capitalised banks are more risk-averse because they want to limit the probability of not meeting capital requirements (Dewatripont & Tirole, 1994).

Table 5 – System GMM Estimation of Asset Quality

Dependent variable: NPL	**(1)**	**(2)**	**(3)**	**(4)**
L.NPL	0.451*	0.474*	0.478*	0.478*
	(0.000)	(0.000)	(0.000)	(0.000)
Macroeconomic variables				
GDP	-0.010*	-0.036*	-0.036*	-0.037*
	(0.000)	(0.001)	(0.001)	(0.001)
INF	0.055*	0.014*	-0.083*	-0.081*
	(0.000)	(0.002)	(0.002)	(0.002)
ΔPR			0.252*	0.251*
			(0.003)	(0.003)
Financial market variables				
SVOL		0.009*		
		(0.000)		
FER		0.005*	0.003*	0.003*
		(0.000)	(0.000)	(0.000)
CRISK		0.343*	0.343*	0.342*
		(0.007)	(0.008)	(0.009)
Global factors				
VIX			0.004*	

			(0.001)	
L.VIX			0.008*	
			(0.000)	
TED				0.085*
				(0.011)
L.TED				0.170*
				(0.009)
	Bank-specific characteristics			
ROA	-0.757*	-0.749*	-0.728*	-0.729*
	(0.002)	(0.003)	(0.003)	(0.003)
CAR	0.031*	0.017*	0.017*	0.017*
	(0.000)	(0.000)	(0.000)	(0.000)
LOAN	-0.014*	-0.012*	-0.012*	-0.012*
	(0.000)	(0.000)	(0.000)	(0.000)
TA	0.077*	0.119*	0.047*	0.045*
	(0.004)	(0.003)	(0.004)	(0.003)
LTD	-0.001*	-0.001*	-0.002*	-0.002*
	(0.000)	(0.000)	(0.000)	(0.000)
CONS.	-0.307*	-2.609*	-0.574*	-0.746*
	(0.076)	(0.091)	(0.103)	(0.095)
No. of Obs.	1,666	1,624	1,624	1,624
Banks (cross sections)	196	196	196	196
Prob > chi2	0.000	0.000	0.000	0.000
Hansen test (p-value)	0.422	0.474	0.529	0.561
AR(1)	0.026	0.029	0.030	0.030
AR(2)	0.727	0.812	0.797	0.799

Notes: * represent statistical significance at level of 1%. Standard errors in parentheses. Global factors of VIX at current and lag levels were included in (3) and of TED were included in (4) to check the robustness of results. SVOL variable was dropped from specification (3) & (4) to avoid multicollinearity problem as it was highly correlated with VIX & TED.

Table 6 – System GMM Estimation of Bank Profitability

Dependent variable: ROA	(1)	(2)	(3)	(4)
L.ROA	0.154*	0.158*	0.155*	0.155*
	(0.001)	(0.001)	(0.001)	(0.001)
Macroeconomic variables				
GDP	0.007*	0.002*	0.003*	0.003*
	(0.000)	(0.000)	(0.000)	(0.000)
INF	0.010*	0.006*	0.008*	0.009*
	(0.001)	(0.001)	(0.001)	(0.001)
ΔPR			-0.007*	-0.007*

			(0.001)	(0.001)
Financial market variables				
SVOL		0.002*		
		(0.000)		
FER		0.004*	0.004*	0.004*
		(0.000)	(0.000)	(0.000)
CRISK		0.018*	0.033*	0.031*
		(0.002)	(0.002)	(0.002)
Global factors				
VIX			-0.020*	
			(0.000)	
L.VIX			-0.004*	
			(0.000)	
TED				-0.200*
				(0.003)
L.TED				0.148*
				(0.003)
Bank-specific characteristics				
NPL	-0.060*	-0.058*	-0.056*	-0.056*
	(0.000)	(0.000)	(0.000)	(0.000)
CAR	0.035*	0.032*	0.032*	0.032*
	(0.000)	(0.000)	(0.000)	(0.000)
LOAN	-0.000*	-0.000*	-0.000*	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
TA	0.111*	0.099*	0.096*	0.095*
	(0.001)	(0.002)	(0.002)	(0.002)
LTD	0.063*	0.094*	0.092*	0.093*
	(0.001)	(0.001)	(0.001)	(0.001)
CONS.	-1.885*	-1.862*	-1.492*	-1.637*
	(0.038)	(0.038)	(0.078)	(0.079)
No. of Obs.	1,682	1,656	1,656	1,656
Banks (cross sections)	196	196	196	196
Prob > chi2	0.000	0.000	0.000	0.000
Hansen test (p-value)	0.326	0.340	0.375	0.374
AR(1)	0.000	0.000	0.000	0.000
AR(2)	0.153	0.103	0.105	0.106

Notes: * represent statistical significance at level of 1%. Standard errors in parentheses. Global factors of VIX at current and lag levels were included in (3) and of TED were included in (4) to check the robustness of results. SVOL variable was dropped from specification (3) & (4) to avoid multicollinearity problem as it was highly correlated with VIX & TED.

Table 7 – System GMM Estimation of Capital Adequacy

Dependent variable: CAR	(1)	(2)	(3)	(4)
L.CAR	0.517*	0.534*	0.536*	0.535*
	(0.001)	(0.000)	(0.000)	(0.000)
Macroeconomic variables				

GDP	-0.096*	-0.034**	-0.037*	-0.035*
	(0.002)	(0.003)	(0.003)	(0.003)
INF	0.052*	-0.011*	-0.009**	-0.010*
	(0.004)	(0.005)	(0.004)	(0.004)
ΔPR			0.044*	0.046*
			(0.006)	(0.006)
Financial market variables				
SVOL		0.006*		
		(0.001)		
FER		-0.010*	-0.010*	-0.010*
		(0.000)	(0.000)	(0.000)
CRISK		0.478*	0.446*	0.450*
		(0.013)	(0.013)	(0.013)
Global factors				
VIX			-0.026*	
			(0.001)	
L.VIX			0.021*	
			(0.001)	
TED				-0.476*
				(0.012)
L.TED				0.247*
				(0.012)
Bank-specific characteristics				
NPL	0.002	-0.013*	-0.013*	-0.014*
	(0.002)	(0.002)	(0.002)	(0.002)
ROA	1.065*	1.004*	0.994*	0.998*
	(0.008)	(0.010)	(0.008)	(0.008)
LOAN	-0.041*	-0.049*	-0.049*	-0.049*
	(0.000)	(0.000)	(0.000)	(0.000)
TA	-0.642*	-0.418*	-0.422*	-0.419*
	(0.006)	(0.006)	(0.006)	(0.006)
LTD	0.004*	0.006*	0.006*	0.006*
	(0.000)	(0.000)	(0.000)	(0.000)
CONS.	19.034*	11.856*	12.785*	12.944*
	(0.121)	(0.164)	(0.139)	(0.142)
No. of Obs.	1,676	1,651	1,651	1,651
Banks (cross sections)	196	196	196	196
Prob > chi2	0.000	0.000	0.000	0.000
Hansen test (p-value)	0.394	0.376	0.497	0.501
AR(1)	0.000	0.000	0.000	0.000
AR(2)	0.210	0.294	0.284	0.284

Notes: *, ** represent statistical significance at levels of 1% and 5%. Standard errors in parentheses. Global factors of VIX at current and lag levels were included in (3) and of TED were included in (4) to check the robustness of results. SVOL variable was dropped from specification (3) & (4) to avoid multicollinearity problem as it was highly correlated with VIX & TED.

Table 8 – System GMM Estimation of Credit Growth

Dependent variable: LOAN	(1)	(2)	(3)	(4)
L.LOAN	0.714*	0.738*	0.740*	0.740*
	(0.001)	(0.001)	(0.001)	(0.001)
Macroeconomic variables				
GDP	0.004*	0.011*	0.011*	0.012*
	(0.000)	(0.000)	(0.000)	(0.000)
INF	0.006*	0.004*	-0.000	-0.001*
	(0.000)	(0.000)	(0.000)	(0.000)
ΔPR			0.014*	0.014*
			(0.000)	(0.000)
Financial market variables				
SVOL		-0.003*		
		(0.000)		
FER		-0.003*	-0.003*	-0.003*
		(0.000)	(0.000)	(0.000)
CRISK		0.012*	0.011*	0.013*
		(0.000)	(0.001)	(0.001)
Global factors				
VIX			-0.003*	
			(0.000)	
L.VIX			0.003*	
			(0.000)	
TED				-0.019*
				(0.001)
L.TED				0.097*
				(0.001)
Bank-specific characteristics				
NPL	-0.017*	-0.018*	-0.019*	-0.019*
	(0.000)	(0.000)	(0.000)	(0.000)
ROA	0.001**	0.008*	0.007*	0.007*
	(0.000)	(0.000)	(0.000)	(0.000)
CAR	-0.013*	-0.014*	-0.014*	-0.014*
	(0.000)	(0.000)	(0.000)	(0.000)
TA	0.293*	0.273*	0.274*	0.274*
	(0.001)	(0.001)	(0.001)	(0.001)
LTD	0.002*	0.002*	0.002*	0.002*
	(0.000)	(0.000)	(0.000)	(0.000)
CONS.	-0.023	-0.128*	-0.410*	-0.471*
	(0.012)	(0.015)	(0.019)	(0.015)
No. of Obs.	1,688	1,658	1,658	1,658
Banks (cross sections)	196	196	196	196
Prob > chi2	0.000	0.000	0.000	0.000
Hansen test (p-value)	0.192	0.198	0.216	0.212
AR(1)	0.005	0.000	0.000	0.000
AR(2)	0.858	0.162	0.184	0.212

Notes: *, ** represent statistical significance at levels of 1% and 5%. Standard errors in parentheses. Global factors of VIX at current and lag levels were included in (3) and of TED were included in (4) to check the robustness of results. SVOL variable was dropped from specification (3) & (4) to avoid multicollinearity problem as it was highly correlated with VIX & TED.

5. Conclusions

This paper investigates bank behaviour in the presence of macro-financial variability, which justifies the second round effects of the 2007-2009 global financial crisis on East Asia. Applying the partial adjustment models and dynamic panel data techniques with System-GMM estimation, the empirical results provide some evidence to confirm that volatility in the global financial markets and domestic macro-financial conditions negatively affect bank asset quality, profitability and lending behaviour. This means that deterioration in asset quality may reduce profitability and directly or indirectly weaken capital for banks that raise capital via retained earnings. There is also evidence to support the effect of macro-financial uncertainties on capital adjustment. As Asian banks are relatively conservative, they keep high capital regulatory ratios and tend to increase the capital buffers as a cushion to absorb negative shocks.

In general, the findings suggest that good fundamentals and highly-capitalized banks do not guarantee a full decoupling from crisis contagion. In response to the crisis, especially to boost economies, stabilise financial markets and shore up the banking system, central banks introduced time-line policy interventions across the region. Complemented by fiscal stimulus packages, monetary policy measures were taken, including policy rates cuts, reserve requirement reductions, government injections of bank capital and quantitative easing. Specifically, the accumulated changes (in basis points) in policy rates for the period from September 2008 to 2009 are as follows: Indonesia (-225), Japan (-40), Korea (-325), Malaysia (-150), Philippines (-200), Thailand (-250) and Hong Kong (-300) (Filardo et al., 2010). Although the empirical results could not provide convincing evidence to support the role of policy rate cuts to boost bank lending, it does not mean that the time-line policy intervention is ineffective but it raises the concern about the pass-through of policy rate cuts to borrowing cost. Moreover, an individual measure may not generate significant effects individually (Diemer & Vollmer, 2015), therefore a joint measure and comprehensive analysis of policy interventions and international cooperation in bank supervision should be examined in further research.

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