Banking Systems, Central Banks and International Reserve Accumulation in East Asian Economies

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Abstract

This paper examines changes in the balance sheets of the banking system in five East Asian economies which were affected by the 1997 Asian Crisis. These countries have persistently accumulated international reserves since the crisis. This paper estimates the impact of reserve accumulation on some important balance sheet variables such as liquid assets, credit and deposits of the banking system by applying panel data techniques. Estimates using data from Thailand, South Korea, Malaysia, Philippines and Indonesia show that there has been robust positive impact of reserve accumulation on the liquid assets and deposits of the banking system after controlling for the effect of other potential variables.

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1 Introduction

Analysis of the banking system has received a great interest in recent years, especially after the global financial crisis of $2007-08$. Studies such as Kindleberger and Aliber (2005), Reinhart and Rogoff (2009) and Gorton (2010) have demonstrated through historical evidence that the banking system rarely escapes any crisis.[1] In most cases, the banking system has usually aggravated and amplified the crisis, and finally suffered from it. A series of crises has proved that a balance sheet weakness of the banking system can ignite and propagate financial crises (Allen et al., 2002). Hence, a growing body of literature has now emphasized the importance of balance sheets of the banking system such as Adrian and Shin (2009), Brunnermeier et al. (2009), Mittnik and Semmler (2011). It has been now recognized that the banking system, in fact, plays an important role in generating boom and bust cycle in the economy by expanding and contracting credit flows. More importantly, the banking system's balance sheets tend to be a mirror image of the economy especially when the balance sheets of the whole economy are not readily available (Villar, 2006).

Crises are usually manifested in the buildup of substantial balance sheet problems in the banking system as seen from the current global financial crisis and the 1997 Asian crisis. In the Asian crisis, currency and maturity mismatches in the banking system created a fragile financial situation (Shirai, 2001).[2] The accumulation of short-term external debts concentrated in the banking system, taking advantage of the financial liberalization and globalization, was one of the important factors behind the East Asian crisis of 1997. Banks made short-term borrowing from abroad for long-term lending domestically, mainly to the real estate sector, which had created imbalances in the balance sheets of the banking system, thereby contributing to the outburst of the crisis, starting from Thailand (Shirai, 2001). In fact, the banking system was the culprit as well as a victim of the crisis in East Asian countries (Eichengreen, 2009; Frankel, 1998).

As a lesson learned from the painful financial crisis, many East Asian economies, including some other emerging economies, have been building up a substantial level of international reserves in the aftermath of the crisis, outpacing traditional benchmark levels (IMF, 2010). Such a persistent reserve accumulation has implications for the balance sheet of the central bank, the banking system and the economy as a whole (Mohanty and Turner, 2006; Banchs and Mollejas, 2010). Reserve accumulations seem to occur by running current account surplus and intervening in the foreign exchange markets (Schularick, 2009). Foreign exchange interventions by the central banks inject the liquidity, i.e. flow of funds into the banking system unless it is sterilized. Even if it is sterilized, the size of the balance sheets of the banking system must change with the reserve accumulation through changing

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[1] With growing financialization in the economy, economic crises have increasingly concentrated in the banking system (Cook, 2008).

[2] An overexposure of the US banking system in the housing sector, financed by the inflows of funds from abroad mainly contributed to the recent global financial crisis of 2007.

the portfolio of the banking system.[3] The central bank's foreign reserves have counterpart liabilities in the form of bonds or currency because foreign exchange reserve build-up has to be financed either through government budget surpluses or by printing money or through accumulation of debt (Polterovich and Popov, 2003). With this reserve build-up, foreign currency assets play an important role in central banks' balance sheets and, consequently, in monetary policy operations (Higgins and Klitgaard, 2004; Banchs and Mollejas, 2010). One important thing to note is that the accumulation of international reserves successfully helped emerging countries to weather out the adverse impact of the recent global crisis of 2007.

Yet the changing balance sheet structure of the banking system as a result of the accumulation of international reserves has not been examined. Despite some studies on the Asian financial crisis, for example Delhaise (1998), Caprio et al. (2005), Cook (2008), and Carney (2009), the literature has hardly covered the changing composition of banks' balance sheets in the post-crisis period compared to the pre-crisis period in relation to the accumulation of international reserves. On the other hand, a number of studies have developed banking models to understand the banking behavior such as Baltensperger (1980), Stiglitz and Greenwald (2003), and Freixas and Rochet (2008). These models are mainly of closed economy types and have ignored the important roles of foreign exchange markets for the banking system in an open economy context. Only a few studies such as Mohanty and Turner (2006) and Ho and McCauley (2009) have discussed some domestic implications of reserve accumulation by examining average bi-variate relationship and descriptive statistics in some Asian countries. They found no strong link between reserve accumulation and domestic private credit growth, but did not examine the impact on the liquidity and deposits of the banking system.

In the literature of international reserves, on the other hand, it has been argued that accumulating international reserves seems to be a rational manner to mitigate the impact of fundamental uncertainty and different types of risks. Experience and evidence have shown that the global financial system is prone to various types of risks such as currency, flight, fragility, contagion and sovereignty, and interactions among those risks (Grabel, 2003). In this context, a stock of foreign currency reserves provides a necessary international liquidity for self-insurance i.e. "the key to self-protection" (Feldstein, 1999), since local currencies cannot take over such a role in international payments. Ocampo (2007) argues that foreign reserves act as a collective insurance against a balance of payments crisis, when there is a lack of effective mechanism for macroeconomic policy coordination. Feldstein (1999), Rajan (2008), and Banchs and Mollejas (2010) also view that holding of international reserves appears to be essential in the world of the asymmetric monetary system for emerging and developing countries, because of the lack of a credible international lender of last resort and monetary cooperation at the regional level. More importantly, given that an IMF bailout cannot be guaranteed and may

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[3] In recent years, emerging countries have been increasing sterilization (Aizenman and Glick, 2009).

not be adequate,[4] sufficiently large precautionary reserves are felt to be essential for a successful defense of the domestic currency and financial systems. As a result, exchange rate stability as well as financial stability could be maintained (Stiglitz and Greenwald, 2010; Obstfeld et al., 2010; Kato et al., 2009; Hviding et al., 2004).

Moreover, Aizenman (2006) argues that the foreign currency reserves can also play an important role as "lender of last resort" in foreign currencies and the mitigation of a terms of trade shock . Some studies such as Rodrik and Velasco (1999), Edwards (2004), and García and Soto (2004) found that the probability of capital account reversal declined with the holding of sufficient foreign exchange reserves. It is observed that countries with a large foreign currency reserve are less likely to be come under the currency attack (Feldstein, 1999; Cheung and Qian, 2009). On the other hand, Rodrik (2006) argues that emerging countries are paying huge social costs by holding the large volume of international reserves. There are some other studies which analyze the impact of capital flows on asset prices such as stock prices and real estate, for example Caballero and Krishnamurthy (2006), and Kim and Yang (2009). However, these studies do not touch upon the impact on the domestic banking system from international reserve accumulation. Hence, this paper, by departing from these arguments, attempts to contribute to the literature by finding a new channel through which accumulation of international reserves can help maintain financial stability in the economy through having various implications for the banking system.

This paper seeks to investigate whether the accumulation of international reserves has any impacts on the balance sheet of the banking system. This will help to draw policy implications for maintaining financial stability and find out a new role of international reserves in the economy. This paper has taken five East Asian countries – Thailand, South Korea, Malaysia, Philippines and Indonesia – affected by the Asian crisis to examine the response of the banking system in the aftermath of the financial crisis.[5] This paper has particularly investigated the relationship of the selected balance sheet variables of the banking system such as liquid assets, private sector credit and deposits with the international reserve accumulation by the central bank using panel data technique, incorporating other potential explanatory variables. It is hypothesized that international reserve accumulation must have impact on the banking system. These selected balance sheet variables are important for financial stability because they can create boom-bust cycles in the economy.

The rest of the paper consists of three sections. Section 2 presents a theoretical framework that links the central bank and the banking system, and identifies potential variables that can affect the banking system. Section 3 presents the empirical findings and Section 4 concludes the discussion.

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[4] Being constrained by the limited capital, the IMF cannot provide adequate international liquidity (Feldstein, 1999).

[5] These countries have highly bank-based financial systems (see Subhanij, 2010).

2 Theoretical Framework

The banking sector's literature has mainly covered the role of the banking systems in credit markets and deposit markets (Bhattacharya and Thakor, 1993) and banks' liquidity preference (Piegay, 2000) so far, ignoring the growing role of the banking system in the foreign exchange markets with the globalization process. Since the balance sheets of the central bank and the banking system are inter-connected, international reserve accumulation by the central bank should have serious implication for the banking system. The money multiplier theory of money supply can establish such an interconnection. For this theory, by definition, money supply in the economy is defined as

$$M = C + D \tag{1}$$

where M is the money supply, C is the currency held by the public, and D is the deposits in the banking system. In the current fractional banking system, the banking system has to keep a fraction of deposits with the central bank as a required reserve RR. In addition, the banking system also maintain excess reserves (ER) for smoothing payment systems as a buffer stock. On the other hand, the monetary base or reserve money (RM) is money held by the public in currency (C) and by banks as reserves (R) with the central bank as

$$RM = C + R \tag{2}$$

According to the money multiplier theory of money supply, money stock in the economy is a multiple of reserve money as

$$M = mRM \tag{3}$$

By combining equations (1), (2) and (3), we get

$$C + D = m(C + R) \tag{4}$$

In equation (4), D is the balance sheet item of the banking system and R is the balance sheet item of both. In this way, equation (4) links the balance sheet of central bank and the banking system. Table 1 presents a typical balance sheet of the central bank. The central bank's assets consist of foreign currency and domestic assets, while its liabilities comprise currency, banking system's reserves, securities, other liabilities and equity capital. The currency and banking system's reserves are monetary liabilities, while the other items in the liability side are non-monetary liabilities.

Table 1: A Typical Central Bank Balance Sheet

Assets	Liabilities
Net Foreign Assets (NFA)	Monetary Liabilities
Domestic Assets(DA)	(i) Currency in Circulation (C)
(i) Government Securities	(ii) Banking system's Reserves (R)
(ii) Loans to commercial banks	Non-Monetary liabilities CBC)
(iii) Other Domestic Assets	(i) Central bank securities
	(ii) others
	(iii) Equity Capital

The balance sheet of the central bank is written as

$$R + C + CBC = DA + e.NFA \tag{5}$$

where R denotes the banking system's reserves with the central bank, C denotes the currencies held by the public, CBC is the non-monetary liability of the central bank. On the asset side, DA denotes the total domestic assets of the central bank and NFA denotes the net foreign assets[6] and e is the exchange rate[7]. Then, replacing $C + R$ in equation (4) from equation (5) gives us

$$C + D = m(DA + eNFA - CBC) \tag{6}$$

Since the NFA consists of international reserves (IR) and other foreign assets (e.g. gold) net of foreign liability ($ONFA$), the equation (6) becomes

$$C + D = m(DA + eIR + e.ONFA - CBC) \tag{7}$$

Equation (7) shows several implications from change in IR. However, assuming other things remaining the same, one possibility could be

$$\frac{\partial D}{\partial IR} > 0$$

Further, Table 2 presents a simplified aggregate balance sheet of the banking system. Major asset side items of the balance sheet of the banking system are private sector credit (PC), net foreign assets (NFA_b), investment (on bond and securities), and reserve balances with the central bank (R). On the other hand, major liability

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[6] The flows in the NFA represents the interactions of three sets of factors: i) foreign exchange interventions ii) aid receipts by the Government, and iii) interest income generated by foreign currency assets itself (Jadhav et al., 2003). However, international reserves accumulation through foreign exchange interventions constitute the major proportion of NFA.

[7] domestic currency price of foreign currency

Table 2: Simplified Aggregate Balance Sheet of the Banking System

Assets	Liabilities
Private Sector Credit (PC)	Deposits (D)
Net foreign assets (NFA)	Other liabilities (OL)
Government & Central bank bonds (G)	(i) bonds
Reserves in central bank (R)	(ii) equity

side items include deposits of different types (D), and other liabilities such as bond and equity. The balance sheet of the banking system is written as

$$D + OL = e.NFA_b + PC + R + G \qquad (8)$$

where D denotes the deposits, OL denotes the other liabilities such as bonds and capital, NFA_b is the net foreign assets of the banking system, e is the exchange rate, PC denotes the credit to the private sector, R is the reserve balance with the central bank,[8] and G is the investment on government (and central bank) securities.

Then, replacing D by using equation (8) in equation (7), and combining R and G as liquid assets LA, we get

$$PC + LA = m(DA + eIR + e.ONFA - CBC) - C - eNFA_b + OL \qquad (9)$$

Then, assuming other things remaining the same, there could be

$$\frac{\partial PC}{\partial IR} = \frac{\partial LA}{\partial IR} > 0 \qquad (10)$$

In this way, international reserve accumulation is likely to have positive impact on deposits, private sector credit and liquidity. This mechanism tends to work through the foreign exchange transactions (mainly called interventions) by the central bank with the banking system. For example, purchasing (selling) foreign exchange injects (mops up) liquidity by increasing (reducing) the central bank's claims on nonresidents on the one hand and the banking system's reserves on the other. If the foreign exchange interventions are sterilized through open market operations, it increases the holding of the securities issued by the government as well as central bank. With the change in banking system's reserves with the central bank emanating from the foreign exchange transactions, the banking system makes a decision on lending or changing portfolio composition.

One important thing to note here is that the nature of exchange rate system tends to determine the necessity of foreign exchange interventions. In case of a freely

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[8] R broadly represents the claims of banking system on the central bank, because it also includes the cash held by the banking system, but it does not include the central bank's securities.

floating exchange rate, there should not be any flows into or out of the central bank's foreign exchange reserves. On the other hand, in case of fixed exchange rate regime, the central bank has no freedom to control its foreign exchange reserves. In between these two extremes, which is the situation generally observed in many emerging and developing countries, the central bank heavily participates in foreign exchange markets through interventions for exchange rate stability (Caprio and Honohan, 1990).[9] It is indeed the foreign exchange market through which international reserve accumulation of the central bank brings changes in the balance sheet of the banking system. The impact of which later transmits to the other markets of the banking system. In this way, any foreign currency inflows into the economy either from the current account or capital account would change the balance sheets of both the central bank and the banking system. Then, both the central bank and the banking system actively manage their balance sheets through portfolio decisions for different motives.[10]

What are the factors that affect the portfolio decision of the banking system? The objective of the banking system is normally to maximize its profit. Following Freixas and Rochet (2008), taking into account the management costs, the profit (π) of the banking system can be written as

$$\pi = r_l PC + rG - r_D D - C(D, PC) \tag{11}$$

where r_L is the interest rate on lending, r_D is the interest rate on deposits, and r is the interest rate on government securities and $C(D, PC)$ is the management costs. PC, G, and D are already defined above. The simple balance sheet identity constraint is $PC + G + R = D$. Since $R = \alpha D$, $G = (1 - \alpha)D - PC$, where α is the reserve requirement for deposits. Then, the profit function becomes

$$\pi = (r_l - r)PC + [r((1 - \alpha) - r_D]D - C(D, PC)$$

By taking decisions on lending and deposits, the profit maximization behavior of the banking system is characterized by

$$\frac{\partial \pi}{\partial PC} = (r_L - r) - \frac{\partial C}{\partial PC} = 0$$

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[9] Foreign exchange intervention is now considered an important balance sheet policy, which transmits through two main channels - signaling and portfolio (Borio and Disyatat, 2009). While signaling channel works through reflecting the central bank's intention in foreign exchange interventions, the portfolio channel brings change in relative supplies of assets (and liabilities). Since assets are imperfect substitutes, any change in the composition of portfolios alters the behavior of banks. Under the portfolio channel, the purchase or sale of foreign currencies from the banking system results in a change in foreign currency portfolios of the central bank with a corresponding change in banking system's reserves with the central bank.

[10] The banks' liquidity preference approach suggests that banks pursue active balance sheet policies instead of passively accommodating the demand for credit (Bibow, 2009).

$$\frac{\partial \pi}{\partial D} = [r(1-\alpha) - r_D] - \frac{\partial C}{\partial D} = 0$$

A competitive banking system adjusts its lending and deposits by making corresponding intermediation margins equal its marginal costs. As a result, as shown in Freixas and Rochet (2008, 73-74), $\frac{dPC}{dr_L} > 0$ and $\frac{dD}{dr_D} < 0$. This means an increase in r_D will entail a decrease in the bank's demand for deposits D and an increase in r_L will entail an increase in the bank's supply of loans. On the other hand, the signs of $\frac{dD}{dr_L}$ and $\frac{dPC}{dr_d}$ depend on the cross effects between deposits and lending or the economies and dis-economies of scope. However, because of a central role in the payment systems, the banking system cannot normally deny accepting deposits[11] but can apply discretion on lending. Further, impact of lending rate (or deposit rate) on the holding of liquid assets can be analyzed as

$$LA = D - PC \Longrightarrow \frac{dLA}{dr_L} = \frac{dD}{dr_L} - \frac{dPC}{dr_L} \lessgtr 0$$

In addition, a competitive banking system gets equilibrium when demand for loanable funds equals the supply of loanable funds. Let $I(r_L)$ be the investment demand by firms,[12] and $S(r_D)$ is the savings function of households as

$$I(r_L) = PC(r_L, r_D, r)$$

$$S(r_D) = B - G + D(r_L, r_D, r)$$

where B is total government bonds issued and G is the government bonds held by the banking system, so $B - G$ is the amount of the bonds held by the households. Since $G = (1-\alpha)D - PC$, $S(r_D) = B + \alpha D + PC$. Assuming constant marginal costs of intermediation $C_L' = \gamma_L$ and $C_D' = \gamma_D$, $r_L = r + \gamma_L$ and $r_D = r(1-\alpha) - \gamma_D$. In equilibrium,

$$I(r_L) = \frac{(1-\alpha)}{\alpha}[S(r_D) - B - PC]$$

which can be transformed as

$$S(r_D) - \frac{1}{1-\alpha}I(r_L) = B \tag{12}$$

Differentiating equation (12) with respect to B, taking into account that r as the function of B as in Freixas and Rochet (2008), we get

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[11] Central bank can only ban individual banks from accepting deposits on regulatory grounds.

[12] In this simple framework, investment demand by firm is equal to their demand for loans, since they do not issue securities (Freixas and Rochet, 2008).

$$\left\{ (1-\alpha)S'(r_D) - \frac{I'(r_L)}{1-\alpha} \right\} \frac{dr}{dB} = 1 \implies \frac{dr}{dB} > 0$$

Then, the effect on D of a change in B is now obtained by differentiating $D(r_D) = \frac{1}{\alpha}[S(r_D) - B - I(r_L)]$ with respect to B (see Freixas and Rochet (2008) for detail). Thus,

$$\frac{\partial D}{\partial B} = \frac{1}{(1-\alpha)^2 \frac{S'(r_D)}{I'(r_L)} - 1} < 0$$

since $S'(r_D) > 0$ and $I(r_L) < 0$. As for the effect on PC, we can differentiate $PC = (1-\alpha)D - G$ with respect to B. Assuming that G is a certain positive portion $(0 < \delta < 1)$ of B, $\frac{\partial PC}{\partial B} = (1-\alpha)\frac{\partial D}{\partial B} - \delta$. Thus $\frac{\partial PC}{\partial B} < 0$. Further, for the impact on the liquid assets of the banking system, we differentiate

$$LA = D - PC = D - (1-\alpha)D + \delta.B = \alpha D + \delta.B$$

$$\frac{\partial LA}{\partial B} = \alpha\frac{\partial D}{\partial B} + \delta$$

Since $\frac{\partial D}{\partial B} < 0$, $\alpha > 0$, and $\delta > 0$, we get $\frac{\partial LA}{\partial B} \lessgtr 0$.

3 Impact of International Reserve Accumulation on the Banking System

This section presents empirical evidence on the impact of international reserve accumulation on the major balance sheet variables of the banking system such as liquid assets, credit to the private sector and deposits, by incorporating other potential explanatory variables indicated by the theoretical framework above.

3.1 Data and Methodology

Based on the availability, annual data for the selected five East Asian economies over the period of 1980-2010 are used for empirical estimation. The panel data technique is applied since this technique increases the degree of freedom by pooling the data. Since the selected countries are in the same region and follow almost similar type of business cycle being affected by the similar external shocks, the panel data technique seems to be appropriate. The following simple basic model is used for empirical estimation:

$$L_{it} = \alpha + X'_{it}\beta + \varepsilon_{it}, \ i = 1....,N; \ t = 1,....,T \tag{13}$$

$$\varepsilon_{it} = \mu_i + v_{it}$$

$$E(v_{it}) \sim N(0, \sigma^2)$$

where i and t are the country and time indices respectively; β is $Kx1$ coefficient vector and X_{it} is a vector of K explanatory variables, μ_i denotes the unobservable individual specific effect and v_{it} denotes the disturbance term. L_{it} is the ratio of balance sheet variables to GDP – liquid assets, private sector credit and deposits in line with Bunda and Desquilbet (2008), Vodová (2011), and Agenor et al. (2004).[13] X_{it} is a set of explanatory variables. Based on the above theoretical discussion, X_{it} includes international reserves to GDP ratio (ir), lending rate (lr) and budget deficits as a percentage of GDP (bd) to take into account the supply of government bonds.[14] Moreover, we consider the rate of GDP growth (gr), which indicates the overall health of the economy - a higher economic growth implies a better perspective for borrowers and more profitable lending for banks (Guo and Stepanyan, 2011) and dummy variable for the Asian crisis period (1997 and 1998) because the selected countries were seriously affected by that crisis. Since the balance sheet items are closely interrelated to each other, we consider common explanatory variables for liquidity, credit and deposits. For each dependent variable, the estimating equation with theoretical expectation sign is written as

$$la_{it} = f(\overset{+}{ir_{it}}, \overset{?}{lr_{it}}, \overset{-}{gr_{it}}, \overset{?}{bd_{it}})$$

$$pc_{it} = f(\overset{+}{ir_{it}}, \overset{+}{lr_{it}}, \overset{+}{gr_{it}}, \overset{-}{bd_{it}})$$

$$dp_{it} = f(\overset{+}{ir_{it}}, \overset{?}{lr_{it}}, \overset{+}{gr_{it}}, \overset{-}{bd_{it}})$$

Most of the data are taken from the IMF's International Financial Statistics online database. However, the budget deficit data are taken from various sources such as Asian Development Bank's Key Indicator 1999 and 2010, Basic Statistics 2011, and the websites of the Central Bank of Malaysia and Indonesia, Remolona (1985) and Nimgaonkar (2009).

Table 3 reports the descriptive statistics of the variables used in the panel estimation. The LA to GDP ratio (la) ranges from minus 10.2 percent to 47.1 percent with 12.0 percent on average; the PC to GDP ratio (pc) averaged at 64.8 percent, ranging from minimum 14.8 percent to maximum 165.7 percent. Similarly, the average value of D to GDP ratio (dp) is 61.5 percent, international reserves to GDP (ir) is 17.1 percent, lending rate (lr) is 12.59 percent, budget deficit to GDP ratio (bd) is -2.04 percent, and average growth rate of GDP (gr) is 5.6 percent (see Table 3). Among the chosen variables, pc exhibits the highest volatility, followed by the dp as shown by the standard deviation (SD).

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[13] For uniformity across the sample countries, we use ratios of balance sheet variables in terms of GDP.

[14] Only the lending rate is chosen here assuming that different interest rates are correlated each other.

Table 3: Descriptive Statistics of the Selected Variables

	la	*pc*	*dp*	*ir*	*lr*	*bd*	*gr*
Mean	12.03	64.75	61.46	17.09	12.59	-2.04	5.57
Max	47.13	165.72	134.71	52.81	32.15	-16.67	13.23
Min	-10.18	14.85	12.07	2.05	5.02	4.75	-13.13
SD	13.04	37.68	32.36	12.53	5.63	3.17	4.22

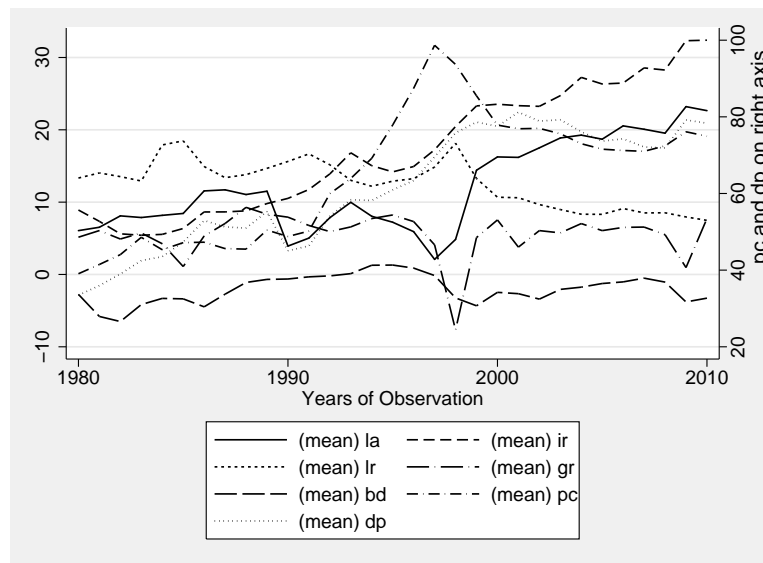Source: Author's calculation

Figure 1: Overall Movement of Variables (Mean) under Considerations

Figure 1 reports the overall movement of cross-sectional average of these variables during the sample period. After a decline during the crisis of 1997-1998, *la* exhibits an upward trend in the post-crisis period, but *pc* is on a downward trend. Further, while *dp* and *ir* show an upward trend, *lr* exhibits a downward trend in the post-crisis period. After a higher deficit in the 1980s, these countries had budget surpluses or balanced budgets in the first half of the 1990s, before the crisis hit them. After the crisis, these countries have budget deficits of varying degrees (see Figure 1). Regarding the GDP growth (*gr*), it fell sharply during the crisis in 1997, recovered after that, but observed a slight fall recently in the aftermath of the global financial crisis of 2007. Detail movement of these variables over the whole sample period is presented in Appendix 1 and 2. Moreover, Figure 2 shows scatter plots between the banking system's variables and international reserves. As expected theoretically, balance sheet's variables exhibits a positive correlation with *ir* .
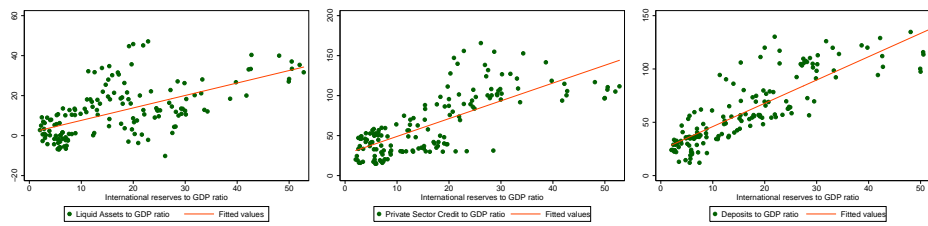
Figure 2: Scatter Plot of *la*, *pc* and *dp* over *ir* in a pooled data

Table 4: Unit Root Test

With intercept and automatic lag selection based on AIC

Null: Unit Root

adjusted t-statistics

Variable	LLC test	IPS test
la	-0.12 (0.45)	1.14 (0.87)
dla	-8.56 (0.00)*	-9.64 (0.00)*
ir	2.32 (0.99)	3.28(.99)
dir	-8.17 (0.00)*	-8.03 (0.00)*
lr	-0.43 (0.33)	0.17 (0.56)
dlr	-8.59 (0.00)*	-9.43 (0.00)*
bd	-2.49 (0.006)*	-2.85 (0.002)*
gr	-6.09 (0.00)*	-5.39 (0.00)*
pc	-1.13(0.13)	-0.58(0.28)
dpc	-5.11(0.00)*	-4.86(0.00)*
dp	-1.18(0.12)	-0.10(0.46)
d(dp)	-5.68(0.00)*	-6.70 (0.00)*

∗significant at 1%

$p - value$ in the parenthesis.

Source: Author's calculations

3.2 Empirical Results

Before estimating the model, Table 4 presents the panel unit root test proposed by Levin et al. (2002) and Im et al. (2003), denoted by LLC[15] and IPS[16] respectively. We have no prior knowledge of the number of lags, p, needed to ensure that the error term in unit root testing equation is white noise, so we choose the number of lags for each panel by minimizing the AIC. As shown in Table 4, variables *la*, *pc*, *dp*, *ir* and *lr* have unit roots, while other variables such as *gr* and *bd* do not. However, the first difference of *la*, *pc*, *dp*, *ir* and *lr* are stationary. Hence, the first difference of these variables such as *dla*, *dpc*, *ddp*, *dir*, *dlr* are used for econometric estimation later.

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[15] LLC test assumes all panels share a common autoregressive parameter.
[16] IPS allows for individual heteroscedasticity.

There could be endogeneity between the banking system's variables, and *lr* and *gr*. For example, a higher private sector credit i.e. *pc* could result in a higher economic growth, i.e. *gr*, while a higher liquidity preference i.e. *la* could reduce the growth of the economy through the working of the financial accelerator hypothesis. Similarly, lending and liquidity preference behavior may induce changes in interest rates in the banking system including lending rate. Hence, one period lag of economic growth rate and lending rate are used, because these variables are pre-determined and must be exogenous for current period balance sheet variables. Looking at the last year's growth and interest rate, the banking system can determine its current period portfolio but the current portfolio decisions cannot change the last year's growth rate and interest rate. Other two variables *ir* and *bd* seem to be exogenous for the banking system; the former depends on the current account dynamics, capital flows and the central bank's policy, and the latter depends on the fiscal policy of the government.

An outlier is observed in Malaysia in 1990 since all banking system's variables witnessed a substantial drop as seen in Appendix 1.[17] An additional dummy variable *dum_outmal*(1990 = 1) for Malaysia is hence used to remove the impact of the outlier. Robust standard errors are computed considering contemporaneous correlation as well as group-wise heteroscedasticity error variance. As shown in Appendix 3 and 4, both fixed effects and random effects are not statistically significant in our case, which shows the poolability of our data.

Table 5 presents the pooled OLS estimates. For *dla*, all explanatory variables have statistically significant coefficients, with adjusted R^2= 0.52. However, only the coefficient of *gr*(−1) is found statistically significant for *dpc* with comparatively low adjusted R^2 i.e. 0.24. On the other hand, for *ddp*, coefficient of *dir* i,e. 0.65 is statistically significant at 1 % level of significance. The coefficient of *gr*(−1) is only significant at 10% level of significance. Adjusted R^2 for *ddp* is relatively higher at 0.59. The low *DW Stat* of 1.45 in case of *dpc* indicates the possibility of serial correlation. The coefficients of *dir* are statistically significant in case of *dla* and *ddp* with theoretically expected sign.

In case of time series cross-sectional data, the possibility of cross-sectional heteroscedasticity, contemporaneous correlation and serial correlation cannot be ruled out. Hence, Table 6 presents the feasible Generalized least square (FGLS) estimates by correcting cross-sectional heteroscedasticity and contemporaneous correlation. AR(1) disturbance is included for correcting serial correlation in case of *dpc* and *ddp*. Since we have T> N, FGLS is appropriate. As we compare Table 5 and Table 6, there are some changes in coefficients of explanatory variables. In case of *dla* , the explanatory power of the model i.e AdjR^2 increased to 0.60, but the significance of *dlr*(−1) disappeared. The magnitude of coefficients of *dir* and *bd* increased, while that of *gr*(−1) declined. In case of *dpc*, only *gr*(−1) and *bd*

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[17] The Malaysian economy recovered from the recession in the first half of 1980s and witnessed a substantial growth of GDP in 1990. To control the economy from over heating, Statutory Reserve Requirement (SLR) was increased gradually from 3.5 percent in 1990 to 9.5 percent in 1994.

Table 5: Pooled OLS Estimates

Cross-section SUR (PCSE) standard errors & covariance (d.f. corrected)

Independent Variables	Dependent variables		
	dla	*dpc*	*ddp*
c	1.78(0.00)	-1.28(0.29)	-0.68(0.43)
dir	0.53(0.00)**	0.28 (0.21)	0.65(0.00)**
$dlr(-1)$	0.29(0.03)*	0.10(0.63)	0.12(0.34)
$gr(-1)$	-0.29(0.00)**	0.57(0.00)**	0.22(0.06)$^+$
bd	-0.22(0.03)*	0.43(0.11)	-0.33(0.11)
dum	-2.77(0.00)**	0.97(0.74)	3.15(0.10)$^+$
dum_outmal	-34.94(0.00)**	-29.5(0.00)**	-68.7 (0.00)**
$AdjR^2$	0.52	0.24	0.59
DWStat	2.15	1.45	1.92
$F-stat$	26.6 (0.00)	8.49(0.00)	35.26 (0.00)
N	145	145	145

$+$ significant at 10%; $*$significant at 5%; $**$significant at 1%

$p-value$ in the parenthesis.

Source: Author's calculations

are found significant at 10% level of significance with the declining magnitude of coefficients but with theoretical expected sign. The significance of AR(1) coefficient shows the persistence nature of private sector credit. In case of *ddp*, as before, *dir* and $gr(-1)$ are statistically significant with a declining magnitude. AR(1) coefficient i.e. 0.18 is found significant at 5% level of significance. AdjR^2 declined from 0.59 to 0.44.

However, diagnostic checks for cross sectional independence i.e. Breusch-Pagan LM test of cross sectional independence and White test for group-wise heteroscedasticity at the bottom of Table 6 show that there is still cross sectional dependency except in case of *ddp*, and group-wise heteroscedasticity in all three cases. This may be due to the structural break and regime changes after the Asian financial crisis. Prior to the crisis, these countries had fixed exchange rate system. After the crisis, they adopted managed floating exchange rate, except Malaysia, which maintained the fixed exchange rate until 2005 through capital control. All of these countries introduced substantial banking sector reforms in the aftermath of the crisis to strengthen the banking system. Some insolvent banks and financial institutions were closed, and others were recapitalized and restructured (Eichengreen, 2009). Moreover, bank supervision and regulations have been made more international standards - high capital adequacy ratio, prudent loan loss classifications, and adequate loan loss provisioning (Adams, 2008). Financing via capital markets has been increasing as a result of the government's active involvement in developing the bond market, which has lowered the pace of bank-led financial deepening (Adams,

Table 6: Feasible GLS Estimates with AR(1)

Independent Variables	Dependent variables		
Number of Obs = 145			
	dla	*dpc*	*ddp*
c	1.18(0.01)**	0.57(0.52)	-0.26(0.66)
dir	0.55(0.00)**	0.15 (0.19)	0.44(0.00)**
dlr(−1)	0.06(0.53)	-0.02(0.84)	0.06(0.49)
gr(−1)	-0.23(0.00)**	0.13(0.09)$^+$	0.13(0.09)$^+$
bd	-0.31(0.00)**	0.35(0.08)$^+$	-0.18(0.28)
dum	-2.10(0.02)*	1.25(0.58)	3.07(0.01)**
dum_outmal	-35.23(0.00)**	-33.11(0.00)**	-74.15(0.00)**
AR(1)		0.31(0.00)**	0.18(0.04)*
AdjR^2	0.60	0.24	0.44
DWStat	2.02	1.96	2.08
F − stat	37.4 (0.00)	7.18(0.00)	16.93 (0.00)
Obs	145	140	140
Diagnostic Check			
LM test$^\$$	29.80 (0.00)	42.35(0.00)	11.85 (0.29)
White Test&	110.2 (0.00)	33.6(0.03)	32.2 (0.04)

+ significant at 10%; ∗significant at 5%; ∗∗significant at 1%

p − value in the parenthesis.

$Breusch-Pagan LM test of independence

& White Test for group-wise heteroscedasticity

Source: Author's calculations

2008). Hence, the relationship between dependent and independent variables might have changed in the post-crisis period.

Hence, we perform the empirical estimates by dividing the whole sample period into two parts – pre-crisis (1980−1996) and post-crisis (2000−2010) expecting the possible changes in relationship between independent and dependent variables. Table 7 presents the feasible GLS estimates for the pre-crisis period. Diagnostic checks show that there are no cross-sectional dependence and group-wise heteroscedasticity in case of *dla*, but both seem to be present in case of *dpc*, and only group-wise heteroscedasticity in case of *ddp*. Hence, the model is relatively good-fit for *dla* than other two dependent variables. As we look at the estimated coefficients at Table 7, *dir* and *bd* are statistically significant in case of *dla* as well as *ddp*. Coefficients of *dlr*(−1) and *gr*(−1) are significant at 10 % level of significance in case of *dpc*.

Table 8 presents the FGLS estimates for the post-crisis period. Diagnostic checks show that there are no cross-sectional dependence in all three cases and no group-wise heteroscedasticity in case of *dla* and *ddp*. This shows that our model is relatively best fit for the post-crisis period. There is still presence of group-wise heteroscedasticity in case of *dpc*, which indicates that chosen explanatory

Table 7: Feasible GLS Estimates

Pre-Crisis (1980−1996)

Independent Variables	Dependent variables		
	dla	dpc	ddp
c	-0.77(0.11)	2.30(0.13)	0.29 (0.77)
dir	0.85(0.00)**	0.17(0.43)	0.85(0.00)**
$dlr(-1)$	-0.08(0.13)	-0.07(0.10)+	0.001(0.99)
$gr(-1)$	0.01(0.85)	0.21(0.10)+	0.19(0.12)
bd	-0.45(0.00)**	0.27(0.33)	-0.30 (0.04)*
Dum_outmal	-36.4(0.00)**	-34.29(0.00)**	-73.91(0.00)**
$AR(1)$		0.35(0.00)**	
$AdjR^2$	0.81	0.31	0.56
$DWStat$	1.78	2.03	1.81
$F-stat$	63.56(0.00)	6.15 (0.00)	17.56 (0.00)
Obs	75	70	70
Diagnostic Check			
LM test$^\$$	11.3 (0.41)	19.37 (0.04)	2.95(0.98)
White Test&	21.0 (0.14)	34.3 (0.003)	26.25(0.03)

+ significant at 10%; ∗significant at 5%; ∗∗significant at 1%

$p-value$ in the parenthesis.

$Breusch-Pagan LM test of independence

& White Test for group-wise heteroscedasticity

Source: Author's calculations

variables are not enough for explaining the dynamics of dpc across our selected countries. Nevertheless, Table 8 depicts interesting findings. The coefficients of the variable dir are now significant for all three cases. It shows that a change in international reserves to GDP ratio seems to impact all of these selected banking system's variables. The magnitude of the coefficient is comparatively higher in case of dla. The impact on dpc only appeared in the post-crisis period. Another important variable impacting both dla and dpc appeared to be bd. This implies that higher budget deficit increases dla and dpc, which may be through availability of liquid financial instruments for the banking system and possible complementary effect for private sector credit flows. Other explanatory variables like gr is only found to impact ddp, not others, and lr remained insignificant for all three cases in the post-crisis period. Such results may be due to moderate economic growth and low interest rate sensitiveness in these economies.

Table 8: Feasible GLS Estimates

Post-Crisis (2000−2010)

Independent Variables	Dependent variables		
	dla	*dpc*	*ddp*
c	-0.24(0.66)	-2.67(0.03)	-2.52(0.00)
dir	0.51(0.00)**	0.42(0.00)**	0.37(0.00)**
dlr(−1)	0.15(0.20)	0.01(0.89)	0.07(0.50)
gr(−1)	0.03(0.69)	0.08(0.44)	0.27(0.05)*
bd	-0.31(0.00)**	-0.46(0.01)**	-0.22(0.26)
AR(1)		0.56(0.00)**	
AdjR^2	0.54	0.58	0.18
DW Stat	2.18	2.31	2.12
F − stat	16.60(0.00)	16.14(0.00)	4.05(0.01)
Obs	55	55	55
Diagnostic Check			
LM test$^\$$	8.15 (0.61)	11.00(0.36)	9.08(0.52)
White Test&	19.25(0.16)	25.85(0.03)	17.6(0.23)

+ significant at 10%; ∗significant at 5%; ∗∗significant at 1%

p − value in the parenthesis.

$\$$Breusch-Pagan LM test of independence

& White Test for group-wise heteroscedasticity

Source: Author's calculations

4   Conclusion

This paper has examined the impact of the international reserve accumulation by the central banks on the banking systems of five East Asian countries – Thailand, South Korea, Malaysia, Philippines and Indonesia– which were seriously affected by the 1997 financial crisis and which have been substantially accumulating international reserves since then. A panel data estimation shows that international reserves to GDP ratio (ir) is a robust factor as expected theoretically, contributing to an increase in liquid assets and deposits of the banking system, even after taking the possible impacts of other potential variables in both pre- and post-crisis period. In the post-crisis period, the ir is even found to contribute positively to private sector credit. However, our models pass the diagnostic checks for the post-crisis sample period only, particularly for liquid assets and deposits. Hence, it can be concluded that reserve accumulation by the central bank generates domestic liquidity and deposits in the banking system. This type of impact of international reserves can be considered as an additional channel for maintaining financial stability through the accumulation of international reserves.

The holding of liquid assets, indeed, provides a cushion to withstand any external shock to the banking system. This may be one reason that has made

the banking system of these countries resilient to the recent global financial crisis of 2007. By contrast, these countries faced serious liquidity crunches during the Asian crisis period because of the outflow of international reserves. Hence, the health of the banking system in emerging countries is closely linked with the holding of international reserves by central bank. In other words, the accumulation of international reserves tends to contribute to financial stability by generating domestic liquidity and creating deposits in the banking system. Because of this, an important policy implication is that any serious unwinding of global imbalances may have serious negative impacts on the banking systems of emerging countries. In addition, the possibility of credit expansion cannot be ruled out, something for which central bank should also be aware of, because the banking system can expand lending if credit demand emerges in the economy.

Moreover, our empirical results show that the budget deficits also impact the liquidity of the banking system positively, which may be due to the fact that government deficit helps to develop liquid bond markets. In addition, since emerging countries have space for fiscal policy, budget deficits can play a complementary role in the expansion of private sector credit, as found in empirical results in the post-crisis period. One policy implication of such a finding is that in addition to other macroeconomic effects, government budget deficits could have significant implications for the banking system.

This study can be extended in several directions. First, the panel estimation can be done by extending the sample countries, which could include not only Asian countries but also Latin American and African countries. Second, other controlling variables could be incorporated to examine the robustness of the impact of international reserves on the balance sheet variables of the banking system such as capital adequacy ratio and non-performing assets. Third, the seemingly unrelated regression (SUR) technique could be applied to verify the empirical results.

Acknowledgments

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Appendix 1: Movement of Dependent Variables
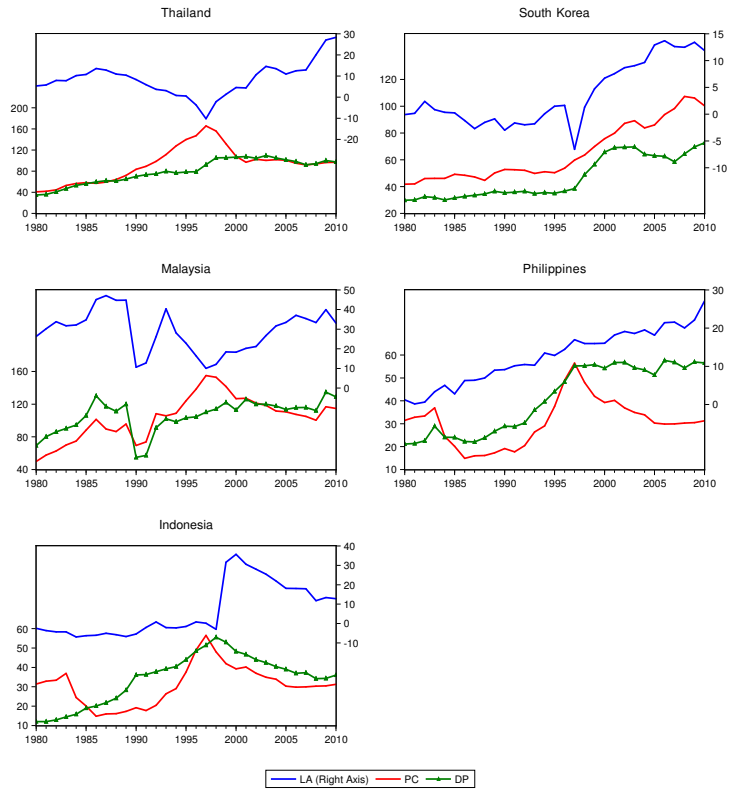
Appendix 2: Movement of Independent Variables

(IR=International Reserves, GR = growth rate, LR=Lending Rate, BD = Budget Deficit; IR and BD are as a percentage of GDP)

Appendix 3: Fixed Effects

Cross-section SUR (PCSE) standard errors & covariance (d.f. corrected)

Independent Variables	Dependent variables		
	dla	*dpc*	*ddp*
c	1.81(0.00)	-0.40(0.77)	-0.23(0.82)
dir	0.53(0.00)	0.26(0.26)	0.64(0.00)
dlr(−1)	0.29(0.03)	0.10(0.61)	0.12(0.33)
gr(−1)	-0.30(0.00)	0.50(0.02)	0.18(0.13)
bd	-0.22(0.07)	0.66 (0.03)	-0.22(0.35)
dum	-2.76(0.00)	0.96(0.74)	3.15(0.11)
dum_outmal	-35.05(0.00)	-31.9(0.00)	-70.03(0.00)
$AdjR^2$	0.50	0.25	0.58
DW Stat	2.15	1.52	1.95
F − stat	15.59	5.71	21.31
N	145	145	145
Redundant Fixed Effect test			
Cross section F	0.10(0.98)	1.49(0.21)	0.76(0.56)
Cross Section χ^2	0.42(0.98)	6.36(0.18)	3.23 (0.52)

+ significant at 10%; ∗significant at 5%; ∗∗significant at 1%

p − value in the parenthesis.

Source: Author's calculations

Appendix 4: Random Effects

Cross-section SUR (PCSE) standard errors & covariance (d.f. corrected)

Independent Variables	Dependent variables		
	dla	*dpc*	*ddp*
c	1.79(0.00)	-1.11(0.38)	-0.68(0.43)
dir	0.53(0.00)	0.28(0.22)	0.65(0.00)
$dlr(-1)$	0.29(0.03)	0.10(0.63)	0.12(0.34)
$gr(-1)$	-0.29(0.00)	0.56(0.00)	0.22(0.06)
bd	-0.22(0.03)	0.47(0.08)	-0.33(0.12)
dum	-2.77(0.01)	0.97(0.74)	3.15(0.10)
dum_outmal	-34.94(0.00)	-29.97(0.00)	-68.73(0.00)
$AdjR^2$	0.52	0.24	0.59
DW Stat	2.15	1.46	1.91
$F-stat$	26.61 (0.00)	8.55 (0.00)	35.26(0.00)
N	145	145	1.45
Hausman test	0.19(0.99)	0.00 (1.00)	0.00 (1.00)

$+$ significant at 10%; $*$significant at 5%; $**$significant at 1%

$p-value$ in the parenthesis.

Source: Author's calculations

Please note:

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