UNIVERSITY OF BIRMINGHAM

CROSS-BORDER FINANCIAL LINKAGES AND INTERNATIONAL FINANCIAL CONTAGION

AN EMPIRICAL STUDY OF EAST ASIA DURING THE 2007-2011 GLOBAL FINANCIAL CRISIS

By

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ABSTRACT

Motivated by the global financial market turbulence in 2007-2011 and the gaps from the literature, this thesis presents an econometric assessment of different transmission mechanisms that propagated and amplified shocks from advanced economies to East Asia. The asset price channel is investigated with MS-VAR model and multivariate unconditional correlation tests. The recursive bivariate probit models are applied to test the liquidity shock transmission via the sudden stop in international lending. The second round effects are examined with partial adjustment models and system GMM estimation. The econometric procedure and testing approach bring about novel results from superior estimation techniques and handle several statistical problems such as heteroskedasticity, non-linearity, endogeneity, omitted variables, simultaneous equations and sample selection bias.

The main finding of the thesis is that despite relatively sound fundamentals and limited exposure to structured credit products, East Asia could not totally decouple from the global financial crisis. Specifically, the asset price channels propagated volatility spillovers from the US and Europe to East Asian equity, foreign exchange and CDS markets. While international volatility spillovers were mainly caused by fundamental links, international behaviour during the shocks intensified the regional linkages and generated contagion effect. There was also contagion evidence associated with the sudden stop in international lending which facilitated the transmission of liquidity tensions in the interbank markets. Finally, contagion was magnified by the second round effects, defined as the feedback loops from the sudden changes in macro-financial conditions which caused adverse adjustment in bank performance. These findings have useful implications for international investors and policy authorities regarding to portfolio diversification and systematic risk containment.

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For the remaining errors and inadequacies in this thesis, the responsibility is entirely mine.

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ABBREVIATIONS

ABF:	Asian Bond Fund
ABMI:	Asian Bond Market Initiative
ACU:	Asian Currency Unit
ADB:	Asian Development Bank
AEs:	Advanced Economies
BIS:	Bank for International Settlements
BOPS:	Balance of Payments Statistics
CEE:	Central and Eastern Europe
CDF:	Cumulate Distribution Function
CDO:	Collateralised Debt Obligations
CDS:	Credit Default Swap
CSV:	Costly State Verification
EDFs:	Expected Default Frequency
EFP:	External Finance Premium
EMEs:	Emerging Market Economies
EMEAP:	Executives' Meeting of East Asia Pacific Central Banks
EMPI:	Exchange Rate Market Pressure
EM-FSI:	Emerging Market Financial Stress Index
FDI:	Foreign Direct Investment
FSI:	Financial Stress Index
GDP:	Gross Domestic Products
GMM:	Generalised Method of Moments
IFS:	International Financial Statistics

IMF:	International Monetary Fund
LGDs:	Loss Given Defaults
LLP:	Loan Loss Provision
MBS:	Mortgage-Backed Securities
OTC:	Over-the-Counter
PDs:	Probability of Defaults
P/E:	Price/Earning
ROE:	Return on Equity
UK:	The United Kingdom
US:	The United States of America
VaR:	Value at Risk
VAR:	Vector Autoregressive
VIX:	Chicago Board Options Exchange Market Volatility Index
WEO:	World Economic Outlook

CHAPTER ONE – INTRODUCTION

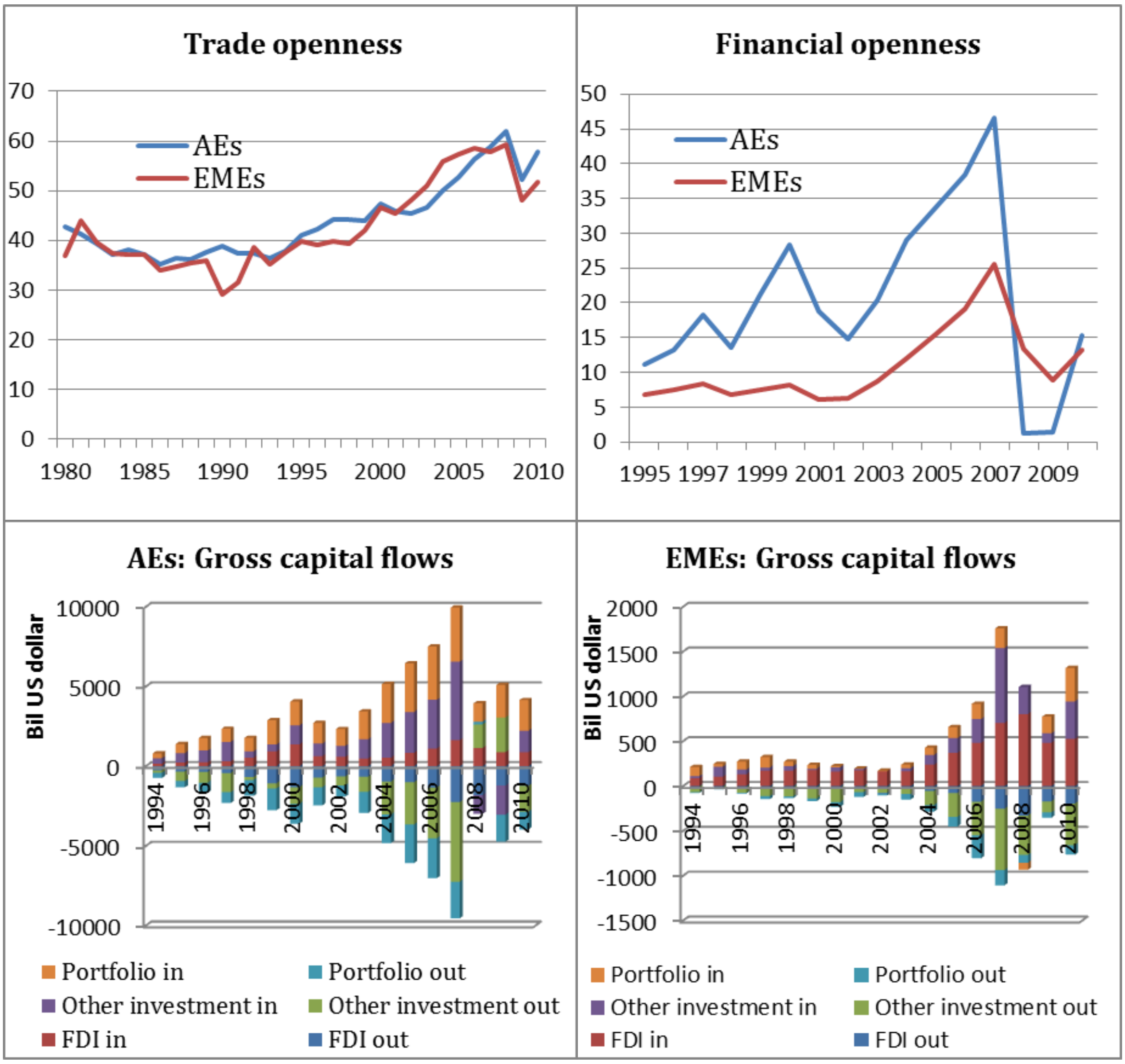
1.1. Research Background

1.1.1.1. Cross-border Financial Linkages: Benefits and Costs

Cross-border financial linkages have increased dramatically over the past three decades and become more and more complex. This is a consequence of globalisation[1], which offers investors a greater opportunity to seek higher rates of return and to diversify risks. The linkages have been dominated by some advanced economies (AEs) and financial centres, while emerging market economies (EMEs) still only account for a small part of the global financial network. According to the IMF (2011), more than 90% of claims issued by EMEs are held by AE residents, while shares held in EMEs are generally small, at 5% or less. However, the cross-border financial linkages have intensified, underpinned by the exponential rise in trade and financial flows. As shown in Figure 1.1, trade openness, measured by the sum of imports and exports as a percentage of GDP and financial openness, measured by the sum of financial account assets and liabilities as a percentage of GDP, have expanded at an accelerated rate since the 1990s. This reflects the increased degree of financial integration, which is at least as high in developed countries as in emerging and developing ones. The increasing global linkages also lead to the complexity of the network; i.e., the thickening of the web of financial links among economies and asset classes (IMF, 2011).

[1] Globalisation mentioned in this context refers to the worldwide movement toward economic and financial interconnectedness and integration, the process associated with increasing flows of trade, investment and communication across national frontiers (Michie, 2003).

Figure 1.1 – Global trade and financial linkages



Source: IMF-World Economic Outlook (WEO), IMF-Balance of Payments Statistics (BOPS) and author's calculations

Empirical evidence has suggested key drivers of the financial network connection, including geographical, historical, economic and financial factors. In particular, stronger linkages occur in clusters of countries that are closer to each other and have similar legal systems and common languages (i.e. stronger regional linkages than global linkages). Higher exposures are also built up in countries that are larger, more developed and financially advanced. Innovation in financial instruments over the past decades has increased the complexity of financial links across countries and been testified by the global financial crisis of 2007-2011. Cross-border linkages and financial integration have generated several economic and financial benefits and costs from a financial stability perspective.

1.1.1.2. Benefits of Cross-border Financial Linkages

Risk diversification: The key benefit of cross-border financial linkages is risk diversification at individual country level. It is well-known from the Markowitz (1952)'s portfolio theory that holding a combination of assets instead of investing in a single one helps to reduce the total variance of the asset portfolio. The gains from risk reduction depend on the correlation of asset returns. With financial liberalisation and integration, domestic investors can diversify their asset portfolios internationally by holding assets issued by firms and financial institutions around the world in addition to domestic ones. They therefore become less exposed to localised shock, contributing to a better sharing of an economy's risk with other countries[2].

Domestic investment and growth enhancement: Another potential stability benefit of financial linkages is that they enable a country to access the world pool of resources (i.e. an individual country's integration into the international capital market). This facilitates household consumption and domestic investment smoothing, improves growth rates and reduces macroeconomic volatility. This

[2] It is also widely documented from the literature that investors fail to exploit diversification benefits, preferring to concentrate their investments in domestic assets. French and Poterba (1993) explain the lack of portfolio diversification in the model of investor preferences and behaviour. For example, investors may expect return in their domestic equity market higher than returns in other markets; on the other hand they may impute extra risk to foreign investments which they have less knowledge about. However, with the focus on analysing cross-border financial linkages and international contagion, the paradox of "equity home bias" will not be mentioned in details in this thesis.

effect is particularly important for EMEs, whose saving capacity is constrained by level of income. International capital inflows can supplement domestic savings, increase levels of physical capital per worker, help the recipient country raise its rate of economic growth and improve living standards (Agénor, 2003). Obstfeld (1995) develops a theoretical model demonstrating that global diversification and international risk sharing can yield substantial welfare gains through their positive effect on expected consumption growth[3]. The channel that links globalised diversification to growth reflects the shift in international portfolios from safe, but low yield capital to riskier, high-yield capital.

In addition to this direct effect on growth, there is a potential indirect effect due to the interaction between competition and efficiency. Foreign entry into a domestic market (i.e. in the form of foreign direct investment, FDI) will tend to increase competition pressure in the host country via various channels. It is clear that the foreign influences increase the number of business entities in the market. Foreign institutions are usually more efficient in terms of technological know-how and managerial skills and experience. Competition may then force domestic institutions to become more efficient as well, hence enhancing stability. Extensive literature has suggested the link between competition and efficiency. Markusen and Venables (1999) demonstrate that cross-border linkages in the supplier industry that is induced by FDI help to reduce costs for both consumers and producers, raise profits and stimulate domestic investment. MacDougall (1960), Grossman and Helpman (1993), Borensztein et al. (1998) and Berthélemy and Demurger (2002) mention that FDI facilitates the transfer or diffusion of

[3] However, Obstfeld (1995)'s model has some limitations for empirical application. For example, it assumes a single consumption good while ignoring the role of goods that do not enter international trade and the role of variation in exchange rates. Another drawback comes from the absence of capital-adjustment costs and related capital-gains effects.

managerial and technological know-how and improves the skills of the labour force via the "learning by doing" effect and on-job training.

Banking system efficiency and financial stability: The diversification benefits and interaction between competition and efficiency appear to be even more apparent in the financial industry. First, foreign bank entrance and competition between banks generate a greater variety of financial services at a lower price; for example, lower lending rates for borrowers. A lower cost of investment will raise domestic borrowers' profits and net worth and consequently reduce the likelihood of defaults. Second, the presence of foreign banks enables the application of more sophisticated banking techniques and highly advanced risk management systems that help to improve the quality of financial services and mitigate credit risk. Third, foreign bank penetration contributes to the stabilisation of domestic lending because it offers domestic firms multiple lending relationship opportunities. When domestic banks are lending-constrained due to idiosyncratic shock, domestic borrowers may substitute domestic lending with foreign-based financing. The same benefits can be obtained on banks' liability side. Specifically, during financial turmoil depositors may shift their funds to foreign banks that are perceived to be sounder than domestically-owned ones, instead of transferring assets abroad through capital flight. Under these circumstances, cross-border linkages increase banking system efficiency and enhance financial stability.

Improved macroeconomic disciplines: One additional stability benefit worth mentioning is enhanced macroeconomic disciplines (Agénor, 2003). Financial liberalisation accompanied by free flows of capital and the effect of foreign factors may stimulate better regulation, accounting standards, and financial and legal structures. This will encourage countries to pursue more disciplined macroeconomic policies and thus reduce the frequency of policy mistakes. As mentioned in Obstfeld (1998), unsound policies (i.e. excessive government borrowing or inadequate bank regulation) may spark speculative capital outflows and higher domestic interest rates. Greater policy discipline translates into greater macroeconomic and financial stability, ensuring a more efficient allocation of resources and higher rates of economic growth.

1.1.1.3. Costs of Cross-border Financial Linkages

Despite extensive potential benefits, increased cross-border linkages have generated a great deal of concern about financial instability, such as domestic misallocation of capital flows that may hamper economic growth; risks associated with foreign bank penetration; the high degree of capital flow volatility; and in particular the risks of cross-border contagion.

Misallocation of capital flows: Although international capital inflows may stimulate domestic investment and raise economic growth, this effect may be quite limited or even become negative in the long-run if the cross-border capital flows are misallocated to unproductive investments. For example, in some catching-up countries, capital inflows are used to finance private consumption or excessive public deficits, or are invested in speculative and non-tradable sectors (e.g. in real estate). Large amounts of funds invested in weak productive sections may push up inflation and real exchange rates, leading to serial problems such as low real interest rates, growing external imbalances and associated large current account deficits, excessive credit and asset price distortions. Misallocation of capital flows usually arises in countries with weak banks (i.e. banks with low capital to risk-adjusted asset ratios) and poorly supervised financial systems (Agénor, 2003). Easier access to the capital market by the banking system may exacerbate the moral hazards problem; i.e., lenders may engage in riskier and more concentrated loan operations. This happened in East Asian economies in the 1990s, causing a serious banking and currency crisis in 1997-1998.

Risks of foreign bank penetration: Although foreign-bank penetration generates potential efficiency and stability benefits, it may weaken the position of the domestic banking system. If domestic banks are burdened with bad debts, operate less efficiently or are technically disadvantaged, this makes them unable to cope with competitive pressures (De Haas and Lelyveld, 2002). Eichengreen and Mussa (1998) emphasise that foreign competition can raise the probability of a banking crisis as lower margins for domestic banks make them more vulnerable to loan losses. In addition, foreign banks usually concentrate their credit provisions on large and often multi-national firms with higher creditworthiness, leaving domestic banks with the remaining bad corporate credit risks and the retail market. The higher degree of credit rationing to small firms and household borrowers may bring about adverse effects on output, employment and outcome distribution. Another risk of foreign bank entrance is the concentration process arising from the pressure of mergers between local banks for them to remain competitive and the acquisition of domestic banks by foreign banks. This would make banks become “too big to fail” and is likely to increase the moral hazard problem and monopoly power.

Capital flow volatility: Global integration with higher financial openness to cross-border transactions increases the level of capital flow volatility because it leads not only to domestic capital flight but also to large capital inflows which are highly susceptible to the sudden reversal in times of financial distress. During the past two decades, currency or financial crises accompanied by capital withdrawals have become more frequent and severe[4]. However, the effects of financial liberalisation on capital flow volatility are varied, depending on the form of capital flows and economic region (Broner and Ventura, 2010). For example, FDI is considered to be more stable and more difficult to liquidate than portfolio and other investment flows (Lipsey, 2001; Berger et al., 2004). Tong and Wei (2009) conduct a test of the effect of capital flow composition in 24 EMEs during the 1999-2009 period and find that the adjustments of international bank loans are sharper than portfolio investment and much sharper than that of FDI flows. The volatile level of capital movement is also higher for short-term liabilities, which are more prone to "cut and run" by international banks during a period of financial turmoil. Additionally, the volatility in net capital flows is more severe in EMEs than in AEs because the change in external liabilities (i.e. a sudden stop in capital inflows) is relatively higher than adjustment in external assets (limited capital outflows) because EMEs are generally less interconnected and less flexible in offsetting the changes in both inward and outward linkages. They are therefore more vulnerable to the one-way risk of deleveraging.

Cross-border contagion: The highest potential cost of financial interconnection and the associated capital flow volatility is the risk of cross-border contagion. Financial literature provides many approaches in defining contagion. Before going to detailed discussion of different theories explaining crises and contagion in

[4] See Broner et al. (2010) for more evidence about capital flow volatility associated with financial crises during the past four decades.

Chapter 3, this section simply mentions the World Bank's broadest definition of contagion as "the cross-country transmission of shocks or the general cross-country spillover effect". On one hand, cross-border financial linkages reduce investors' exposures to domestic shocks. On the other hand, investors become more vulnerable to foreign shocks. In other words, financial linkages may facilitate shock propagation across countries through various transmission mechanisms. The most obvious channel is from direct exposure, i.e. overlapping claims that different countries/regions or banking sectors have on one another. A negative shock that hits one country will cause unexpected losses in others because their claims on the troubled country fall in value. If the loss is substantial enough, it will cause a crisis in the affected countries. Allen and Gale (2000) and Freixas et al. (2000) develop theoretical models to demonstrate that the possibility of contagion depends strongly on the completeness of the structure of interregional claims. For example, countries whose banking sectors had more exposure to structural credit products in the United States of America (US) experienced larger losses during the 2007-2009 subprime mortgage crisis. In that case, European banks were major purchasers of asset-back securities and obtained dollar-funding in the US money markets (Bernanke et al., 2011). They therefore suffered more severe sub-prime losses than EMEs in Asia or Latin America. This affected their domestic lending and consequently led to the economic recession.

Another financial channel which contributes to the spread of the financial crisis across countries arises through asset prices. Following a shock in one country, international investors may have to sell assets in other countries to meet margin calls, capital requirements or just to reduce risk exposure as dictated in the Value at Risk (VaR) model. By doing so, investors cause asset prices out of the crisis country/region to fall and the original shock can spread across different markets. From standard portfolio theory, Schinasi and Smith (1999) prove that a shock to the asset-return pattern in one country usually leads to wealth allocation across countries. Banks from a common creditor country may also face a liquidity problem when they experience a marked deterioration in the quality of their loans in one country; they hence attempt to reduce the overall risk of their loan portfolios by reducing their exposures in other high-risk investments in EMEs. For example, at the height of the problem in the euro zone area, European banks tended to reduce their cross-border claims, or sell and scale-down non-core, nondomestic business in host economies, causing a rapid synchronised deleveraging effect in EMEs.

A complex network as a consequence of cross-border linkages is also likely to give rise to information asymmetries and increase the potential for herding behaviour, flight to quality and a liquidity crunch (IMF, 2011). In the absence of complete information, an adverse shock in one country may serve as a “wake-up-call” for international investors and encourage them to re-evaluate the risk associated with their portfolios, triggering a broad-based pull-back from other countries, especially those with the same conditions as the crisis country. Investors could derive information not only from their own portfolio, but also from the actions of other investors, independently of their own private information signals. This may increase the potential for herding behaviour and liquidity crunches. Calvo and Mendoza (2000) explain the herding behaviour arising from the cost of gathering and processing country-specific information. Uninformed (or less informed) investors tend to observe and copy from informed investors who act early in adjusting their portfolios. If informed investors move to a bad equilibrium, then less-informed and uninformed investors, by following the informed ones, cause another bad equilibrium. Bad equilibrium is characterised by a devaluation, a decline in asset prices, capital outflows and/or debt default.

Switches between multiple equilibria may also arise due to changes in investors' self-fulfilling expectations or a general increase in risk aversion. In the bank run model of Diamond and Dybvig (1983), individual depositors decide either to hold funds or withdraw from a bank depending on the actions of other depositors. If the others run, then it is optimal for an individual to run too. In this framework, contagion occurs depending on whether investors coordinate in good or bad equilibrium. A shock in one market may also change investors' risk perception (i.e. increased risk aversion), so that the equilibrium risk premium in all risky investments rises (Schinasi and Smith, 2001; Acharya and Pedersen, 2005). For example, during the US subprime crisis, when globally investors were concerned about where the subprime related casualties might emerge, they de-risked their portfolios by selling down holdings in corporate bonds, equities, and property securities, opting instead for the safe haven of cash or treasury-related securities. This is known as the "flight to quality" effect.

It is worth noting that cross-border linkages and financial integration are a double-edge sword: on one hand they improve risk sharing by diversifying away localised shocks; on the other, they increase systematic risk and make the global financial network more fragile. Standard portfolio theory suggests that the net effect is positive; i.e., the overall volatility of an internationally diversified asset portfolio will be lower than a purely domestic one which justifies the rationale of financial linkages. However, the extreme turbulence in the world financial markets during the past three decades, evidenced by the emerging market financial crises in the 1990s and early 2000s, the damage to the US subprime credit market with its spillover effects on global financial markets between 2007 and 2009, and the rising problems in the euro zone area in 2010-2011, have raised a big concern that whether the financial instability risk/cost of cross-border financial linkages has been appropriately assessed. The global financial system seems currently to be in a state of shock and there is the possibility that the whole process of globalisation has been threatened by the current instability. Even countries that are not considered "systematic" ex ante in terms of economy size and financial openness could become the epicentre of systematic financial crises and financial linkages facilitate the transmission of shock across countries. Despite the importance of contagion risk in the context of financial integration and innovation, it is not yet fully understood what the transmission mechanisms are and little work has been done so far to stop it. Therefore, investigating cross-border financial linkages and crisis contagion is a matter of immediate concern to both the international policy community and international investors.

1.1.2. The US Subprime Credit Crisis and Volatility Spillovers across the Global Financial Markets

The 2007-2011 global financial crisis vividly illustrated how a localised shock originating from the US subprime mortgages propagated through multiple linkages across borders and asset classes, turning into a large –scale systematic crisis (IMF, 2011). Considered by many economists as the largest financial bailout in US history since the 1930s, the US subprime mortgage credit crisis started in the summer of 2007. As pointed out by Olowski (2008), this was the consequence of a series of factors: boom and bust in housing markets, associated with easy credit conditions; growth in asset securitisation and the development of new structured financial products; inaccurate credit risk assessment and asset valuation models and inadequate financial supervision and regulation. Together with the growth in the housing market, characterised by annual double-digit increases in typical US housing prices (estimated at 124% during the period 1997-2006), the large inflow of foreign funds, supported by low interest rates, contributed to creating housing and credit bubbles. In addition, the housing market was largely aided by the securitisation of mortgages as well as new financial structured products (for example, mortgage-backed securities - MBS[5], collateralised debt obligations - CDO[6] and credit default swaps - CDS[7]), which derive their values from mortgage payments and housing prices. The securitisation not only increased the connectedness between financial institutions, both within and across countries, but also led to complex and hard to value assets on the balance sheets of these institutions. This brought about large uncertainty that affected the global financial network. Indeed, these financial structured products attracted institutions and investors around the world to invest in the US housing market. When housing prices began to decline and interest rates started to rise in 2006 and 2007,

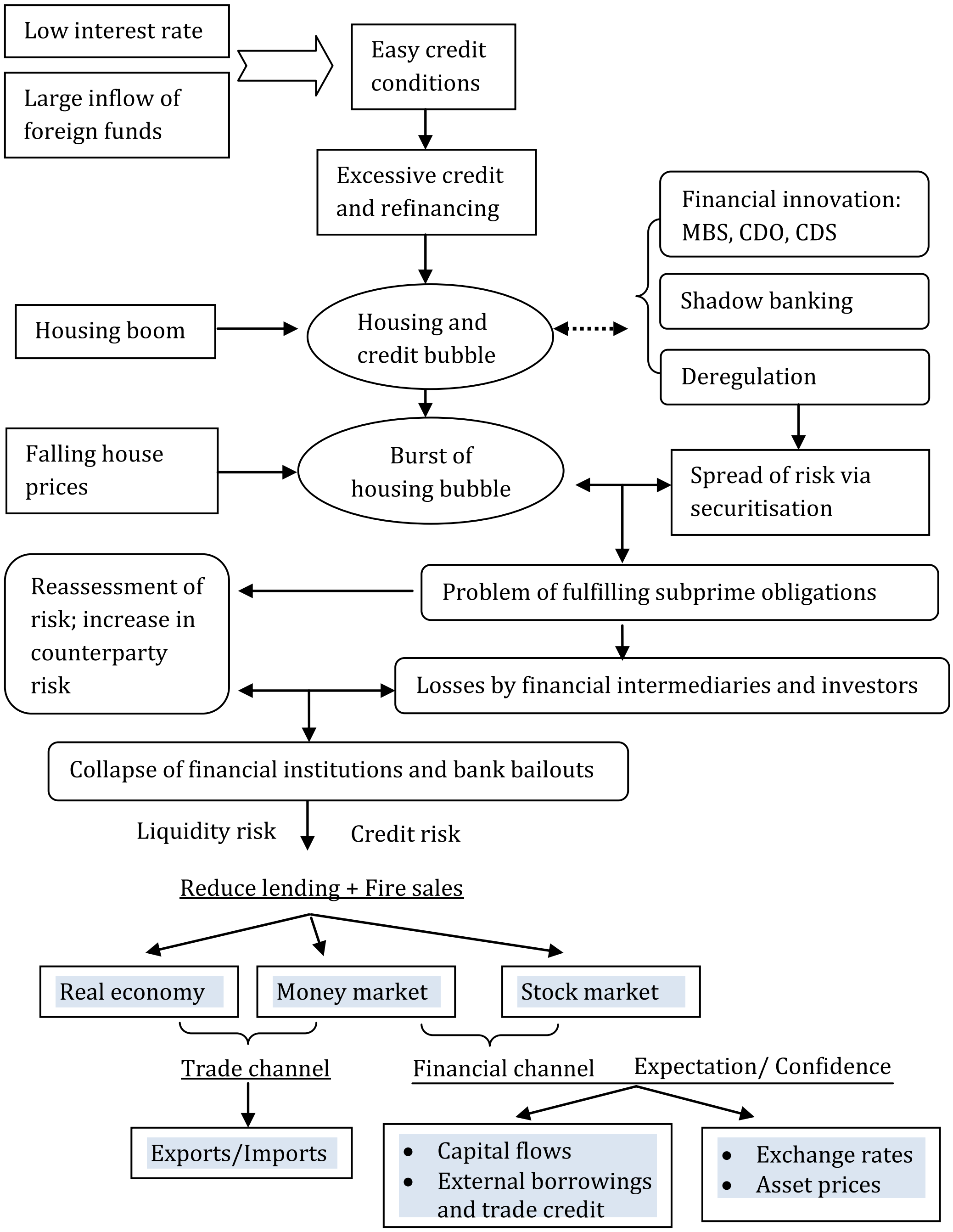
[5] MBS are debt obligations created from the pooling of mortgage loans, mostly in residential property. There are three parties involved in the structure of MBS. The ***sellers*** generate mortgage-loans which are then purchased by ***issuers*** (banks, mortgage companies and other institutions) and assembled into pools by a governmental, quasi-governmental, or private entity. The issuers then issue securities that represent claims on the principal and interest payments made by borrowers on the loans in the pool. The third-parties, usually institutional ***investors,*** invest in MBS to obtain higher yields than government bonds, as well as an opportunity to diversify their portfolios.

[6] CDO is a debt security, which is collateralised by different types of debt obligations such as bonds and loans of different maturities and credit quality.

[7] CDS is an OTC contract that provides insurance against credit default. In this contract, the protection buyer makes a fixed payment, called CDS spreads, to the protection seller and in exchange receives compensation if a credit instrument (typically a bond or loan) goes into default.

mortgage loans exceed house values, which resulted in significant losses on this loan type and other refinancing activities. Customers' wealth was drained and the financial strength of financial institutions was eroded. With the significant increase in default and foreclosure, the crisis started to expand from the housing market to the banking sector and then to other parts of financial markets (See Figure 1.2).

Figure 1.2 - The US subprime crisis and its impact on financial markets



The problems showed up first in the US financial markets and then resulted in global market turmoil. Since the second half of 2007, the financial world has been a different place, beginning with the fact that many banks and financial institutions wrote down their holdings of subprime-related securities, estimated at US$ 1.5 trillion of subprime MBS only to August 2008 (IMF, 2009). The banks' big losses in toxic assets and bad loans as a consequence of the bursting of the housing bubble were estimated by the IMF at US$ 2.8 trillion from 2007-2010 (US$1 trillion of US banks' losses and US$1.8 trillion from European banks). This in turn led to the failure and bail-out of several US and European banks, and over 100 mortgage lenders during 2007 and 2008. As turbulence in the US subprime mortgage market deepened in 2008, several financial institutions failed, were acquired under duress, or were subject to government takeover. They included Merrill Lynch, Bear Stearns, Lehman Brothers, Fannie Mae, Freddie Mac, Countrywide Financial, Washington Mutual, Wachovia Mutual and AIG in the US; Northern Rock, Alliance and Leicester, Roskilde Bank, Fortis and Straumur Investment Bank, ABN-Amro, RBS in Europe.

Money markets were subject to this bank-run, which made credit for banks less available and more expensive. The tension in inter-bank markets due to the liquidity squeeze and credit freeze intensified the financial crisis and brought the global financial system to the brink of collapse, forcing immediate and dramatic responses from the USA Federal Reserve and central banks in other countries. The TED spreads[8] rose sharply from July 2007 and remained volatile for the following period of time until they reached an unprecedented level of 4.65% on October 10,

[8] The TED spreads (the difference between 3-month LIBOR and the US 3-month Treasury bill rate) is commonly used as a measure for perceived counterparty risk between banks.

2008, breaking the previous record set after the Black Monday crash of 1987 (Figure 1.3). While interbank markets across AEs showed signs of severe stress, there was clear evidence of increased global investors' risk aversion and a flight to quality and liquidity, underscored by a strong demand for 10-year US Treasury bills as a 'safe' haven. The volatility spilled over into the equity markets. During the period from June 2007 to November 2008, the US lost an estimated average of more than a quarter of its collective net worth (IMF, 2009). The S&P 500 fell 45% from its 2007 high. On September 29, 2008, the S&P 500 fell 8.8%, which was its largest one-day percentage decline since Black Monday in 1987.

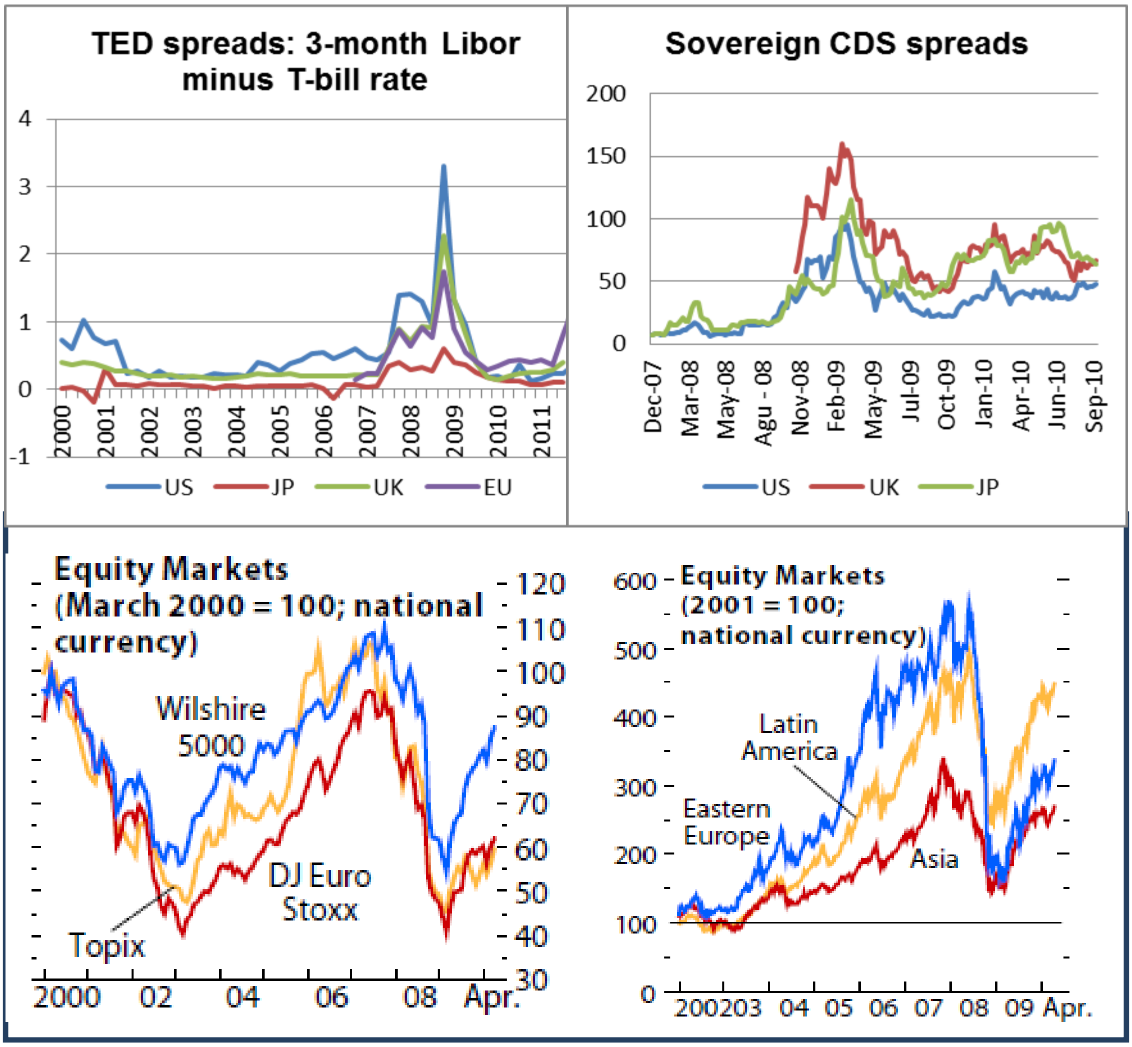
The fall of Lehman Brothers on 15 September, 2008 exposed the interbank markets to an even higher level of counterparty and liquidity risk and set off an avalanche of world-wide deleveraging. Following this event, the sharp increase in default-risk premium and equity risk-premium caused a dramatic asset devaluation in stock markets in many parts of the world (Figure 1.3). As portfolio outflows and run-to- quality accelerated, sovereign spreads and the costs of insuring against sovereign default soared across a wide range of EMEs. Deleveraging in the form of capital outflow represents additional macroeconomic problems. Not only do countries have to deal with a domestic credit problem as a consequence of the sudden stop in capital inflow, but they also have to suffer downward pressure on foreign exchange rates. EMEs with large current account deficits and whose banks were more reliant on foreign wholesale funding were more affected and had to accept large depreciation if they had not built up enough foreign reserves or were unable to access IMF credit support. For example, Korea and Russia had to employ their foreign reserves, while Ukraine, Hungary, Pakistan and Latvia received substantial financial support from the IMF in the last quarter of 2008 to cope with currency depreciation pressures arising from an unwinding of their portfolio position and severe strains on their banking sectors.

Financial spillovers via foreign exchange, stock and real estate markets and money and debt markets have a negative impact on the real economy by lowering consumption and investment activity. Falling global demand and the drying up of trade finance dramatically eroded global trade flows. According to a report by the World Bank, the volume of world merchandise trade plunged by 9% in 2009. EMEs which were highly export-oriented suffered most; for instance, exports in Southeast Asia switched from double-digit growth to a double digit decline. Consequently, economic slowdowns spread into all regions across the world, with an estimated contraction of the global economy in 2009 of 1.7%, the first decline on record in world output according to the World Bank. The localised financial crisis turned into a deep global recession, which affected EMEs at least as much as AEs.

Gallego et al. (2010) demonstrated three different financial transmission channels of the global financial crisis on EMEs: the direct channel, indirect channel and second-round effects (See the Appendix 1.1). The direct effect arises from a country/ region's direct exposures to toxic assets. The indirect financial channels work via capital outflows and asset price depreciation in stock markets, foreign exchange markets and money and debt markets due to the deterioration of foreign investor sentiments toward EMEs. Second round effects relate to "feedback loops from a slump in economic activity which may negatively impact on financial institutions, inter alia, via deteriorating credit quality, rising non-performing loans

(NPL), declining profitability and increased problems retaining the necessary capitalisation" (Gallego et al., 2010, p.235). However, the depth and length of the crisis impact differed across countries and regions depending on the level of economic and financial integration, as well as the resilience of the economies.

Figure 1.3 - Counterparty risk and sovereign credit risk



Source: Datastream and IMF-WEO

1.2. Motivations and Research Questions

Motivated by the turbulence in the global financial markets in 2007-2011 and the gaps from the literature, this thesis presents an econometric assessment of different transmission mechanisms that propagated and amplified shocks from

AEs to East Asian countries. Although considered to be a great success story in the history of economic development, East Asia was severely hit by two major financial crises in just over a decade. The first severe damage was associated with the regional currency crisis in 1997-1998, triggered by the weakness and imbalance in the Thai economy. This represented a new kind of financial crisis that challenged economic development models in the so-called “miracle economies” as well as imposing some limitations on the first and second-generation models of currency crises. The most striking feature of this event is cross-border spreading of a crisis, even with or without direct trade and financial linkages. Since then, the literature on international financial contagion has disseminated and become an essential part of the intellectual framework investigating financial crises. A decade after the 1997-1998 crisis, East Asian countries implemented structural financial reform and experienced a remarkable recovery in economic development. Therefore, the region entered the global financial crisis with relatively strong macro fundamentals and a healthy financial position, especially in the banking sector in terms of capital adequacy and credit rating. In addition, the financial institutions in East Asia had very limited exposure to subprime-related instruments; the estimated subprime losses in the crisis were therefore insignificant. Under these circumstances, it might be expected that all the lessons learned from past crises and regional time-line policy responses helped the regional economy and financial markets to successfully decouple from the global economic and financial turmoil. Despite the fact that East Asia stayed resilient during 2007 and the first half of 2008, the region financially gave in to the stream of negative news from the collapse of Lehman Brothers in September 2008. This fact raised a broad research question that: What are the transmission mechanisms that propagated and amplified external shocks to East Asia and how these mechanisms worked?

Investigating the current literature of financial crises and contagion channels, we identify the following gaps from which specific research questions have been built on and help give more convincing answers for the broad research question.

First, a large body of empirical studies have tested for asset price volatility linkages and evidence of financial contagion across countries. The theoretical literature suggests that co-movements in asset prices may be linked to either "common shocks" and "interdependence" of fundamentals or "shift-contagion" caused by investor behaviour. While interdependence refers to the stable cross-market linkages, the shift contagion addresses the nonlinear nature of financial interaction. However, the empirical role for shift-contagion appears to be relatively limited. Moreover, a wide range of different methodologies has been used; each is subject to some specific statistical problems, making it difficult to assess the significance of asset price channels and the evidence for contagion. For example, Forbes and Rigobon (2002) point out that the correlation coefficient tests of contagion via asset prices and returns are biased in the presence of heteroskedasticity. After adjusting for the heteroskedasticity problem, they find that there is no evidence of (shift) contagion, but only interdependence in several financial crisis episodes. However, Corsetti et al. (2005) argue that the result of "no contagion, only interdependence" is due to arbitrary and unrealistic restrictions on the variance of country-specific shocks. Taking this caveat into account, their empirical tests provide some evidence of contagion and some interdependence. In an effort to seek more robust evidence of contagion in recent financial crises, the Research Question One (RQ1) is therefore articulated as follows.

RQ1a - How do asset prices facilitate the transmission of volatility shock across borders?

RQ1b - How do empirical estimates of asset price volatility linkages relate to theoretical assumptions as generally used in the literature on shift-contagion which is caused by investor behaviour?

Second, regarding the limited role of investor behaviour, empirical evidence points to the existence of portfolio rebalancing effects caused by liquidity problems and capital constraints, and risk aversion effects (Moser, 2003). Many studies document that international banks are likely to cut back foreign loans after experiencing marked deterioration in loan quality in one country, causing cross-border lending contagion. The more countries rely on external funding from the same creditors, the more vulnerable they are to sudden reversal of international lending flows. The gap in the literature of cross-border banking and contagion is that the majority of studies use gravity model and base regression to decide pull and push factors driving cross-border banking flows rather than directly testing how international banks transmit shock across countries via the sudden stop. This therefore provides the motivation for Research Question Two (RQ2):

RQ2a – How can cross-border banking expose domestic financial markets to the risk of a sudden stop in international lending?

RQ2b - Do international banks withdraw their exposures across the board or do they discriminate between countries, and if so, how?

RQ2c - Was the sudden stop in international lending linked to the tensions in host countries' interbank markets?

Third, the literature on the transmission of global shocks between economies mainly investigates the real effects via trade links, or the financial effects via co-movement of asset prices and international capital flows. Limited attention has been paid to the potential second round effects, defined as the adverse feedback loops caused by the slumps in economic activity and deterioration in financial markets that may negatively impact the domestic banking sector. Even if a country has a sound banking system and remains resilient to external shocks, it may encounter a threat of traditional credit risk and contraction on bank lending prompted by macro-financial linkages. Another gap arises from the modelling approach of bank behaviour. While most literature focuses on adjustment in individual dimensions of bank behaviour, little research has been conducted on simultaneous adjustment in overall bank performance given each serves as an endogenous factor of the others. These gaps motivated the formation of Research Question Three (RQ3).

RQ3a - How did domestic banks react to changes in macro-financial conditions during the global financial crisis and how can their reactions to those risks be modelled?

RQ3b - Do bank behaviour adjustments magnify the impact of global shock?

RQ3c - How do empirical estimates of bank reactions relate to the behavioural assumptions generally used in the theoretical literature?

Although the real effect via trade links being straightforward and significant in East Asia during the global financial crisis, this thesis mainly focuses on financial links and financial transmission mechanisms, given their complexity for appropriate anticipation and measurement relative to trade links. East Asian economies to be investigated in this study include Thailand (TL), Indonesia (ID), Malaysia (ML), Philippines (PH), Korea (KR), Singapore (SG) and Hong Kong (HK). They are considered as key players in Asia, who have contributed significantly to the remarkable economic growth since the 1990s and helped the region gain world admiration as 'Miracle Asia'. They are also countries who have experienced substantial transformation in macro-financial developments but are still unable to totally decouple from financial crises.

1.3. Research Contributions

The essential contribution of this thesis is that it brings together empirical studies of financial transmission mechanisms and works on the aspects that have not yet been widely investigated by the literature of shock propagation; i.e. the joint effects of the sudden stop in international lending and its feedbacks to the interbank market tensions; the second round effects of contagion; and the simultaneous adjustments in overall bank performance. Moreover, the improvement in testing with the combination of different econometric techniques, increases the contribution of the research as it addresses several statistical problems and leads to novel empirical results from superior methodologies.

Accordingly, in order to evaluate the asset price channel and the existence of shift contagion, the MS-VAR models and multivariate version of unconditional correlation tests are applied. The econometric procedure takes into account the endogeneity of variables, non-linear linkages, heteroskedasticity, simultaneous equations and sample selection bias. Those problems have not yet been handled altogether in any single work on this topic. This, therefore, enhances the robustness of the research's empirical results.

With respect to the analysis of cross-border banking and contagion, this thesis appears to be the first to use the recursive bivariate probit model and the first to test the hypothesis of the sudden stop in international lending and the simultaneous effect of the sudden stop on the interbank market tensions in host countries. The base regression technique which has been widely used in the literature is subject to model uncertainties due to the nonlinear nature of international capital flows, as verified by low R^2 in the estimated results in many empirical papers. In other words, it fails to capture the distribution of probabilities of extreme events. The econometric models applied in this study fit the nature of the data as well as the research objective and brings about new findings.

Regarding to the assessment of the second round effects, the partially adjustment models and dynamic panel data techniques with system Generalised Method of Moments (GMM) estimation is utilised to model the adjustment in four dimensions of bank performance, i.e. asset quality, profitability, capital buffers and lending behaviour. This study adds more value to the thesis because it bridges the gaps from the literature by focusing on microeconomic conditions and institutional factors in shock propagation across countries as well as modelling many dimensions of bank behaviour. Additionally, the econometric method is considered to be preeminent in handling omitted variables, endogeneity, fixed effects, persistent series and dynamic panel bias.

Finally, the findings from this research have a lot of useful implications for central banks and financial regulators to contain the systematic risk and prevent the next crisis from happening. Moreover, this will also underpin the rationale of portfolio diversification for international investors.

1.4. Structure of the Thesis

The structure of the thesis is as follows.

Chapter two reviews macro-financial strengths and vulnerabilities in East Asia, which provides the background to analyse regional responses to shock and contagion effects in the following chapters. It starts from East Asia economic conditions before the outbreak of the 1997-1998 crisis and clarify how financial liberalisation generated regional vulnerabilities. Next, the causes and consequences of the financial crisis in 1997-1998 is analysed, basing on theoretical models of currency crises and international financial contagion framework. Discussion on economic and financial reforms after the crisis follows. Despite the remarkable recovery and strong fundamentals, the region has still faced some challenges associated with globalisation and liberalisation which connect those countries to the rest of the world. This kind of cross-country linkages has created different transmission mechanisms to propagate global shocks to East Asia.

Chapter three examines the first transmission mechanism, asset price volatility linkages, which address research questions 1a and 1b. The MS-VAR framework is used to model dynamic volatilities and volatility spillovers from the US and Europe to East Asian equity, foreign exchange and sovereign debt markets. Then, the multivariate version of unconditional correlation test is applied to evaluate whether this type of asset price linkages and volatility transmission is a consequence of interdependence or "shift-contagion" caused by investor behaviour.

The econometric testing is based on time series data of weekly stock returns, foreign exchange rates and changes in sovereign CDS spreads.

Chapter four extends the empirical evidence on investor-based contagion, especially the role of international banks in cross-border shock transmission in loan provision. This chapter will seek convincing explanation for research questions 2a, 2b and 2c. Firstly, using Bank for International Settlements (BIS) banking statistics, it characterises the evolution of cross-border banking activities in East Asia and the potential vulnerability to contagion. Then, the univariate and recursive bivariate probit models are employed to empirically test the hypothesis of the sudden stop in international lending and the links between the sudden stop and the interbank market tensions in host countries. We also quantify the marginal effects of global and country-specific risk factors on the probability of a sudden stop and liquidity shock transmission.

Chapter five 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 on East Asian economies. Applying partial adjustment model and system GMM estimation, this chapter provides an econometric analysis of bank behaviour in times of sudden change, capturing both the size and direction of balance sheet adjustments in interactions with shocks in the financial system and economy as well as international contagion effects. The estimation procedure is based on a panel of 174 commercial and investment banks and bank-owned companies from eight East Asian countries over a period from 2003 to 2011. The findings help answer the research questions 3a, 3b and 3c.

In Chapter six, the main empirical findings are summarised and the policy implications discussed. The limitations of the work will be noted and areas for further research suggested.

CHAPTER TWO – MACRO - FINANCIAL STRENGTHS AND VULNERABILITIES IN EAST ASIA: FROM THE 1997-1998 REGIONAL CRISIS TO THE 2007-2011 GLOBAL CRISIS

2.1. East Asian Economic Performance, Financial Liberalisation and the 1997-1998 Financial Crisis

2.1.1. East Asian Economic Performance and Financial Liberalisation before the 1997-1998 Financial Crisis: A Brief Review

Referred to as one of the great success stories in the history of economic development, East Asia started its episode of rapid and sustained economic growth in the 1960s. Radelet et al. (1997) provide four reasons which explain the spectacular growth in East Asia relative to other countries/regions: (i) their economies had substantial potential for catching up as they entered the 1960s with low incomes[9] and relatively well-educated workers; (ii) their geographical and structural characteristics were by-and-large favourable (i.e. they are located on the

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[9] In Radelet et al. (1997), the basic growth framework which is based on neoclassical growth models predicts conditional convergence of income, i.e. an initially low income (relatively to its own long-run potential level) country will grow faster than those that are already closer to the long-run potential level of income. The basic model is expressed as follows:

(1) $\log\left(QL_t^i\right) = a + bZ_t^i$ (The logarithm of the long-run steady-state level of output per worker, QL_t^i depends on policy and structural variables of time t denoted as Z_t^i).

(2) $\frac{dlog(Q_i^t)}{dt} = c\left[\log\left(QL_t^i\right) - \log\left(Q_t^i\right)\right]$ (The growth rate of output per worker, dlog(Qi)/dt is proportional to the gap between long-run level and current level of output).

(3) $\frac{dlog(Q_i^t)}{dt} = a' + b'Z_t^i - clog\left(Q_t^i\right)\ where\ a' = ac\ and\ b' = bc$

Equation (3) derived from (1) and (2) describes that current growth rate of output per worker is a function of structural and policy variables Z_t^i and the current level of output, Q_t^i.

This model helps to explain why wealthier countries, with relatively large capital stocks and already operating near the world's technological frontier, tend to grow more slowly than low-income countries that are catching up with the leaders.

coast) ; (iii) the demographic transition following World War II worked in favour of more rapid growth (i.e. declining fertility rates, favourable trends in literacy and education and public health policies which raised life expectancy); and especially (iv) their economic policies with export-led growth strategies were thoroughly implemented via the establishment of export processing zones, duty exemption schemes, incentives packages for FDI, convertible currencies and macroeconomic stabilities. During the period from 1965 to 1990, the twenty three economies in East Asia grew faster than those of other regions. The achievement was attributable to the eight best-performers: Japan, Hong Kong, Singapore, Korea, Indonesia, Malaysia and Thailand, who experienced average growth rates of over 5.5% per year in per capita terms between 1965 and 1990, while over the same period the growth in high-income economies was only 0.8% and that of all low and middle-income countries was merely 0.4% (Page, 1994). Table 2.1 shows information on the growth of GDP, exports and living standards in seven East Asian countries. It is indeed remarkable that some countries achieved double digit growth rates for both GDP and aggregate exports in the 1990s. Over the 16 year period from 1980 to 1996, the total exports of Thailand, Indonesia, Malaysia and Korea increased from US$ 68 billion to US$ 361 billion, raising the share of these four countries in total exports from 2.8% to 5.4%, and in total exports of EMEs from less than 11% to more than 22% (Dholakia, 1998).

This sustained and rapid economic growth resulted in large-scale reductions in poverty and considerable improvement in living standards across countries, which earned the region the reputation as an "East Asian Miracle" (Page, 1994). By the mid-1990s, the region succeeded to a large extent in eradicating poverty, represented by a significant decline in poverty ratios, especially in Thailand, Indonesia, Malaysia and Korea. Within the comparisons of growth rates and Gini coefficients, the World Bank (1997) demonstrated that the distribution of income was substantially more equal in all high-performing Asian countries and improvements in income distribution coincided with a period of rapid growth.

Table 2.1 - Growth of GDP, exports and living standards in East Asian countries

	HK	SG	KR	ID	ML	TL	PH
Exports (annual %)							
1980	12.27	22.95	8.15	5.53	3.17	7.71	39.82
1990	8.26	12.92	4.45	3.36	17.82	13.39	1.86
1992	17.68	7.22	12.21	13.71	12.6	13.81	4.28
1995	10.01	22.06	24.39	7.72	18.96	15.44	12.04
GDP (annual %)							
1980	10.31	10.05	-1.49	8.72	7.44	5.11	5.15
1990	3.9	12.11	9.16	9	9.01	12.17	3.04
1992	6.09	7.03	5.88	7.22	8.89	8.08	0.34
1995	2.29	7.28	9.17	8.4	9.83	9.24	4.68
Per capita income ($US)							
1980	5,691	4,913	1,674	517	1,802	681	689
1995	23,428	22,922	11,467	1,013	4,287	2,816	1,070
Poverty ratio (%)							
1965			40	60	49	57	
1995			5	14	9	13	

Source: World Bank-World Development Indicators

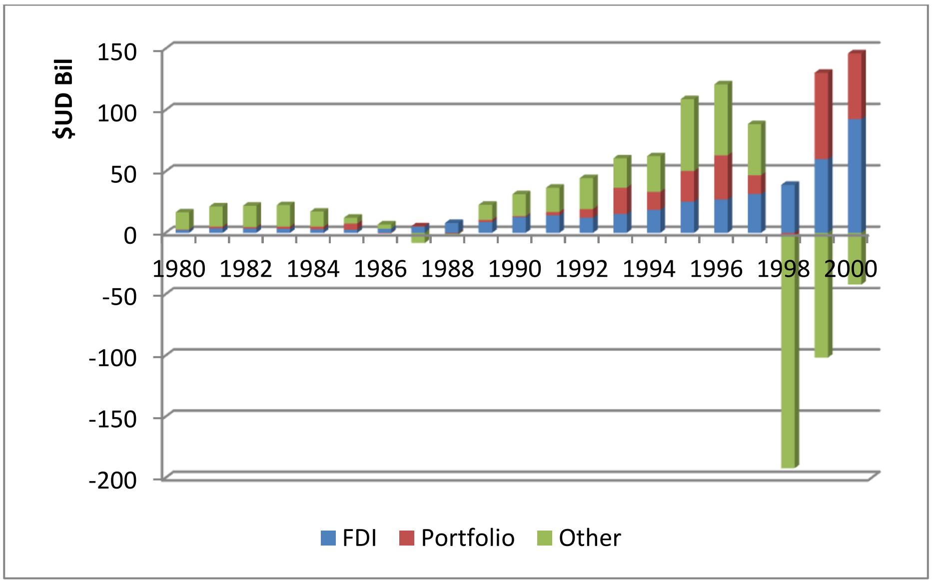
Furthermore, East Asia enjoyed a sustained development path with considerable macroeconomic stability. In the period from 1994 to 1996, many countries in the region displayed low inflation, fiscal surpluses or balances, limited public debt (except Thailand and Korea) and substantial foreign exchange reserves. The most notable feature of East Asian growth was a significantly high rate of investment. Gross domestic investment grew by over 15% per year in Malaysia, Thailand, Indonesia and more than 7% in Korea between 1990 and 1996, while this figure in the US was 4.1% and in other high-income countries only 0.8% (Dholakia, 1998). To sustain such high levels of investment, the governments encouraged domestic savings through a variety of interventionist schemes[10]. However, there was still significant gap between the domestic saving rate and aggregate investment rate as domestic savings lagged behind high investments. Therefore, East Asia countries had to turn to external resources (i.e. international capital inflows). The large scale of flows of capital was not only accelerated by the pursuance of financial market deregulation and liberalisation since the late 1980s but was also encouraged by a credible pegged exchange rate regime. Together with a trade openness-oriented policy, the ongoing financial integration process made these economies more closely linked with the rest of the world through cross-border financial transactions and the associated rapidly increasing capital mobility.

In 1990, total net capital flows to EMEs were about US$ 50 billion, half of which went to Asia (Ito et al., 1999). While the majority of capital flows to China were in the form of direct investment, most of the flows to East Asia took the form of bank credit, mainly concentrated either in areas with high volatile returns (stocks and real estates) or in areas with substantial capacity. Figure 2.1 shows the net capital inflows in seven East Asian countries (Hong Kong, Singapore, Indonesia, Malaysia, Philippines, Korea and Thailand) during the period 1980-1996, highlighting the dominant proportion of banking flows, i.e. trade credit and loans. Lending by foreign banks accounted for 60% of the 1996 private capital flows to Thailand, Indonesia, Malaysia, Philippines and Korea, a major part of which were short-term credits. This made those economies become large borrowers in international

[10] Governments in East Asia countries applied a variety of interventionist mechanisms to stimulate domestic savings: encouraging postal savings systems (Korea and Malaysia), forcing high private savings through mandatory provident fund contributions (Malaysia and Thailand), and stringent controls on consumer loans and high taxes on luxury consumption (Korea, Malaysia and Thailand) (Dholakia, 1998).

capital markets. Foreign banks were also provided greater freedom of entry in those countries.

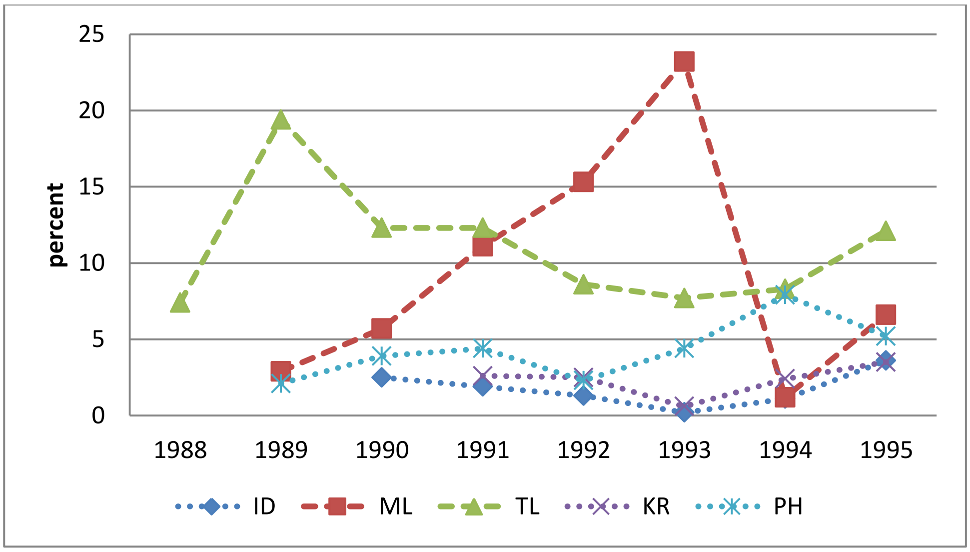
Figure 2.1 – Net capital inflows to East Asia



Source: IMF-BOPS

Notes: Net capital inflows refer to net incurrence of liabilities. A positive sign indicates an increase in liabilities, and a negative sign indicates a decrease in liabilities. Other flows consist of bank loans, trade credit and other investments.

Figure 2.2 – Net capital flows to GDP in selected East Asian countries



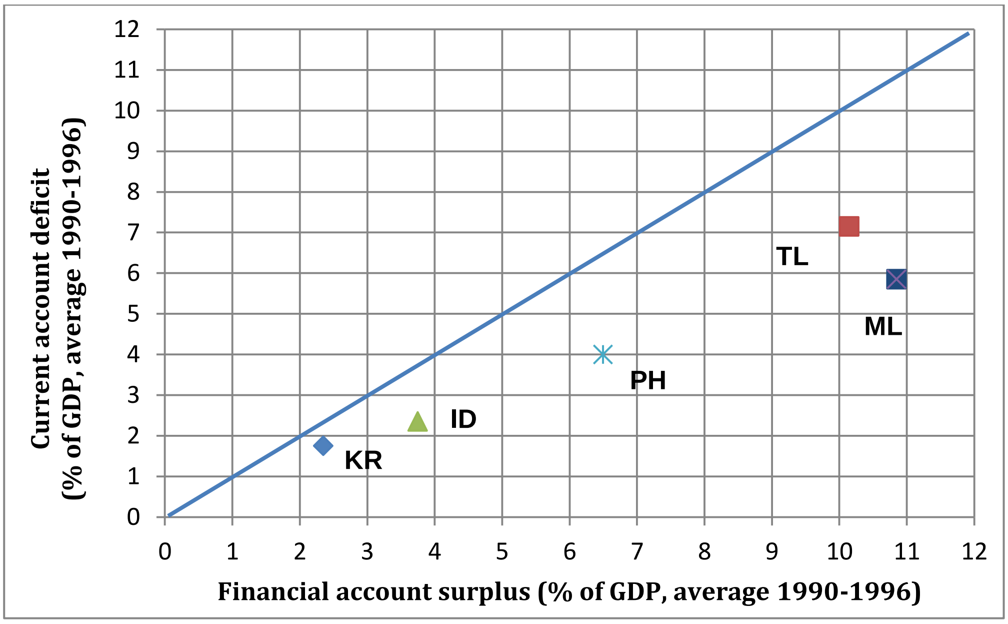
Source: Ito et al. (1999)

Relative to the size of recipient economies, Malaysia (1991-1993) and Thailand (1989-1995) received the largest net capital inflows, exceeding 10% of GDP[11] (Figure 2.2). Indonesia, Korea and Philippines also attracted increasing capital, although their size in ratio to GDP did not reach the levels of Malaysia and Thailand. In 1996 alone, total net capital flows into these five countries (Asian-5) amounted to a staggering US$ 70 billion (Claessens et al., 2000). Although capital flows are essential for sustaining economic growth in host countries, the high intensity of capital flows brings about severe macroeconomic problems, especially local currency appreciation, which will weaken a country's price competitiveness and export industries. This kind of risk substantially threatened East Asian countries as most of them had current account deficits, especially Thailand and Malaysia (Figure 2.3). Moreover, many East Asian countries also revealed some structural weaknesses both at macroeconomic and microeconomic levels. One of the most serious challenges was that Thailand, Indonesia and Korea accumulated substantial short-term and foreign-currency denominated debts, exceeding 100% of official reserves (see Table 2.2). With large levels of foreign debt, mainly intermediated through the banking system to private sectors, domestic banks engaged in overlending and domestic firms engaged in overinvestment, departing from profit maximisation objectives (Dickinson and Mullineux, 2001). This was aided by the lack of effective risk management, prudential supervision and regulatory structures, which made the financial system even more fragile. These underlying fundamental problems triggered a downward expectation from private sectors, causing the sudden withdrawal of funds and precipitated a speculative

[11] Capital inflows of this magnitude are difficult to manage (Khan and Reinhart, 1995; Folkerts-Landau and Ito, 1995)

attack on the Thai baht, eventually pushing the regional economy into a dramatic financial meltdown with serious economic, social and political consequences.

Figure 2.3 - Capital flows vs. current account deficits in East Asia



Source: IMF – International Financial Statistics (IFS)

Table 2.2 – Ratio of short-term debt to official reserves (%)

	1990	1991	1992	1993	1994	1995	1996
TL	58.3	67.8	69.5	89	96.4	119.4	110.3
ID	130.7	139.7	158.5	145.6	147.4	175.6	167.2
KR	72.9	81.6	69.5	60.2	123.1	142.5	195.4
ML	19.3	18.8	21.0	25.4	24.2	30.4	40.8
PH	216.2	109.2	98.5	85	80.3	67.9	67.9
HK	23.4	21.7	18.2	17.2	16.4	16.4	22.2
SG	2.7	2.7	2.3	2.0	1.7	1.8	2.6

Source: Asian Development Bank (ADB)-Key Indicators (2001).

2.1.2. The Financial Crisis of 1997-1998

The Asian financial crisis of 1997-1998 was a totally unanticipated event, which challenged the "Miracle Asian" models of economic development and implied some limitations from the first and second generation models of currency crises[12]. In mid-summer 1997, a half century of regional economic progress came to a crashing halt (Jackson, 1999). The crisis originated in the increasing pressures on the Thai economy in the first half of 1997, including an unsustainable current account deficit; a significant appreciation of the real effective exchange rate; deteriorating fiscal balances; remarkably visible weakness in the financial sector which faced currency and maturity mismatches and financial companies with wide exposure to the real estate sector. Under these pressures, the Thai baht was floated on July 2, 1997 and the crisis was quickly spread over the East Asian region, then on to other EMEs (Russia and Brazil) and even had some effects on developed markets in Europe and North America (Claessens and Forbes, 2004). Between June 1997 and the end of the year, the average currency depreciation in the twelve largest EMEs was as high as 39%, while in the four hardest hit countries (Thailand, Indonesia, Malaysia and Korea), the average increase in dollar rates was more than 80%. Although the crisis started from some fundamental weaknesses and financial sector problems in Thailand, it was the cross-border financial linkages that exacerbated it and exposed the region to full-fledged financial panic. Following Thailand, Indonesia and Korea had to enter an IMF rescue package, and even other East Asian countries that did not need recourse to IMF assistance faced severe downturn and recession. It became quite apparent that East Asian economies were

[12] The first generation models built up from the founding work of Krugman (1979) and Flood and Garber (1984) identify a speculative attack arising from the run on foreign reserves, and the exchange rate crisis is in fact punishment for inappropriate macroeconomic policies, such as exchange rate commitment and budget deficit monetisation.

The second-generation models are based on the potential non-linearity in the policy reaction function, which happens when governments react to the changes in private behaviour or when they face an explicit trade-off between fixed exchange rate policy and other objectives. In this circumstance, crises could be driven by self-fulfilling expectations as the costs of defending fixed exchange rates may themselves depend on anticipations that the currency peg will be maintained.

inextricably linked to each other and the speed of contagion was totally unexpected.

In fact, the crisis phenomenon was believed to be a consequence of insufficient institutional development during the "miracle" boom, as well as the inevitable outcome of financial liberalisation associated with the massive cross-border capital inflows (Corbett et al., 1999). The crisis included several interlinked phenomena, which can be disentangled by in-depth analysis guided by conventional theories of currency crises and the literature on international financial contagion.

The third generation model was a good response to Asian crisis, which joined the monetary crisis and the fragility of the financial sector and contagion effects from other countries. One strand of third generation models focuses on moral-hazard problems associated with governments' guarantees for financial sectors' liabilities (Mackinon and Pill, 1996; Dooley, 1997; Krugman, 1998; Corsetti et al., 1998). Under this framework, the Thai crisis was viewed as an "insurance crisis" arising from disequilibria caused by moral hazard problems. Like Thailand, other East Asian countries experienced massive international capital inflows in the 1990s, which were translated into rising domestic credit as a consequence of explicit and implicit public guarantees on investments. Given the frangibility of financial sectors caused by the lack of transparency, inadequate disclosure and supervisory standards, and poorly managed financial liberalisation, the guarantees and "crony capitalism", led banks to engage in moral-hazard lending, overindebtedness and the excessively raising of NPL. Implicit government guarantees also encouraged firms to make excessively risky investments departing from profit maximisation objectives. Moreover, much of the bank lending was poured into non-tradable assets (for example, real estate), creating a financial bubble preceding the crisis. When the bubble burst because of low and declining returns on investment, banks' collateral, which were already subject to sharp value falls, generated further asset sales and a consequent collapse in asset prices. This in turn resulted in financial health deterioration in banking and corporate sectors. Therefore, there were always interactions between banking problems, asset price damage and currency crisis. In Krugman (1998), moral hazard and asset prices were main contributors to expose Asia to speculative attacks.

The alternative strand of third generation models explained Asian financial crisis arising from the self-fulfilling panic on domestic private liquidity (especially in Thailand and Indonesia). Chang and Velasco (1998) extended the Diamond-Dybvig (1983) models of bank run to emphasize on the illiquidity of the domestic financial system as a centre of problem in an open economy with unrestricted capital markets. As the credit channel is especially important in bank-dominated financial system in Asia, international capital inflows with a significant proportion of short-term borrowings were intermediated by domestic banks into less liquid long-term lending to firms. This increased currency and maturity mismatches in banks' balance sheets. When the banking sector got into trouble, the currency became vulnerable. Hence, the beginning of the banking crisis was triggered by the self-fulfilling expectations of creditors before the Thai baht crisis. More specifically, the crisis hit when speculators anticipated the reversal of capital inflows in the near future because the private sector would be unable to service its debts. As capital inflows were supporting the pegged exchange rates, once they stopped the government would run out of foreign reserves. The currency crisis was effectively that of the first generation currency crisis model, but driven by the unsustainable banking sectors which created the adverse expectations of capital flows.

The severity and deepening of East Asian financial turmoil were exacerbated by financial contagion. First, there were monsoonal effects of common shock (Baig and Goldfajn, 1998). The depreciation of the Japan yen vis a vis the US dollar since mid-1995 and some deterioration in terms of trade (as manufactured exports began to be commoditised in the context of excess worldwide supply) led to the overvaluation of domestic currencies in East Asian countries. Not only did the Asia-5 have significant trade relationships with Japan and US (Table 2.3), with Japan in particular accounting for one-third of total imports to Thailand, but East Asia products competed directly with Japanese products in global (mostly US) markets. The depreciation of the yen deteriorated East Asian export competitiveness, which contributed to export slowdown and consequently worsened their current accounts. Together with these external shocks, the intra-regional trade linkage structures contributed competitiveness deterioration, currency depreciation and spillover effects.

Table 2.3 - Export share of the Asia-5 in 1997 (as percentage of total exports)

	TL	ML	PH	ID	KR	US	JP
TL		4.6	1.2	2	1.8	19.8	15
ML	3.7		1.3	1.5	3.2	18.3	12.4
PH	2.4	3		0.4	1.8	34.7	16.1
ID	1.7	2.4	1.4		7.1	16.3	24.7
KR	2	3.1	1.6	2.9		16.6	10.6

Source: Baig and Goldfain (1998)

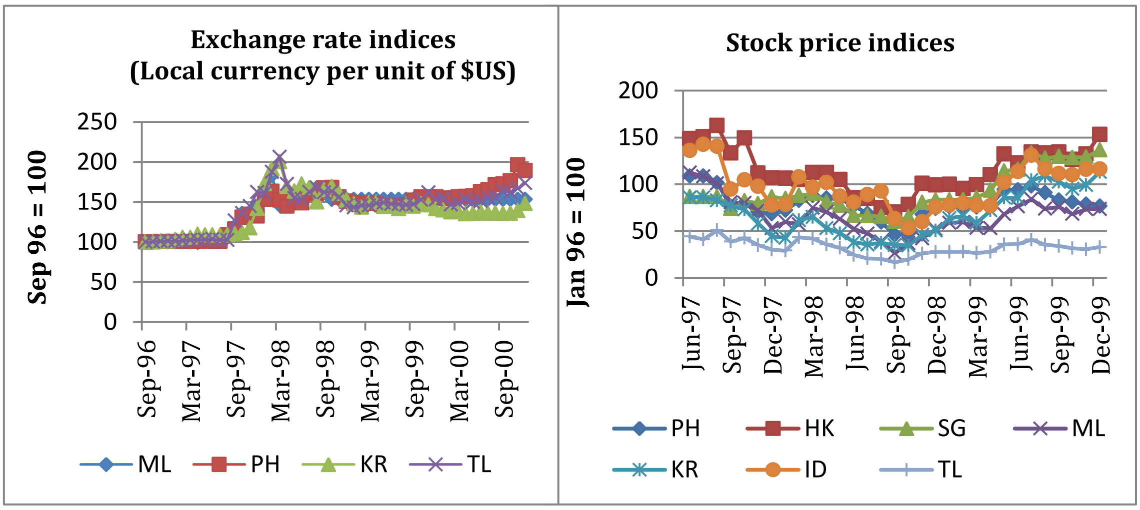
Almost immediately after the Thai baht lost roughly 15% of its value against the U.S. dollar on July 2, 1997, the values of other East Asian currencies fell precipitously. The Philippine peso was allowed to freely float on July 11; the

Malaysia ringgit peg was abandoned on July 14; the Indonesian rupiah was to float on August 14 and the Korea exchange rate band was officially abandoned on December 4 and moved to a floating system in mid-December. The Sigapore dollar did not escape unscathed either, although it held its value better than other currencies. In Hong Kong, the monetary authorities had to raise interest rates to defend its currency board after the Hong Kong dollar was tested in late October, leading to sharp fall in the Hang Seng index. This generated a shock wave around global financial markets and depressed stock prices in both Europe and the US on October 27, with reverberating effects again on East Asia.

The simultaneous falls in exchange rates and asset prices (Figure 2.4) reflected the massive capital outflows. This was shown by the stylised facts that after peaking at a tremendous US$ 96 billion of capital inflows in 1996, 1997 saw a reversal of US$ 105 billion, equivalent to 11% of the combined GDP of the Asia-5. This represented "the most significant geo-financial adjustment in the relatively new era of globally integrated capital markets" (Makin, 1999, p.408). As the financial linkages in the region were substantial through bank loans, there was a significant share of capital reversals relating to the recalling of loans and the cutting off of credit lines in the region from its common lender, Japanese banks. International banks from the US and Europe also considered rebalancing the overall risks of their portfolios by reversing bank credits from the region, causing the transmission of shocks. The cut and run of international investors was also a consequence of the transmission of information about the financial health of financial and corporate sectors in economies with a similar structure and the panic reactions of international investors (Radelet and Sachs, 1997, 1999, 2000; Krugman , 1999). When the crisis started in Thailand, investors looked more critically at vulnerabilities elsewhere in the region and discovered the same problems of financial health and short-term external debts in Indonesia, Malaysia, and Korea. The new information amplified their concerns and when investors lost confidence, they decided to pull their investments out of these countries.

The crisis continued to have global effects when Russia decided to devaluate the ruble, and was then forced to reschedule its domestic government debts on August 17, 1998. As a number of highly leveraged investors, including hedge funds, who traded the assets in Russia incurred large losses, the Russian crisis was felt in EMEs. Following this event, Latin America financial markets encountered severe stress in September and October. In January 1999, Brazil imposed a forced devaluation on the real, while other Latin American countries such as Mexico, Argentina, Venezuela, Chile, Colombia and Ecuador also suffered direct or indirect effects. The Federal Reserve Bank of New York had to organize a private rescue, accompanied by a reduction in US interest rates, to help avoid a systemic global crisis.

Figure 2.4 - Exchange rate indices (monthly average) and Stock price indices



Source: Datastream

2.2. Macro-Financial Strengths and Vulnerabilities before the Global Financial Crisis of 2007-2011

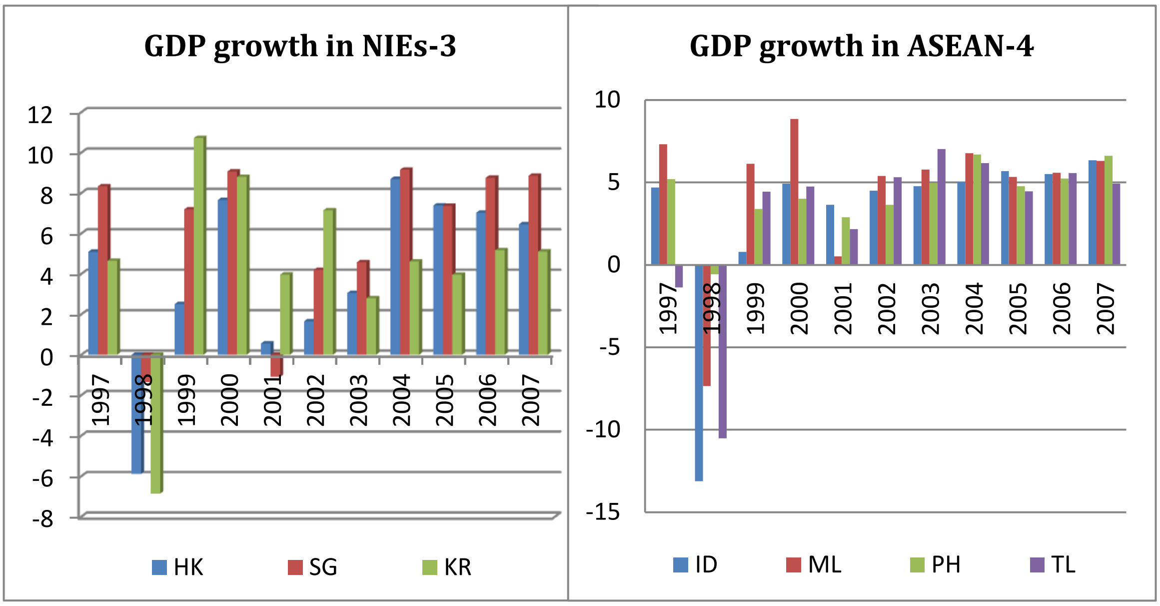
2.2.1. Macroeconomic and Financial Developments

A decade after the financial crisis of 1997-1998, East Asian economies showed a buoyant recovery thanks to prudent macroeconomic policies and efficient financial reforms. At the beginning of the crisis, immediate measures were taken by central banks, including direct intervention through the sale of US dollars on the exchange market, the widening of the trading band for national currencies against the US dollar, the raising of short-term interest rates and the curbing of forward foreign exchange transactions. However, these measures could not restore confidence in local currencies. After the crisis, the Asia-5 were forced to abandon their exchange rate pegs and adopted a managed floating exchange rate system. Exchange rates are now determined by market forces. One of the most important reforms was financial restructuring as this was the root of the fundamental weakness which caused the crisis. Financial reform focused on restructuring financial institutions in compliance with the Basel capital adequacy requirement, closing problem banks and financial companies, reducing NPL, encouraging mergers and acquisitions, establishing the Best Practice Guidelines, and strengthening bank regulation and supervision. Realising the adverse effects of short-term capital flows on the banking system, stock and exchange markets, East Asian countries paid attention to regulating and monitoring short-term capital movements, discouraging massive inflows of hot money, and relying more on foreign direct investments and long-term foreign loans to meet private financial requirements.

2.2.1.1. Macroeconomic Developments

Ten years after confronting the reforms needed to rebound from the crisis, East Asian experienced relative macroeconomic stability. Economic growth recovered from a deep decline in 1998, with average 5-6% annual GDP growth between 1999 and 2006 (see Figure 2.5). Compared to the period before the regional financial crisis of 1990-1996, GDP growth had slipped by an average 2.5% per year in the Asian-5 (Wang, 2008). The slower rates of real GDP growth in the post-crisis period were partly due to the sluggish recovery in fixed investments, which were around 5-20% below 1997 levels (Khor and Kit, 2009).

Figure 2.5 – Annual GDP growth rates in ASEAN-4 and NIEs-3



Source: IMF-WEO

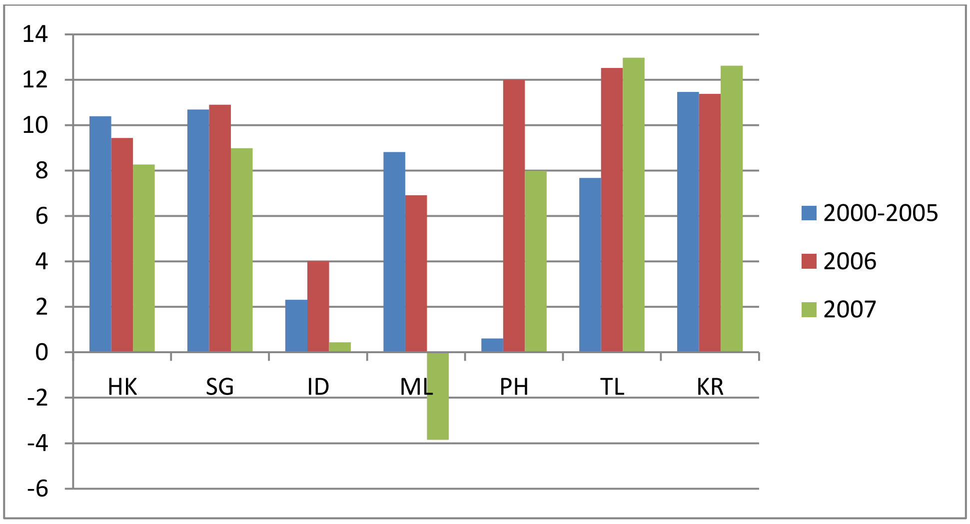
Table 2.4 provides evidence about the decline in investment rates (gross-fixed capital formation to GDP) in all the crisis-hit countries. However, the lower rates of investments may not necessarily be bad. Instead, it reflects a reasonable adjustment from the high and unsustainable rates built up before the crisis in non-productive sectors. In 2007, prior to the global financial crisis, GDP growth remained strong throughout East Asia, at around 7.4%, despite the US-led global slowdown. Real per capita incomes significantly exceeded pre-crisis levels, around 75% higher in emerging East Asia (World Bank, 2007).

Table 2.4 - Gross fixed capital formation to GDP ratios

	1990	1995	2000	2005	2005/1995
TL	40.4	41.6	22.0	29.0	-30.3
ID	28.3	31.9	19.9	23.6	-26
ML	33.0	43.5	25.6	20.0	-54
KR	36.9	37.0	28.2	-30.1	-18.6
PH	23.1	21.6	21.2	14.9	-31
SG	32.9	33.7	30.6	22.3	-33.8
HK	26.1	34.8	26.4	20.9	-40

Source: Bhaskaran (2009)

Figure 2.6 – The growth of exports of goods and services



Source: IMF-WEO

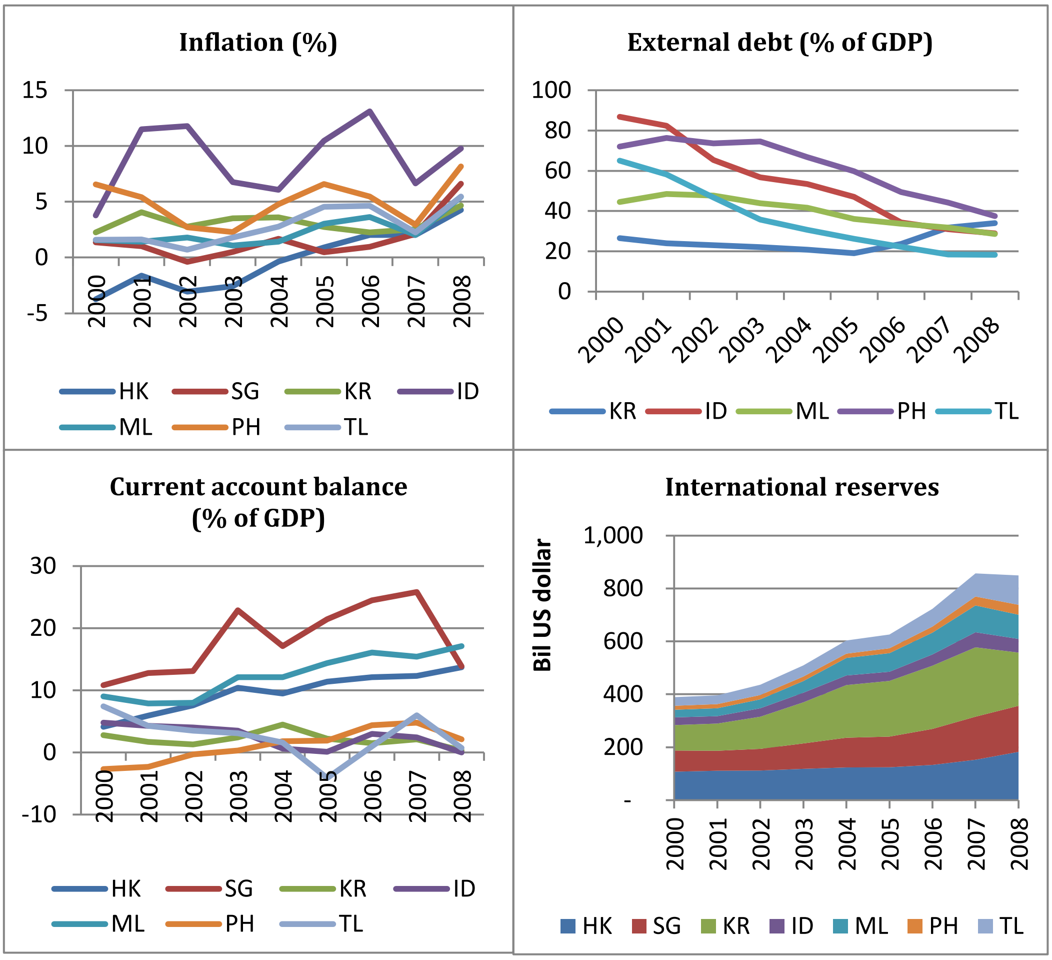
Trade performance also improved, characterised by rapid trade growth and a steady increase of their share of world trade. Some countries, such as Thailand, Korea and Singapore, even achieved two-digit growth rates of export of goods and services from 2000 to 2007. Merchandise exports increased from 34% of GDP in 1995 to 42% in 2005, and overall share of world exports continued to rise, from

15.5% in 1995 to 17.9% in 2005. Including China, East Asian trade accounted for around 40% of the total increase in world trade over the period. This export-oriented strategy is key to understanding economic growth in the region. There was also a structural shift from lower-end products to a more diversified export base.

One of the prominent records in macroeconomic performance in East Asia after the 1997 crisis are the shifts in current accounts from deficits to surpluses and the large build-up of foreign exchange reserves. The regional current account reached 7.1% of GDP in 2006 (World Bank, 2007). Reserves were even far exceeding the proposed optimal levels for precautionary purposes, i.e. reserves stood well above the 100% ratio recommended by the Greenspan-Guidotti rule for reserve management[13]. By mid-2007, reserves levels exceeded 100% of short-term external debts in most economies. However, large balance of payment surpluses and reserve accumulation may yield the potential adverse impact of exchange rate appreciation on competitiveness, exports and employment. By intervening in foreign exchange markets, most economies in the region have resisted upward pressure on exchange rates. For example, Malaysia (and China) widened the band for their currencies in 2005 and other countries have gradually moved towards greater exchange rate flexibility.

[13] See Jeane and Ranciere (2006) regarding the optimal level of international reserves for EMEs.

Figure 2.7 – Macroeconomic performance in East Asia



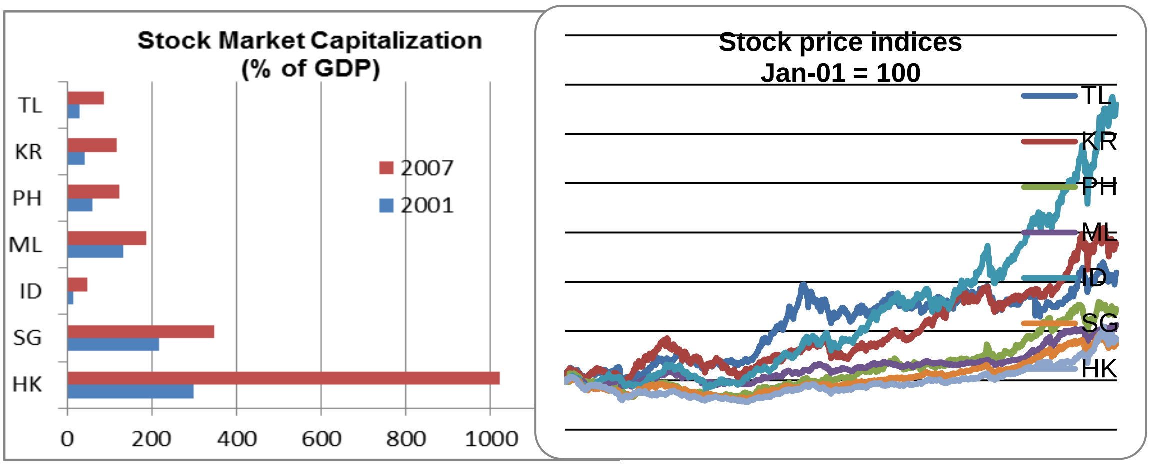
Source: ADB statistics

Additionally, the government fiscal positions were healthy and there was declining trends in government debts as a percentage of GDP. Indeed, some countries such as Hong Kong, Singapore, Korea and Thailand were enjoying budget surpluses by 2007. The 2000s also saw successful monetary policy manipulation in terms of bringing inflation under control. Central banks in many East Asian countries focused clearly on maintaining price stability and some adopted formal inflation targeting regimes. Core inflation behaved well, and even headline inflation was low and stable in Korea, Malaysia, Philippines and Thailand. In Indonesia, there was a significant drop in inflation from 13% in 2006 to 6% in 2007. Additionally, the region as a whole experienced a general narrowing of the dispersion of private sector inflation forecasts and inflation expectation stability, even during the crisis (Filardo et al., 2009). Price stability helped weaken the pass-through effects of exchange rates to domestic prices and allowed central banks to pursue greater exchange rate flexibility. Figure 2.7 provides some stylised facts concerning the macroeconomic condition in East Asia countries from 2000 to 2007, which imply a relatively robust performance in many aspects before the breakout of the global financial crisis in 2007.

2.2.1.2. Financial Reforms and Developments

The financial sector has undergone dramatic restructuring since the 1997 crisis, which has brought about substantial changes in the size, diversity, efficiency and stability of capital markets and banking systems. According to the World Bank (2007), total assets of East Asian financial systems reached US$ 9.6 trillion in 2005, over one fifth the size of US markets and almost half of that of Japan. Stock markets in seven East Asian countries have been booming since 2001, both in market capitalisation and asset prices. As shown in Figure 2.8, stock market capitalisation as a ratio to GDP doubled or tripled in most countries during the period 2001 to 2007, except for Singapore and Malaysia, who saw less significant increases. The growth was most spectacular in Hong Kong, which made it into the global top ten countries in terms of market capitalisation. By the end of 2007, the average stock market capitalisation in Asia-5 was about 126% of GDP, which is quite comparable to that of AEs. Market liquidity also increased substantially, with an overall dollar turnover rising by 150% during 2002-2006. New capital raised through initial public offerings, IPO and secondary share offerings also reported a major jump, rising to US$ 86.2 billion between January and November 2007. Accompanied with sizable expanded markets, price performance was no less impressive. Over the period 2001-2007, stock prices rose over 100% on average. Data on price/earnings (P/E) ratios (Table 2.5) indicate that East Asian equity markets were not overpriced. The rise in stock prices reflected a solid increase in corporate profits rather than pure speculation. The stability of P/E ratios indicates the strong performance of East Asian corporates over the period and these trends continued in 2007 and the second half of 2008.

Figure 2.8 - Stock market capitalisation and price indices, 2001-2007



Source: Datastream and ADB statistics

Table 2.5 – Stock market development in East Asia

	New Capital Raised by Shares Jan - Nov, 2007 (in $US billion)			Price/Earnings Ratios 2002 -2006				
	Total	IPOs	Secondary	2002	2003	2004	2005	2006
HK	61.0	31.8	29.2	15.6	19.0	18.7	15.6	17.4
SG	8.8	4.5	4.3	21.2	24.9	16.6	15.4	19.4
KR	6.5	3.1	3.4	15.2	10.1	15.8	11	11.4
ID	4.5	1.5	3.0	33.1	10.8	9.7	12.5	14.7
ML	2.1	0.3	1.8	14.9	31.7	20.0	15.2	24.2
PH	1.9	0.4	1.5	14.4	19.2	18.3	14.8	14.6
TL	1.4	0.3	1.1	7.0	7.0	9.4	9.4	8.1
Total	86.2	41.9	44.3					

Source: Pakravan (2008)

Surging asset prices increase investors' nominal wealth, boost consumer confidence and higher spending, and improve firms' and banks' balance sheets, which will in turn lower external finance premiums (EFP) and encourage corporate investment via the so-called "financial accelerator effect". Empirical research shows that the wealth effect of asset prices plays a significant role in emerging Asia (Kuralbayeva et al., 2006). However, booming asset prices also bring about challenges of financial and economic volatility, thus threatening macroeconomic stability. In general, East Asian equities markets were assessed to be relatively stable compared with those of other regions, but there was cross-country heterogeneity. SG's was considered the most stable market, followed by Hong Kong and Malaysia, while Indonesia, Philippines, Thailand and Korea were assessed to be the least stable (World Bank, 2007)[14].

Bond market development was prioritised and various national and regional initiatives (e.g. Asian Bond Market Initiative-ABMI and Asian Bond Fund-ABF) were implemented to remove impediments to the issuance and trading of local currency bonds. Bonds outstanding for the region as a whole saw a sizeable growth from US$ 0.4 trillion in 1997 to US$ 1.5 trillion in 2006, albeit with considerable variation across countries. The Korea bond market is relatively large, representing around 112% of GDP. The Malaysia market has been growing for years thanks to significant improvements in its regulatory framework, insurance process and market transparency. However, the Philippine bond market has yet to blossom.

[14] According the World Bank (2007), cross-country analysis suggested that in the sample of 100 economies worldwide, SG's securities market fell in the highest (most stable) quartile, followed by HK and ML in the second-highest quartile. ID, PH, TL and KR fell in the bottom quartile.

Much of the growth in bond markets was accounted for by government bonds (largely to restructure the banking system), while corporate bonds remain quite a small proportion of the overall market (Table 2.6). Corporate bonds have been led by high-quality borrowers such as quasi-government entities. Lower-quality borrowers (i.e. those with credit ratings below single –A) have been unable to access the domestic markets, instead relying on banks and foreign currency bond markets. The key reason for small and underdeveloped corporate bond markets in most of the countries in the region is the lack of liquidity in the secondary markets and the difficulties in pricing the default risks of potential issuers. For example, in Philippines corporate bonds are over-the-counter (OTC) or privately negotiated between sellers and buyers. There is no available information about trading volumes, turnover, settlement, pricing or distribution. The absence of transparency, legal issues and creditworthiness of issuers also impede bond market development. Moreover, in emerging East Asia, heavy reliance on FDI financing as well as high repatriation risks associated with stringent capital controls and uncertain exists leave limited room for domestic bonds to thrive. They are also the main reason for restricted foreign participation in East Asian local currency bond markets. Table 2.7 reveals sharp increases in US holdings of East Asian bonds over the period 2001-2006. However, it is much smaller than that of Latin America[15] and emerging Europe[16], averaging 0.35% (for emerging Asia in general), compared to 2.03% and 0.71%, respectively.

[15] Latin America: Argentina, Brazil, Chile, Colombia, Mexico, Peru and Venezuala

[16] Emerging Europe: Croatia, Czech Republic, Hungary, Poland, Russia, Turkey and Slovakia

Table 2.6 - Bond markets in East Asian countries

Countries	Bonds outstanding (% of GDP)		Value traded ($US billion, in 2005)		Turnover ratio (%, in 2005)	
	1997	2006	Government	Corporate	Government	Corporate
HK	26	35	542.4	7.59	34.7	n.a.
SG	24.7	66	130.5	5.83	3.2	n.a.
ID	1.9	21	27.7	0.9	0.6	0.2
ML	57	93	84.3	38.1	1.8	0.8
PH	22.4	38	46.43	0	n.a.	0
KR	25.2	112	952.2	382.2	3.3	1.0
TL	7.1	51	70.1	5.6	2	0.3

Source: Ghosh (2006)

Table 2.7 - US participation in EME local currency bond markets

	In $US billion		Percentage of Total	
	2001	2006	2001	2006
HK	0.07	0.25	0.29	0.65
SG	0.04	2.48	0.13	4.42
KR	0.25	2.32	0.06	0.25
ID	0.01	1.08	0.01	2.04
ML	0.02	1.06	0.02	0.9
PH	0.01	0.04	0.05	0.14
TL	0.03	0.58	0.08	0.55
Emerging Asia	0.06	2.77	0.06	0.35
Emerging LA	0.46	10.73	0.15	2.03
Emerging Europe	0.74	4.74	1.37	0.71

Source: Burger et al. (2008, 2010).

Overall, the depth and breadth of East Asian securities markets have improved greatly during the decade following the 1997-1998 crisis, driving the markets more closely to international standards in terms of disclosures and regulations, and especially to their opening up for foreign investors. Market development has also been manifested by a significant increase in trading volume, market players and especially a broadening of the types of instruments available, including Islamic securities, asset-backed securities and various derivatives[17]. This has allowed domestic borrowers a greater diversification of funding sources, contributing to a reduction in currency and liquidity risks and an enhancement of the overall risk-bearing capacity of the economies.

However impressive the growth in securities markets, the banking sector has still dominated the East Asian financial system, accounting for more than 60% of total financial sector assets. Together with improvement and development in capital markets, the banking system has experienced significant structural changes in capitalisation, operational efficiency and risk management. Consolidation and privatisation took place in the aftermath of the 1997 crisis, which resulted in a significant decline in the number of banks; a remarkable increase in foreign ownership and a marked rise in banks' assets and liabilities. For example, the number of commercial banks declined from 238 in 1997 to 134 in 2004 in Indonesia, from 51 to 24 in Philippine, and from 36 to 25 in Malaysia. Foreign ownership increased from 9% in 1997 to 31% in 2004 in Indonesia; from 12% to 21% in Korea, and from 16% to 26% in Malaysia. In Thailand and Philippine, foreign ownership was relatively small, at around 10% at the end 2004. Banks extended fee-based services in new areas (i.e. securities and insurance), formed strategic alliances with other financial institutions and even outsourced their non-core operational functions to achieve greater operational efficiency.

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[17] Prior to the global financial crisis, derivative markets and structured credit markets based on mortgages and consumer finance assets began to develop in East Asian as a way to ease market access for lower-quality borrowers. However, the markets are small and illiquid compared to those of the US and Europe. Only a few segments function well. For example, Korea has a large bond futures market, and Hong Kong and Singapore have large foreign exchange swap markets. Only in Australia and Japan are all kinds of derivatives widely traded.

In five of the crisis-affected countries, NPL were dealt with and declined from an average of 30% in 1998 to an average of 6% in 2006 due to a combination of write-offs, debt restructuring and recoveries. NPL ratio was lowest in Korea, standing at around 1.3% between 2003 and 2008, as Korea transferred a sizable proportion of NPL to the centralised asset management company KAMCO initially after the 1997 crisis and to specialist asset-management companies from the US in recent years. Bank profitability as measured by return on equity (ROE) saw impressive improvement, reflecting a steady growth in lending, a widening of net interest margins and an increase in non-interest income. The most remarkable record in profitability belongs to Indonesian banking sectors, which was at an average of 28% in the period 2003-2008, rising from the negative levels of 1998.

Table 2.8 - Indicators of banking system soundness for the period 2003-2008

Country	Capital Adequacy (CR[a])	Asset quality (NPL[b])	Earnings (ROE[c])	Liquidity (Loan/Deposit)
HK	14.75	1.80	19.06	79.80
SG	15.51	3.53	11.66	80.13
KR	12.03	1.38	13.24	98
TL	13.81	9.55	11.48	85.67
ID	19.73	5.43	28.23	76.11
PH	17.11	9.88	9.23	70.44
ML	13.53	9.61	16.98	78.4

Memorandum

(a) Basel III: an adequately capitalised bank must have a CR of at least 10%

(b) At the peak of the 1997 East Asian crisis, NPL ratio was 32.5% in ID, 35% in KR, 30% ML, 20% in the PH, and 33% in TL (Laeven and Valencia, 2008).

(c) ROE (2003-2008) of US banks = 12.86, Australian banks = 21.36

Source: Calculated by author based on IMF-FSI data

Improved asset quality and profitability enabled banks to strengthen their capital base. The average reported capital adequacy exceeded 10% of total risk-weighted assets, therefore they were considered as well-capitalised banks under the Basel

III Capital Adequacy Framework. The traditional banking model remained dominant, with loan-to-deposit ratios of less than 100% in most economies, implying relatively low reliance of the region on wholesale funding. Additionally, a majority of commercial banks reported high ratios of short-term assets to liabilities. Table 2.8 shows various indicators based on the standard supervisory framework of banking crisis CAMEL, which suggests the overall soundness of the East Asian banking system during the period 2003-2008.

In general, the recovery from the 1997 crisis has by most accounts been very impressive. Once again, East Asia (including China) has been considered as the fastest-growing region in the world, which accounts for close to half of global growth. These economies entered the global financial crisis with such strong and sound economic and financial positions that the international financial community expressed the belief about Asia decoupling myths from the problems in the US and Europe as the crisis intensified.

2.2.2. East Asian Vulnerabilities to the Contagion Effects of the Global Financial Crisis

Despite the remarkable recovery and the underlying strengths of macro-financial fundamentals at the onset of the global economic and financial crisis, East Asia remained vulnerable, mainly because of deeper international integration and extensive trade and financial linkages with the rest of the world. The role of exports in the economy has increased over times, restrictions in foreign ownerships have been easing and capital accounts become more liberalised.

The past decade saw the surging trade flows in the region. As shown in Figure 2.9, trade openness measured by exports and imports over GDP rose in major economies such as Hong Kong, Singapore, Thailand, and Korea. The region had strong external dependency and the importance of exports reached an unprecedented level with the export to GDP ratio nearly 50% in 2006, compared with the world average of 25%. Although the trade openness process was accompanied by a significant increase in export markets' diversification, the US remained the region's single largest market, having absorbed on average 15% of the region's total exports in 2003-2007. The euro-zone comes second, accounting for around a 14% share. This made East Asia reliant on the US[18] and AEs in Europe for its growth.

Beside the rapid growth in inter-regional trade, there was also considerably booming intraregional trade[19]. Within seven East Asian economies to be analysed, intra-regional exports accounted for 29% of GDP, while this figure was quite small in Latin America (7%) and emerging Europe (9%), according to IMF (2009). Although a higher share of intra-regional trade helps cushion East Asia's exports against the downturn in AEs, it contributes to stronger interdependence between economies in the region and exposes them to competitive devaluation risks. In addition, emerging East Asia has pursued managed-floating exchange rates instead of flexible exchange rates, and relied largely on (partially) sterilised intervention[20]

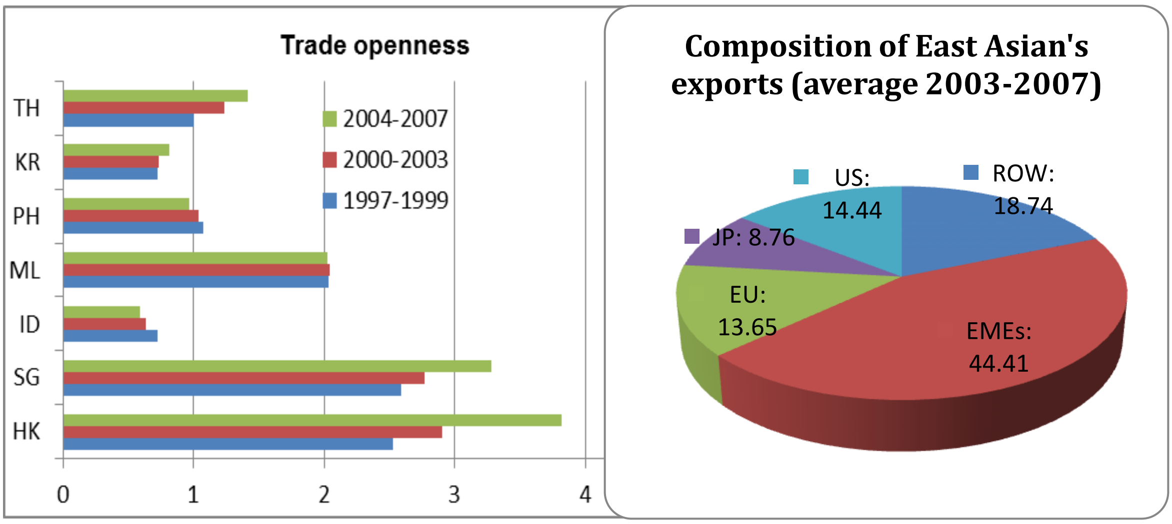
[18] The HK Monetary Authority (2007) estimated that a 10% decline in the US imports could lead to a 2.9% decline in total export of NIEs and a 3% decline in total exports of ASEAN, reflecting the vulnerability of East Asian to the fluctuation of US demands.

[19] During the period 1990-2006, intra-regional trade rose by 8.5 times, compared to 3 times in trade flows outside emerging Asia (IMF, 2007).

[20] Sterilised foreign exchange intervention involves the exchange of foreign and domestic currencies and monetary operations (open-market sales and purchases of securities) to equalise the effects of foreign exchange transactions on the domestic monetary base. Many Asian countries issued debts with different maturities to sterilise the monetary impact of foreign exchange intervention. However, sterilisation was rarely complete, as central banks tolerated downward pressure on interest rates given the environment of low inflation and large excess capacity.

to keep their currency competitive. This increases East Asian vulnerabilities to external demand shocks.

Figure 2.9 - Integration with international trade

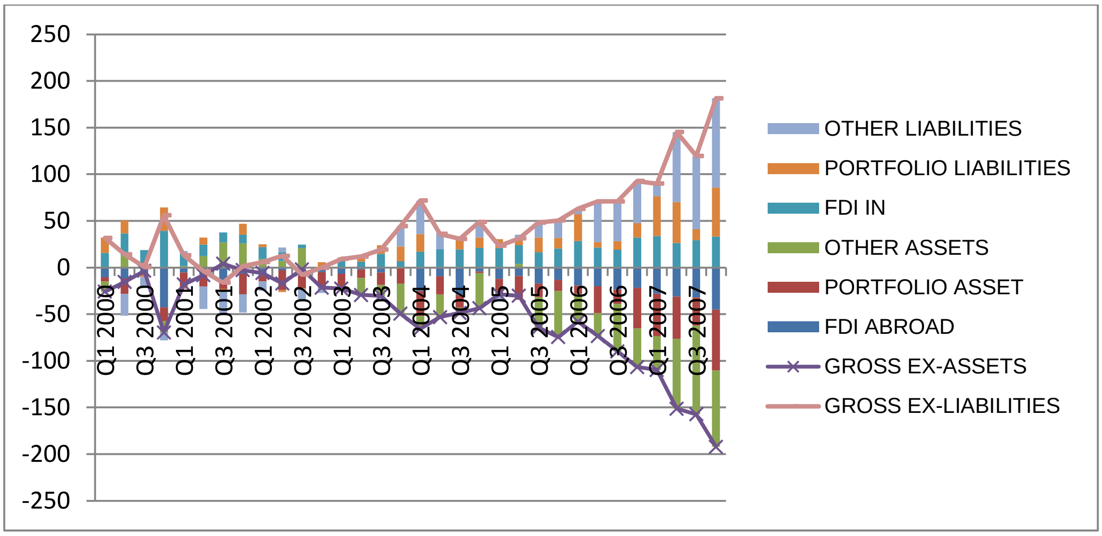


Notes: Trade openness = the sum of exports and imports as a share of GDP; ROW = rest of the world

Source: Calculated by author based on data from the IMF-Direction of Trade Statistics.

Together with the deeper integration with international trade, cross-border financial activities also expanded in East Asia over the last ten years. Based on the measures suggested by Lane and Milesi-Ferretti (2007), the aggregate level of de facto financial integration in emerging Asia doubled in 2007, compared with that of 1985. The surge in asset prices encouraged by policy changes in favour of greater exchange rate flexibility and capital account openness attracted large capital inflows to the region. The gross private capital flows in emerging Asia in general accounted for 15% of GDP in 2007, around 5% points higher than the level before the 1997-1998 crisis. Not only did international investors increase their holdings of East Asian assets, but local investors also started to increase their foreign investments and diversify their holdings into riskier and more sophisticated equity, credit and currency derivatives. As a result, there was an upward trend in all components of both capital inflows and outflows.

Figure 2.10 -International capital flows in East Asia (in $US billion)

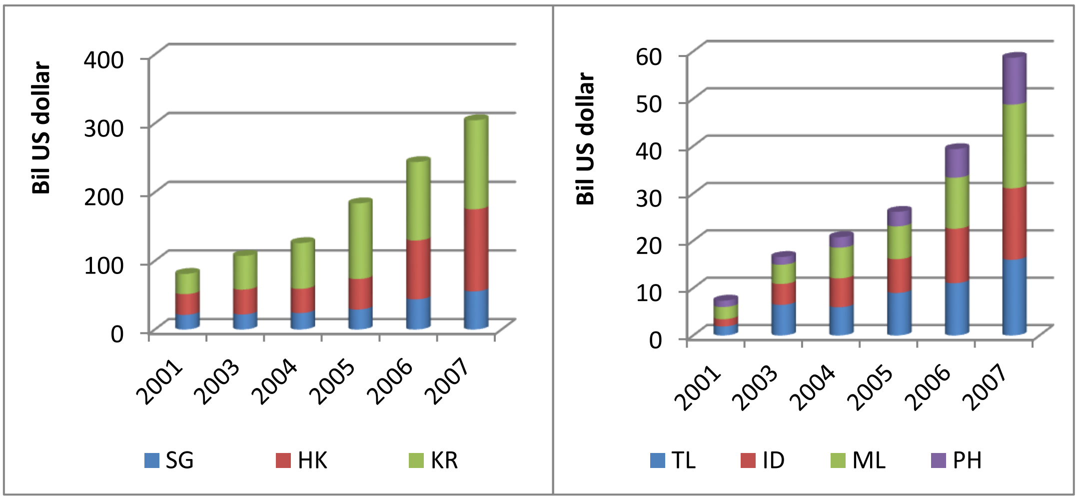


Source: IMF-IFS

Figure 2.10 shows that gross foreign capital inflows into the seven East Asian countries rose substantially during the period 2000-2007 and reached nearly US$ 185 billion in Q4, 2007. A large proportion of these inflows were in portfolio investment and in banking flows, which were considered more volatile and more prone to the sudden stop during the financial crisis. The stock of portfolios held by international investors (mostly from AEs) in East Asia was about 25% of GDP in these economies at the end of 2007. The portfolio flows were especially large in Korea, where equities holdings by non-resident investors were almost one-half of market capitalisation (McCauley, 2010), making this country highly susceptible to changes in global market sentiments and the consequent deleveraging effects. US investors had the largest presence in East Asian stock markets, accounting for a significant share of the total value of stocks held by foreign investors: 50% in Korea, 43% in Singapore, 38% in Indonesia, 36% in Hong Kong, 34% in Thailand,

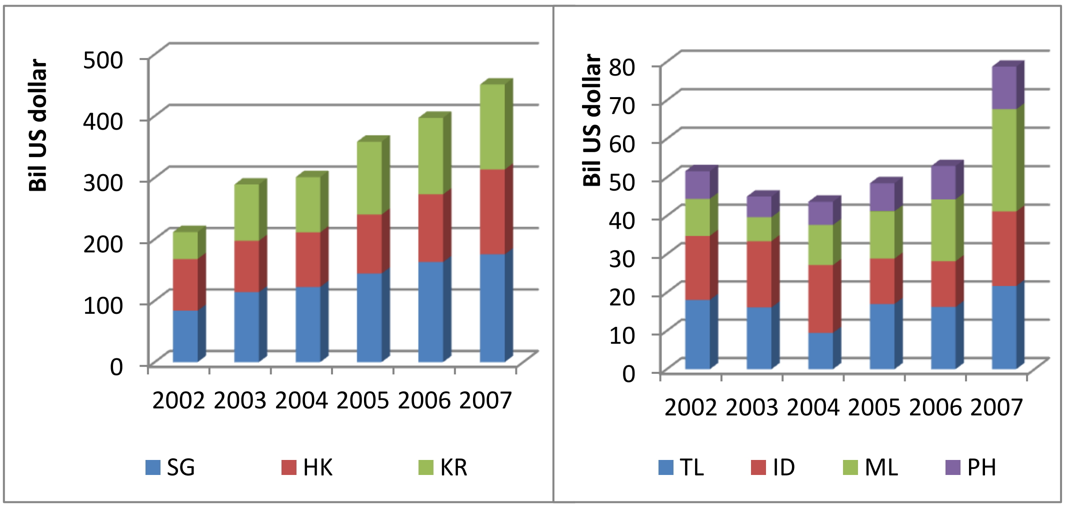
and 33% in Malaysia (Shirai, 2009). The 2000s also saw an unprecedented accumulation of US assets by East Asian residents (Figures 2.11 and 2.12), which exposed them to losses resulting from declines in asset prices in the run-up to the US subprime crisis.

Figure 2.11 - US holdings of East Asian equities



Source: US Department of Treasury

Figure 2.12 – East Asian holding of US equities (US$ billion)



Source: US Department of Treasury

Like portfolio flows, cross-border banking flows have resumed since 2002 after experiencing a substantial unwinding during the 1997 crisis. Despite the fact that the amount of external assets and liabilities of banking sectors in East Asian countries remained relatively small compared to those of AEs, they were large in terms of GDP, especially in the two financial centres of Hong Kong and Singapore. While portfolio flows come mainly from US investors, cross-border banking flows have been increasingly dominated by European banks, accounting for more than half of the aggregate flows. Nearly 80% of cross-border banking flows to East Asian countries is in the form of international bank lending, which has become a crucial source of funding to finance the credit expansion and rapid economic growth in several countries. Especially in Korea, banks more and more rely on wholesale funding. At the end of the first quarter of 2007, the country's short-term external debts rose to a record level of US$ 129.8 billion, exceeding the previous peak in 1997 (Khor and Kit, 2009). The build-up of international loans prior to the global financial crisis drove East Asian challenges to cross-border shock transmission in loan provision by multinational active banks. Moreover, the structure of loan flows with a high concentration in banks from three AEs: the US, UK and Japan, and similarity in credit structure among East Asian countries increases the regional vulnerabilities to wake-up call effects and common lender effects.

2.3. The Impacts of the Global Financial Crisis on East Asian

Contrary to the initial hope about East Asian decoupling, the region has been severely affected by shocks and contagion from the global economic and financial market turmoil of 2007-2009. The effects have occurred in both real economies and financial markets through different transmission channels, which may interact and feedback on each other.

2.3.1. Impact on Real Economies

East Asian real economic development was badly affected by the contraction in real GDP growth across the region between Q3, 2008 and Q3, 2009, averaging -3.4%. Apart from Indonesia, which saw moderate adjustment in GDP growth rate, nearly all countries fell into outright recession, with negative year-on-year growth up to the first half of 2009 (Table 2.9). The regional economic slowdown was comparable to that experienced during the 1997-1998 crisis (see Appendix 2.1). Trade channels appeared to be the most prominent transmission mechanism of real impact, in that export volumes were significantly down in the second half of 2008, reflecting the evaporation of import demand in AEs (notably from the US and Europe). By December 2008, aggregate exports had contracted by 18% year-on-year and the peak-to-trough decline was 47% on an unweighted basis. Imports also tumbled across the region, with a similar or even a slightly higher rate, compared to those of exports. This contributed to a further small rise in East Asia's trade balance. For countries highly open to trade like Hong Kong and Singapore, the effects of the fall in trade were particularly severe (Figure 2.13). Thailand, Malaysia and Korea were also very open (located further to the right of Figure 2.13) and hence suffered significant declines in growth relative to trend[21]. The shrinking demand for East Asian exports was aggravated by the drying up of trade finance through the disappearance of letter of credits as the global US dollar liquidity shortage intensified.

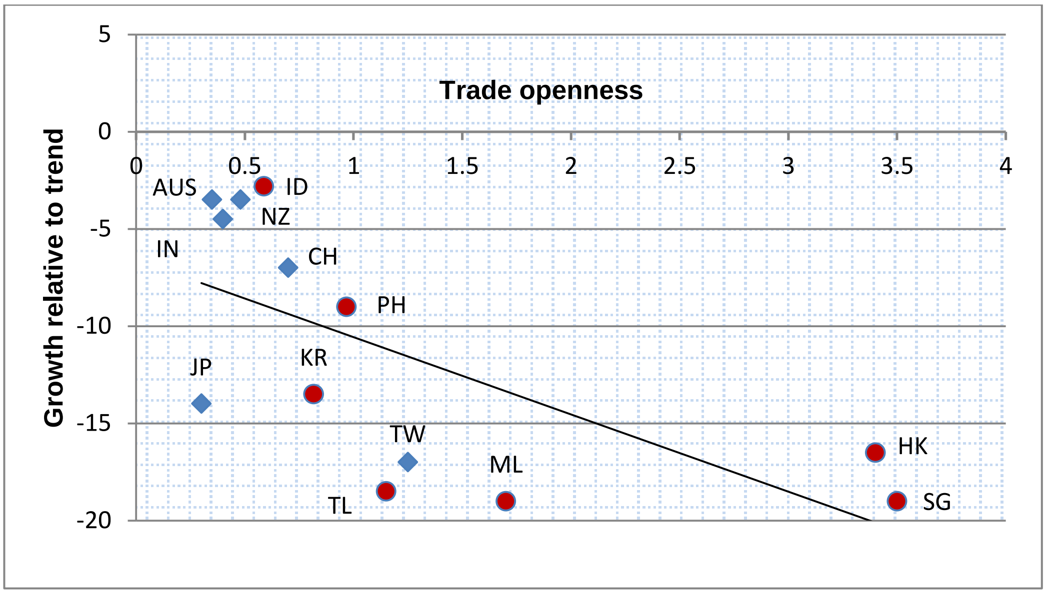
[21] Growth relative to trend is measured as percentage point difference between the realised rate of growth during Q4, 2008 and Q1, 2009 and trend growth. Trend growth is the average annualised growth rate during 2006 and 2007 of smoother GDP using the Hodrick-Prescott filter.

Table 2.9 - Real GDP growth rates (year on year % change)

	Q1-08	Q2-08	Q3-08	Q4-08	Q1-09	Q2-09	Q3-09
HK	7.04	4.00	0.94	-2.68	-7.76	-3.08	-1.69
SG	8.08	3.19	-0.29	-3.67	-8.85	-2.04	1.93
ID	6.22	6.30	6.25	5.28	4.52	4.14	4.27
ML	7.60	6.62	5.13	0.33	-5.76	-3.74	-1.13
PH	-6.38	-6.39	-5.87	-7.76	0.96	1.63	0.52
KR	5.52	4.36	3.28	-3.33	-4.19	-2.07	1.04
TL	6.32	5.21	3.05	-4.13	-7.05	-5.15	-2.80

Source: IMF, IFS

Figure 2.13 - Trade openness and GDP growth (Q4, 2008 - Q1, 2009)



Notes: TW: Taiwan, AUS: Australia, NZ: New Zealand, IN: India, CH: China

Source: Bernanke (2009)

The huge fall in exports also generated large knock-on effects on domestic demand, with the plunge in exports leading to factory closures and rising job losses. Negative consumer and business sentiments discouraged household spending and corporate investment. As a result, the composition of GDP growth showed major adjustments in domestic demand in a number of countries. Consumption experienced the fastest deterioration in Korea, while private capital investment also fell sharply in Singapore, Thailand and Korea. The fears of deep and prolonged recession prompted East Asian governments to introduce aggressive fiscal stimulus packages, amounting to US$ 84 billion in Korea, US$ 45 billion in Thailand, US$ 18.1 billion in Malaysia, US$ 13.8 billion in Singapore, US$ 6.5 billion in Philippines and US$ 6.3 billion in Indonesia during end-2008 and 2009. The largest stimulus packages were launched in Japan and China, reaching nearly 13% of GDP.

2.3.2. Impact on financial markets

While the real transmission mechanisms through trade volumes were straightforward, the financial contagion channels (which are the main focus of this study) appeared to be more challenging, as financial linkages are much more complicated. The vulnerabilities depended on financial openness and reliance on funding markets, as well as various country-specific risk factors. Financial transmission channels were activated via the direct effect of toxic assets and the indirect effect via asset prices, money and debt markets, and the second round effects on the banking sector (Gallego et al., 2010). Direct effects which related to the losses associated with the adverse changes in prices of toxic assets were fairly negligible in East Asia compared with the global scale of the problem[22]. This was due to the relatively limited exposure of the region to structured credit products and subprime lending. For example, banks in Indonesia and Malaysia had virtually no direct exposure; banks in Philippines and Thailand dealt with structured credit products but on a small scale and banks in Hong Kong, Singapore and Korea reported more exposure in CDO and asset-backed securities, but less than 5% of total assets. Several factors can help explain the small direct exposure to US subprime mortgage-related products. First, deposit-taking banks are still dominant

[22] Total write-downs and credit losses in Asia (excluding JP) on the whole represented only 3% of the global total amount of US$ 2.9 trillion (Kawai, 2009).

in East Asia, while the number of specialised financial intermediaries and complex financial products is relatively small. The East Asian financial system is still at a premature stage of the overall securitisation process. Second, booming local lending business is more promising for profitability purposes than engaging in foreign structured products and competition pressure is not as intensive as that of mature markets in the US and Europe. Third, those stylised facts reflected the cautious post-1997 crisis attitude of regulators, who have insisted that local banks should have sufficient risk-management capacity before investing in complex structured products. Therefore, damage to the US subprime credit market did not pose a significant direct threat to East Asian financial systems. However, the indirect transmission channels via asset prices, reversal of capital flows, and pressure in money and debt markets due to the deterioration in the global investors' risk appetites have proved to be extremely severe.

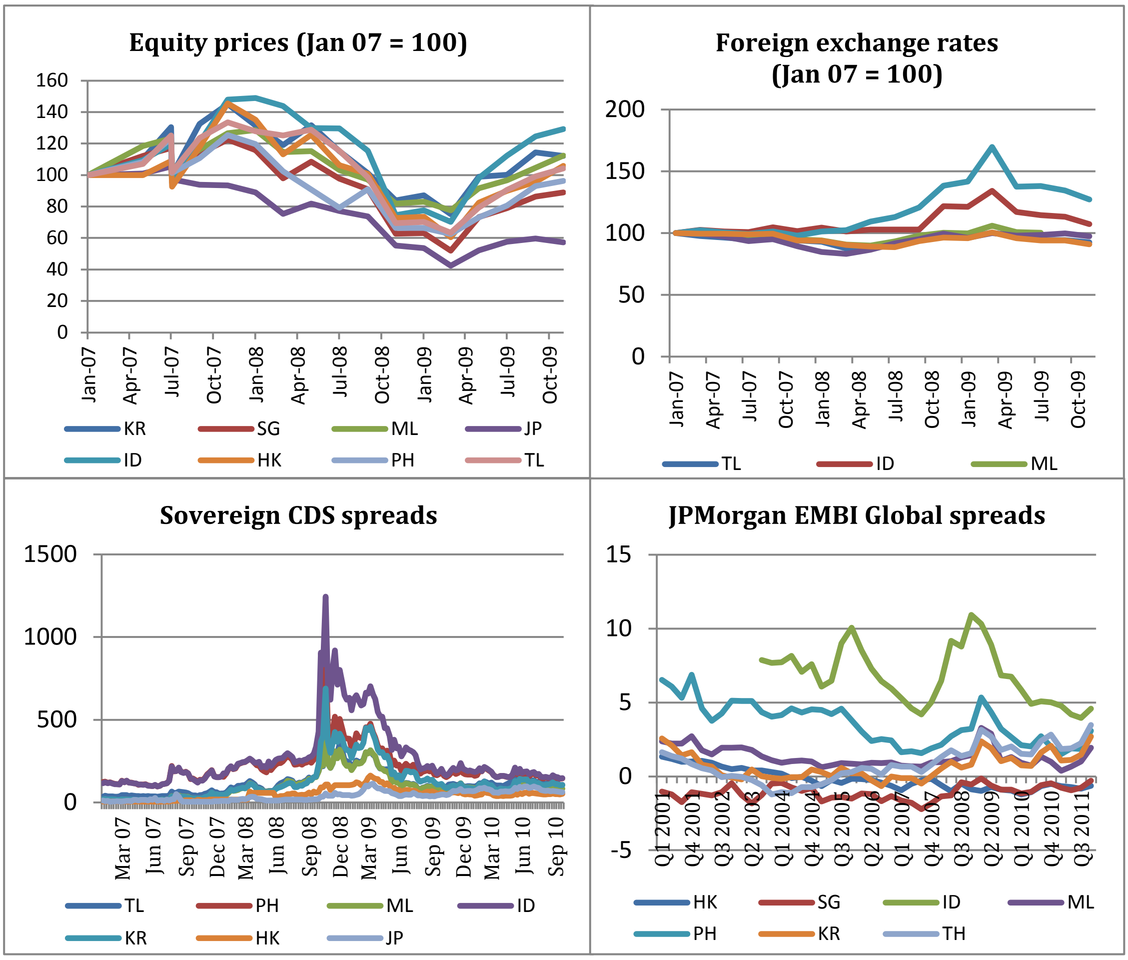
2.3.2.1. Asset Prices

Asset prices and international capital flows played an essential role in transmitting the global shock to East Asia. Given the close financial linkages with AEs, the region was extremely sensitive to the fall in equity and bond prices in the US and the knock-on effects of such losses via increased risk aversion amongst international investors. Despite the fact that East Asian asset prices were rather resilient in 2007, financially they gave in to the stream of negative news from the US in mid-September 2008. The bankruptcy of Lehman Brothers led to the collapse of global risk appetites and the consequent substantial liquidation of East Asian assets and large capital outflows, causing a sharp decline in equity markets, a widening of sovereign bond and CDS spreads, a depreciation of regional exchange rates, and a decline in offshore bank lending. Outflows only from equity markets in Asian EMEs were estimated to have reached about US$ 70 billion in 2008. Following the reversal in capital flows, equity indices fell an average of almost 40% in two months. Over the crisis period as a whole (July 2007 to August 2009), the decline in East Asian equity markets was -17%, with the largest reduction occurring in Singapore (-27%), Thailand and Philippines (-21%). Booms in property markets also came to an abrupt end, with house prices declining across countries, notably in Hong Kong (20%) in 2009. Even in China, house prices fell for the first time since 2005, forcing the government to take measures to revive the property market. House price falls could affect consumption due to a decline in household wealth and the devaluation of collateral for securing credit.

In debt markets, sovereign bond spreads and sovereign CDS spreads peaked in the region. In emerging Asia, Indonesia showed the most dramatic rise in the Emerging Market Bond Index (EMBI+) spread, leaping from 168 basis points in July 2007 to more than 928 basis points in December 2008. Sovereign CDS spreads also rose at an unprecedented level in the aftermath of Lehman Brothers' collapse: 100 basis points in Hong Kong and Singapore, 500 basis points in Korea and Philippines and 885 basis points in Indonesia. CDS spreads tended to increase more in those countries which had experienced a crisis or default or had higher capital mobility (Kim et al., 2010).

The reversal of capital flows and carry trade was accompanied by rapid exchange rate depreciations. The Korean won experienced the largest fall, depreciating by 40% against the US dollar from the beginning of 2008 through to its trough in March of that year. The Indonesian rupiah fell 22% over the same period. The Malaysian ringgit, Philippine peso and Thai baht fell in the range of 4 - 15% against the US dollar. On foreign exchange turnover, foreign exchange transactions across two major Asian foreign exchange markets declined sharply, by around 15.3% in Japan and 22.5% in Singapore. A continual rise in risk aversion led to shrinkage in foreign exchange swap transactions. Moreover, a further squeeze in the foreign exchange markets also reflected tightened trade financing in the wake of lower growth prospects.

Figure 2.14 - Sharp financial market deterioration



Source: Datastream and author's calculations

Figure 2.14 illustrates the adverse effects on asset prices of different market segments, which contributed to an increase in East Asian financial stress indices

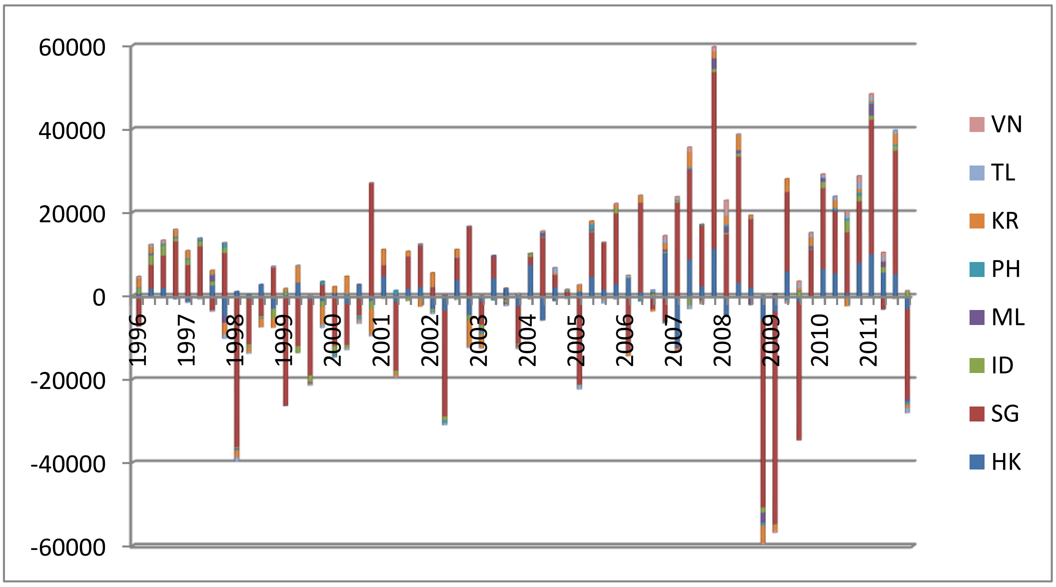
(FSI) during the crisis period (see Appendix 2.2). The emerging market financial stress indices (EM-FSI) introduced by Balakrishnan et al. (2011) seek to combine equity, debt and exchange rate pressure into a single index. As shown in Appendix 2.2, EM-FSI across the seven East Asian countries peaked from Q4-2008 to Q2-2009, with the main contributors coming from stock market returns and high sovereign spreads. The level of East Asian financial stress was even higher than that of other EMEs and was considered as high as its own level at the height of the 1997-1998 crisis (Goldstein and Xie, 2009). Generally speaking, international capital flows and asset prices played essential roles in transmitting the global shocks to East Asia. This will be analysed in chapter three of the thesis.

2.3.2.2. International Lending and Transmission of Interbank Market Tensions

One of the salient features of the global financial crisis was the severe liquidity shortages in US-dollar denominated funding, which led to disruption in the international money markets. Multinational active banks responded to these difficulties by reducing cross-border claims, scaling back their activities and increasing the cost of borrowing in various EMEs, including East Asia. In the last quarter of 2008, foreign claims from BIS reporting banks to East Asia dropped by roughly 12%, with the US and UK-headquarter banks accounting for half of the decline. The most remarkable reversals came from international lending flows, which became negative in a number of countries between Q4 2008 to Q2 2009, intensifying the already existing funding difficulties (Figure 2.15). The sharpest reduction in cross-border banking flows happened in the financial centres of Hong Kong and Singapore. However, a number of factors helped these countries to buffer financial markets against vulnerabilities, such as persistent current account surpluses, high sovereign rating, and especially the active repatriation of funds invested abroad by domestic investors.

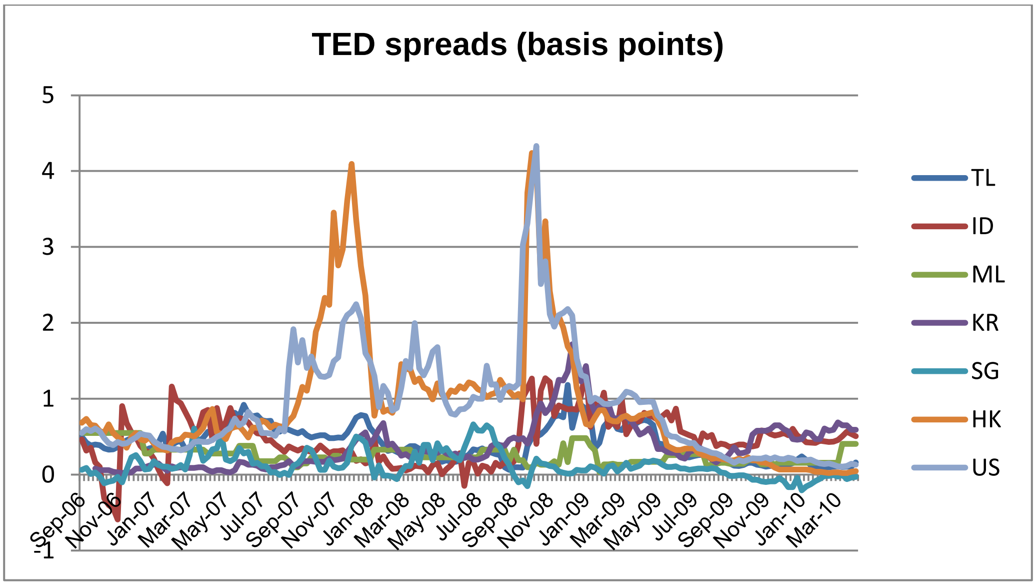
Figure 2.15 - External loans of reporting banks vis à vis East Asian countries

(Exchange rate adjusted changes, in millions of US dollars)



Source: BIS, locational banking statistics

Figure 2.16 - Interbank market tensions and widening TED spreads



Source: Datastream

The drying up of global liquidity had particularly serious repercussions for Korea, as this country strongly relied on the wholesale funding market, which accounted for about one-third of Korean bank funding. Other low rated economies in the region were also badly affected, especially in private sector companies with high levels of external debt. With respect to the curtailment of offshore credit, low-grade borrowers from Indonesia and Philippines lost access to markets, while high-grade borrowers with large external financing requirements faced much higher funding costs. This contributed to the transmission of interbank market tension from AEs to a number of East Asian countries, characterised by the widening of TED spreads, which mirrored those of the US (Figure 2.16). Domestic banks had to either seek to borrow US dollars from local sources or to sell local currency assets. Although cross-border banking flows rebounded in 2010, East Asia remained vulnerable to the deleveraging process of European banks at the height of the debt crisis in the euro-zone area. Many leveraged corporations still faced substantial refinancing or rollover risks. Swap lines with central banks and massive liquidity injections were introduced to reduce deleveraging pressures and support investor risk appetites. The role of international lending flows in transmission of interbank market tensions will be empirically tested in chapter four.

2.3.2.3. Second-round Effects on Banking Sector

As analysed in section 2.2.1.2, the East Asian banking sector entered the global financial crisis in a strong position due to the structural reforms and conservative regulatory regime developed in the 2000s, in light of the lessons learned during the 1997-1998 financial crisis. Indicators of capital adequacy, asset quality, earnings and liquidity during the period 2003-2008 were relatively sound. However, due to the mounting pressure in regional macroeconomic and financial market conditions in 2008 and 2009, rating agencies expected the substantial pressure on loan quality to be the biggest threat faced by the East Asian banking sector.

Specifically, banks would face traditional credit risks from the slump in economic activities, as well as a general loss of confidence and heightened risk aversion in financial markets. This would therefore lead to an increase in NPL, higher provisions, lower profitability and considerable erosion of banks' capital, which may have negative implications for further lending. Towards the end 2009, some major banks across the region reported a slightly pick-up in NPL ratio and declining profitability indicators. Stress testing of the East Asian banking system conducted by Pomerleano (2009)[23] estimated the prospective capital shortfalls faced by the region and suggested banks should raise additional funding to offset bad-loan losses and increase Tier 1 ratios. Despite various measures introduced by central banks to facilitate the supply of credit and avoid a credit crunch that could exacerbate a recession (e.g. local currency liquidity support, capital injections and credit guarantees scheme to SME loans), real domestic credit growth still decelerated in Hong Kong, Singapore, Korea and Indonesia, while it moderated in other countries. This gave rise to concern about the adverse feedback loops between the real and financial sectors, referred as the second-round effects of the

[23] Pomerleano (2009) calculated the projected capital shortfall for the banking system in the East Asia and Pacific regions based on the following assumptions: a leverage ratio of Tier 1 capital to assets of 5%, NPL of 8% of assets, and 100% coverage ratio of reserves to NPL. The author found that the prospective capital shortfalls could be as high as US$758 billion and the largest estimated Tier 1 shortfalls are as follow: Korea (US$44.5 billion), China (US$109.1 billion), and Japan (US$518.8 billion).

global crisis on EMEs. An in-depth analysis of bank behaviour under uncertainties and evidence of the second round effects will be made in chapter five of the thesis.

2.4. Conclusions

Despite having been referred to as a miracle of historical economic development, East Asia was severely hit by two major financial crises in just over a decade. This chapter has examined the macro-financial strengths and vulnerabilities of East Asia from the 1997-1998 regional financial crisis to the global financial crisis in 2007-2011. In contrast to the former crisis, which originated from a regional fundamental weakness and fragile financial sectors, East Asia entered the global financial crisis in a relatively strong economic and financial position. It seemed that the lessons learned from the past crisis had served Asia well to stay resilient from to the global turmoil. However, the wild swings in East Asian financial markets shattered the decoupling myths surrounding those economies. There were some important financial channels through which external shocks were transmitted to the region's financial markets - with significant impact and feedback on the regional economies as a whole. At the height of the global financial crisis, East Asia, among other EMEs, experienced peak-to-trough changes in exports, equities prices, sovereign debt spreads and interbank-market tensions, and spikes in total FSI, but with considerable variations across countries. The macroeconomic story shows that the real impact is fairly straightforward. Countries which are most open to trade appear to be most vulnerable to external shock. However, the financial story appears to be more complicated, as vulnerabilities and the contagion effect depend on various special factors.

CHAPTER THREE - ASSET PRICES, VOLATILITY LINKAGES AND FINANCIAL CONTAGION: ANALYSIS USING THE MARKOV SWITCHING VECTOR AUTOREGRESSIVE (MS-VAR) FRAMEWORK

3.1. Introduction

The liberalisation of capital markets around the world has allowed free movements of information and capital flows, driving international asset prices and volatility linkages. The literature on the historical financial crises during the past decades has suggested the important role of asset prices in the transmission of idiosyncratic shock across countries (Kindleberger and Aliber, 2011). This has been confirmed by the stylised facts of the global financial markets when several equity price indices in AEs as well as EMEs fell sharply immediately after the collapse of Lehman Brothers in September 2008 and the US subprime crisis was quickly transmitted around the world, causing global financial market turmoil in 2008-2009. Even the resilient financial markets of Asia were not immune from volatility spillovers, which affected many financial market segments such as equity, debt and foreign exchange markets. Although testing for cross-market correlations and volatility linkages has a long history in asset pricing, the literature has gained momentum since the seminal work of King and Wadhwani (1990), who showed the stock markets' volatility spillovers during the American stock market crash in October 1987. The findings have important implications since cross market linkages have intensified during extreme events such as financial crises, as the changes in asset price or return volatilities in one market usually cause movements of asset prices/returns or their volatilities across a cluster of national markets, despite very different economic circumstances. In this way, financial stress has rapidly spread between countries and regions.

This chapter investigates empirically volatility linkages in assets prices and financial contagion from the US and Europe to East Asia countries during the 2007-2009 global financial crisis and the subsequent European debt crisis. Theoretical and empirical studies have used many approaches to defining and measuring financial contagion[24], some of which focus on fundamental causes, while the others are based on investor behaviour. Following the literature on volatility spillovers and the crisis-contingent theories, financial contagion is modelled as the structural change in the transmission mechanisms, specifically an increase in cross-market linkages after a volatility shock in one country. This is also termed as "shift-contagion" by Forbes and Rigobon (2002). This approach has useful implications for both international investors and policymakers in terms of portfolio diversification and risk management. The increase in market integration and occurrence of shift-contagion diminishes the benefits of risk diversification in international financial portfolios, which in turn affect optimal asset allocation and global hedging policies. Moreover, the excessive co-movements of assets prices and returns may propagate country-specific shocks to economies with even very strong fundamentals. Therefore, authorities should pay attention to regulatory developments in terms of capital requirements and controls.

The shift in cross market linkages conveys an important theoretical assumption that the underlying distribution of asset prices and returns yields multiple

[24] See Claessens and Forbes (2004), Dungey et al. (2005) and Cheung et al. (2009) for literature survey on the theoretical and empirical framework of the contagion of financial crises.

equilibria, which is consistent with the generation models of financial crises. Using Markov-Switching Vector Autoregression (MS-VAR) models, we not only address the analysis of financial interconnection, but also convey the idea of multiple equilibria, in that there is a jump between different regimes for asset price linkages among markets following a shock in one country. MS-VAR also helps to identify endogenously the crisis period by allowing the presence of sudden switches in variance, and by the estimation of the probabilities of a shift between different regimes. This framework enables us to measure how crisis-prone East Asian financial markets are. Moreover, the correlations are conditional on each regime; hence, in order to facilitate the test of a shift-contagion, we apply Dungey et al.'s (2005) multivariate version of the Forbes and Rigobon's (2002) unconditional correlation tests based on the breakpoint time endogenously identified by the MS-VAR system.

This work analyses the proxies for general stress in the equity market, foreign exchange market and sovereign debt market, as these three financial market segments have been generally considered to be more related to global risk premia and capital flows, implying susceptibility to global financial conditions. Therefore, the fall in stock price and returns, pressure on exchange rates and increasing sovereign spreads and the associated volatility increase might not only indicate the depth of the crisis, but also gauge the diffusion of idiosyncratic shock among countries and regions.

The structure of this chapter is as follows. Section 3.2 provides the theoretical framework and empirical evidence of dynamic interdependences of international financial markets and financial contagion. In section 3.3, the econometric methodologies to test financial asset price volatility linkages and evidence for contagion effect are discussed. Data description and preliminary analysis are presented in section 3.4, while section 3.5 will provide some discussion on empirical results. Section 3.6 concludes the chapter.

3.2. International Financial Contagion and Asset Price Volatility Linkages: Theoretical and Empirical Frameworks

3.2.1. Financial Contagion and Contagion Transmission Channels

The term “contagion” is usually used in epidemiology to explain the spread of medical disease by direct or indirect contact. As cited in Moser (2003), many economists also use this term to express different meanings, such as the spread of wage increases secured by labour unions to non-union firms or sectors (Ulman, 1955); the spread of business fluctuations across economies (Mack and Zarnowitz, 1958) and the spread of speculative trading across individuals (Murchison, 1933; White, 1940). The East Asian crisis in 1997-1998 sparked the widespread use of the term “contagion” to refer to the spread of financial market turmoil across countries. Since then, a vast number of studies have attempted to explain the theory with different approaches and through a number of phenomena. These theories can be conceptually divided into two categories (Forbes and Rigobon, 2001, 2002; Claessens and Forbes, 2004), with an emphasis either on direct fundamental linkages or indirect linkages via changes in investor behaviour.

3.2.1.1. Fundamental-Based Contagion and Non-Crisis-Contingent Theories

The first strand of theoretical literature explains the fundamental causes of crisis propagation, such as common shocks[25], trade links and direct financial links. This is, therefore, termed as "fundamentals-based contagion" by Kaminsky and Reinhart (2000), "spillovers" by Masson (1998) or "interdependence" by Forbes and Rigobon (2002).

Common shock: A common shock or global shock, such as a slowdown in world aggregate demand, a shift in international interest rates, changes in commodity prices or bilateral exchange rates between major world economies can simultaneously affect the fundamentals of several economies, which thereafter leads to the co-movements of asset prices and/or capital flows in the affected countries. For example, a rise in the US interest rate adversely affects the funding of EMEs by increasing their debt serving costs and eroding their credit worthiness, potentially triggering crises in one and/or some of them (Moser, 2003). Unanticipated drops in export prices may weaken corporate sector balance sheets and hence the financial sector balance sheets in export-oriented economies. Shifts in exchange rates between major currencies generate adverse effects on price competitiveness and export growth. Calvo and Reinhart (1996) and Chuhan et al. (1998) identify movements in capital flows to Latin America that were associated with swings in interest rates in the US. Corsetti et al. (1999) explain the 1995-1996 strengthening of the US dollar versus the yen and the long-lasting slowdown in Japanese economic growth as an important factor contributing to the weakening of exports of several East Asian countries and leading to the subsequent financial crisis in 1997-1998.

[25] Masson (1998) proposes the term "monsoonal effects" rather than contagion for common shock.

Trade links: International trade can transmit shocks from one country to another through income effects and price competitiveness. If a country undergoes a financial crisis, it will suffer an economic slowdown and income deterioration, leading to a fall in its import demand. This will directly affect firms that export products to that country. Trade links also magnify shock propagation through competitive devaluation. When two countries are trading partners or compete with each other in a third foreign market, a financial shock that causes exchange rate depreciation in one country will deteriorate the other country's export competitiveness. As a result, the second country is likely to devaluate its currency to re-balance the external sectors. Gerlach and Smets (1995) advance this theory in explaining the 1992 EME crisis. They present a model showing that a forced depreciation of one country's currency has effects on prices and income for its trading partners by producing trade deficits and gradual declines in international reserves. This makes the collapse of the exchange rate in the first country speed up the collapse of the rate in the second economy. Corsetti et al. (2000) indicate that "competitive devaluation can cause larger currency depreciations than are required by the initial deterioration in fundamentals" (p.23). Glick and Rose (1999) prove the importance of international trade associated with cross-country correlations in exchange market pressure in five different currencies crises in 1971, 1973, 1992, 1994 and 1997.

Direct financial linkages: Another fundamental cause of financial contagion relates to direct financial linkages. The global integration and the expansion of large complex financial institutions that engage in interbank contracts, syndicated loan insurance, equity and bonds and OTC derivatives make economies become more and more integrated through international financial systems. This type of interconnectedness increases liquidity spillovers (e.g. difficulties in rolling over liabilities) not only in the banking sector but also in non-banking sectors. For example, during the crisis in 1997, Thai firms faced a limitation to engagement in FDI, and provided bank lending and other forms of investments to other East Asian countries. In the context of the US subprime mortgage credit crisis, direct financial contagion relates to the large losses and greater degree of financial distress in European banks who held large amounts of US MBS and were highly dependent on dollar funding. The case of Northern Rock is also an illustrative example about how a medium-sized institution faced with a liquidity squeeze can trigger negative network externalities. Chan-Lau et al. (2009) model spillovers and contagion of credit and funding shocks from direct interbank linkages in the network of several financial institutions. The model is based on the balance sheet effect given the balance sheet identity of a financial institution being expressed as follows:

$$(\mathbf{3.1})\ \sum_j \boldsymbol{l_{i,j}} + \boldsymbol{a_i} = \boldsymbol{k_i} + \boldsymbol{d_i} + \boldsymbol{b_i} + \sum_j \boldsymbol{l_{j,i}}$$

where $l_{i,j}$: loan from bank *i* to bank *j*; a_i: bank i's other assets; k_i: capital; d_i: deposit; b_i: long-term and short-term borrowings; and $l_{j,i}$: bank *i* borrow from bank *j*. A credit shock is triggered by the default of institution *h* on its debt from bank *i*, given the default rate μ and loss given the default $\mu l_{i,h}$. The loss is absorbed by bank *i's* capital, which will then lead to the new balance sheet identity after the shock:

$$(\mathbf{3.2})\ \sum_j \boldsymbol{l_{i,j}} + \boldsymbol{a_i} - \boldsymbol{\mu l_{i,h}} = (\boldsymbol{k_i} - \boldsymbol{\mu l_{i,h}}) + \boldsymbol{d_i} + \boldsymbol{b_i} + \sum_j \boldsymbol{l_{j,i}}$$

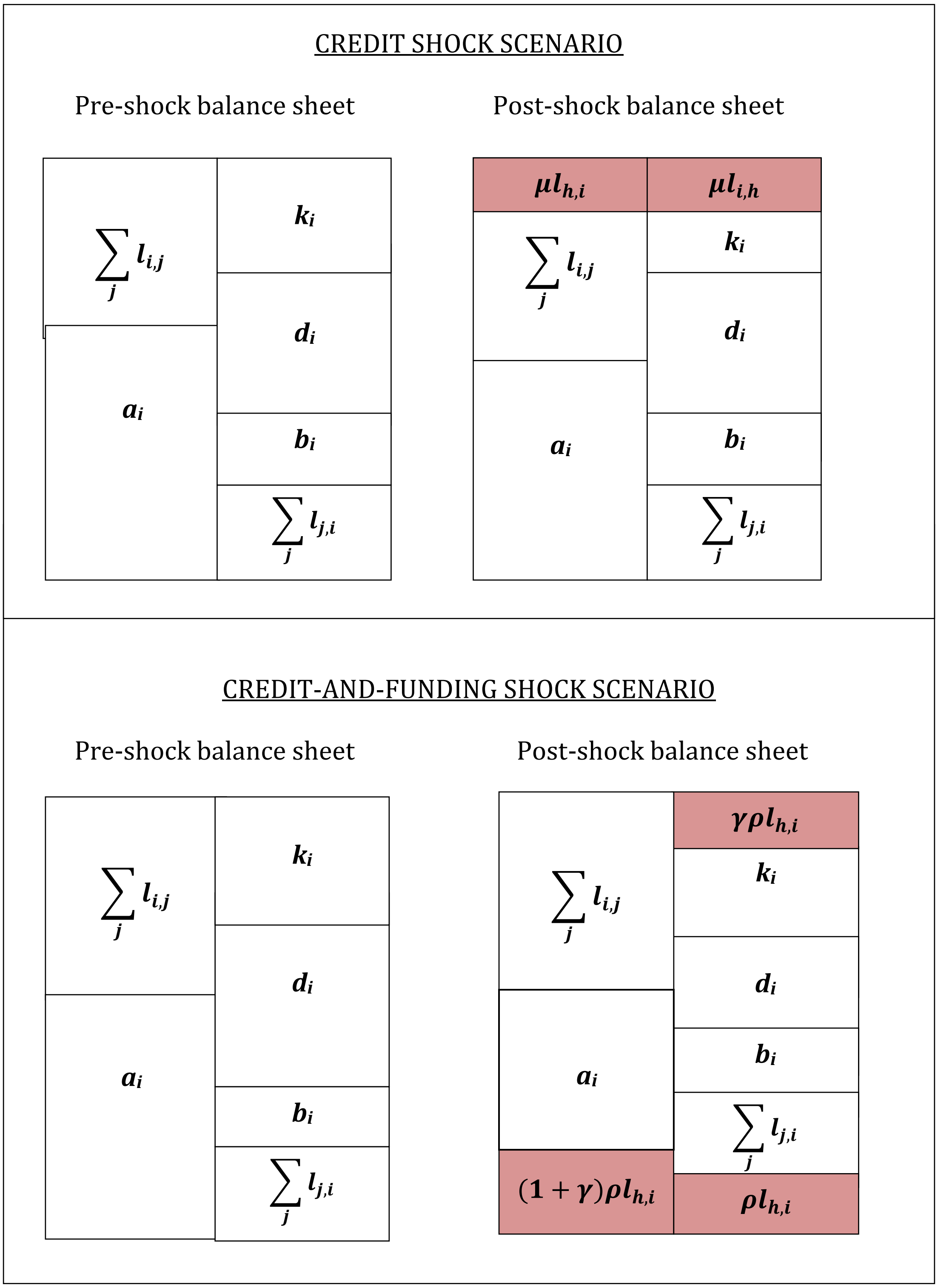
If bank i's capital is insufficient to absorb the loss ($k_i - \mu l_{i,h} < 0$), the default of h will cause the failure of bank i and may trigger further failures of other financial institutions in the interbank network through domino effects.

On the contrary, if the default of institution h causes the loss of funding for bank i, it may lead to a fire sale of bank i's assets. Assuming that bank i is able to replace only a fraction $(1-\gamma)$ of the loss of funding from bank h and it is forced to sell assets worth $(1+\rho)\gamma l_{h,i}$ in book value terms. The funding-shortfall-induced loss, $\rho\gamma l_{h,i}$, is absorbed by bank capital , the new balance sheet identity is recognised as follows:

$$\mathbf{(3.3)}\ \sum_j \boldsymbol{l_{i,j}} + \boldsymbol{a_i} - (\mathbf{1}+\boldsymbol{\rho})\boldsymbol{\gamma}\mathbf{l}_{\mathbf{h,i}} = (\boldsymbol{k_i} - \boldsymbol{\rho\gamma l_{h,i}}) + \boldsymbol{d_i} + \boldsymbol{b_i} + \sum_j \boldsymbol{l_{j,i}} - \boldsymbol{\gamma l_{h,i}}$$

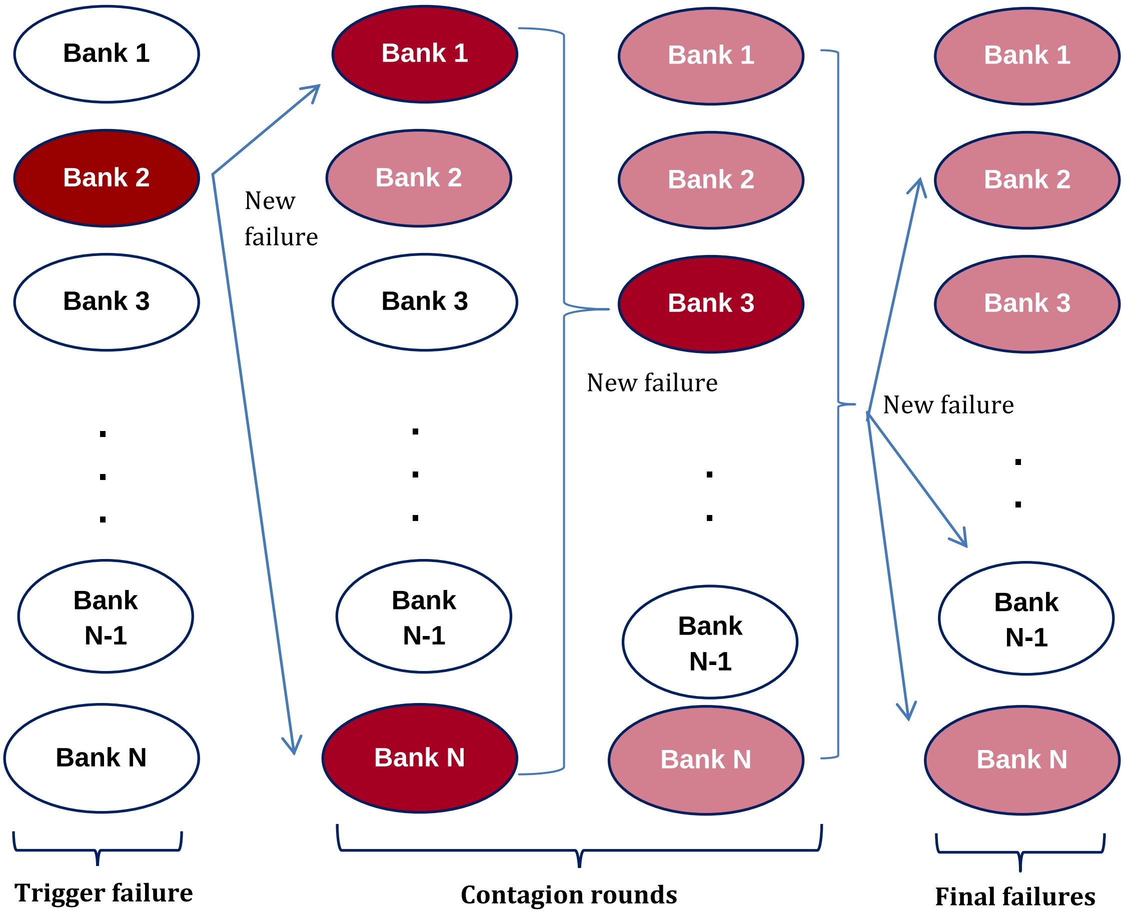
This scenario is illustrated as credit-and-funding shock in which the failure of an institution causes a liquidity squeeze to the others funded by the defaulting one. Therefore, an institution's vulnerability not only stems from its direct credit exposure to other institutions but also from its inability to roll over part of its funding from interbank market that forces it to sell assets at discount to restore its balance sheet identity. Figure 3.1 illustrates the balance sheet effects from two different scenarios: credit shocks and funding shocks. In the network of interbank exposures, these kinds of shocks will be transmitted throughout various financial institutions via domino effects and cause various rounds of financial contagion (see Figure 3.2).

Figure 3-1 - Credit shock and credit-and-funding shock analysis



Source: Chan-Lau et al. (2009)

Figure 3-2 - Network approach: systematic interbank exposures and contagion



Source: Chan-Lau et al. (2009)

Fundamental-based contagion relates to the broad definition of the World Bank. Accordingly, contagion is defined as the cross-country transmission of shocks or general cross-country spillover effects. The theoretical explanations of fundamental-based contagion have been classified as non-crisis contingent theories, which assume that there is no significant difference in the transmission mechanism before or after financial crises (Forbes and Rigobon, 2002). Instead, any large cross-market correlation after a shock is just a continuation of linkages that existed before the crisis. Therefore, this form of market co-movement is considered as normal interdependence rather than contagion. Shock propagation through fundamentals reflects an optimal response of one country to speed up adjustment to the new equilibrium caused by external shocks (Moser, 2003). However, common shock, trade links or direct financial linkages cannot fully explain some contagious financial crises in EMEs (for example, the 1998 Russia crisis), where the fundamental relationships between affected countries are quite limited. There should be other transmission mechanisms driving the co-movement of financial markets during the time of stress beyond fundamental links.

3.2.1.2. Investor-based Contagion, Shift-Contagion and Crisis-Contingent Theories

The second strand of literature focuses on investor-based contagion or "pure contagion" (Masson, 1999; Kumar and Persaud, 2002) introducing shock propagation unrelated to fundamentals but generated by the change in behaviours of trading agents in financial markets. The actions of international investors will increase the volatility linkages and the corresponding cross-border contagion. Different theories explain investor-based contagion from different perspectives, and can be classified into the three following groups: (i) multiple equilibria and changes in self-fulfilling expectations; (ii) liquidity problems and portfolio rebalancing and (iii) information asymmetries and herding behaviour (Dornbusch et al., 2000).

Multiple equilibria and self-fulfilling crises

The most common explanation for pure contagion is associated with theories of multiple equilibria arising as a result of changes in investors' self-fulfilling expectations (Masson, 1999). In this framework, a crisis in one country causes another country to jump to a bad equilibrium, characterised by devaluation, a sharp fall in asset prices, capital outflows and/or debt default. As explained by the macroeconomic feedback models, an adverse expectation of an event (i.e. devaluation or default) can be triggered by a set of macroeconomic fundamentals such as a fall in foreign reserves to a threshold level (in first generation models) or increasing interest rates (second generation models). This may feedback in an adverse way on prospects for the economy, making the possibility of the occurrence of that event more likely. For example, devaluation expectations will raise inflation expectations and wage demands, increasing the likelihood of the government's decision to devalue in order to avoid unemployment. Higher interest rates induce private agents' expectation of devaluation, increasing the authorities' willingness to allow for devaluation because they find it is too costly to maintain an exchange rate peg as the increasing interest rates will raise bank funding costs and dampen economic activities.

Another illustration for multiple equilibria is related to the bank run model of Diamond and Dybvig (1983), in which a large number of customers suddenly withdraw their deposits from a bank if they believe that it is or might become insolvent. In other words, individual depositors need to form an expectation about the behaviours of other depositors: if the others run, then it is optimal for an individual to run too. The bank run will exhaust a bank's liquid assets, which encourages further withdrawals and leads to bank bankruptcy. Sachs (1984) applied this model in the area of international lending to describe creditors' collective actions or panics: "if each bank believes that all other banks will stop lending, all banks will stop lending" (Sachs, 1984, p.32). Generally speaking, contagion occurrence depends on whether investors coordinate in good (no-run) or bad (run) equilibrium.

However, these sorts of multiple equilibria models were developed only for countries in isolation, which has not provided a clear link to shock propagation across borders. Masson (1998) proposes a two-country model to explain contagion as an event when one country jumps to a "bad" equilibrium following a crisis in another emerging country. The model can be mathematically summarised as follows.

First, based on balance of payments models, the probability of a country's devaluation (π_t) occurs when its foreign reserves R_t fall below the critical level $\overline{R}$. Changes in reserves depend on a country's trade balance, T and its indebtedness D, paying interest rate r^*, then:

$$(\mathbf{3.4})\ \boldsymbol{R_{t+1} - R_t = T_{t+1} - (r^* + \pi_t \delta) D}$$

$$(\mathbf{3.5})\ \boldsymbol{\pi_t = Pr_t\big[T_{t+1} - (r^* + \pi_t \delta) D + R_t - \overline{R}} < 0\big]$$

where $\boldsymbol{\delta}$ is the extent of the expected devaluation in percentage terms.

Second, the model introduces the interaction between two EMEs (a and b), taking into account monsoonal and spillover effects. Assuming that country a's trade balance depends on the logarithm of the real exchange rate (RER), which gives weight x on country b, y on the US and $z = 1 - x - y$ on the rest of the world. Nominal exchange rates for a, b and the rest of the world are $S_t^a, S_t^b, \overline{S}_t$ (dollar price of local currency). Trade balance and the real exchange rates can be expressed in the following equations:

$$(\mathbf{3.6})\ \boldsymbol{T_t^a = \overline{T} - \beta RER_t^a + \epsilon_t^a}$$

$$(\mathbf{3.7})\boldsymbol{RER_t^a = S_t^a - xS_t^b - z\overline{S}_t}$$

An equivalent equation exists for country b.

The assessment of the probability of devaluation in country a (π_t^a) now becomes more complicated, as it depends on the probability of devaluation in country b (π_t^b) such that:

$$(\mathbf{3.8})\ \boldsymbol{\pi_t^a} = \left(\mathbf{1} - \boldsymbol{\pi_t^b}\right)\boldsymbol{Pr_t}\left[\overline{\boldsymbol{T}} - \boldsymbol{\beta}\left(\boldsymbol{S_t^a} - \boldsymbol{xS_t^b} - \boldsymbol{z}\overline{\boldsymbol{S}}_{\boldsymbol{t}}\right) + \boldsymbol{\epsilon_t^a} - (\boldsymbol{r}^* + \boldsymbol{\pi_t^a\delta})\boldsymbol{D^a} + \boldsymbol{R_t^a} - \overline{\boldsymbol{R}} < 0\right] + \boldsymbol{\pi_t^b Pr_t}\left[\overline{\boldsymbol{T}} - \boldsymbol{\beta}\left(\boldsymbol{S_t^a} - \boldsymbol{xS_t^b} + \boldsymbol{x\delta} - \boldsymbol{z}\overline{\boldsymbol{S}}_{\boldsymbol{t}}\right) + \boldsymbol{\epsilon_t^a} - (\boldsymbol{r}^* + \boldsymbol{\pi_t^a\delta})\boldsymbol{D^a} + \boldsymbol{R_t^a} - \overline{\boldsymbol{R}} < 0\right]$$

Equation 3.8 explains three channels of crisis contagion. The first channel works via monsoonal effects in the form of changes in the international interest rate r^* or the dollar-yen rate S_t. The second channel, the spillover effects, is subject to changes in the initial level of the exchange rate of country b. The third potential mechanism is the expectation of devaluation in country b ($\boldsymbol{\pi_t^b}$), which will have a direct effect on the possibility for self-fulfilling expectation $\boldsymbol{\pi_t^a}$, and it can feedback onto itself through an equation analogous to equation 3.8 for b.

In conclusion, Masson's (1999) model puts forward a pure form of contagion unexplained by fundamental links only (monsoonal effects and spillover effects). Although the values of composite fundamentals can be used to identify a country's vulnerability to multiple equilibria, as jumps between equilibria are triggered by stochastic events, the existence of contagion makes the early warning crises difficult and unpredictable.

Liquidity problems and portfolio rebalancing

A crisis in one country may make international investors sell off assets in several markets (especially in EMEs) to rebalance their portfolios. By doing so, investors cause asset prices out of crisis country/region to fall and the original shock can spread across borders. There are different motivations behind the behaviour of liquidation and rebalancing across markets. First, liquidation arises due to correlated liquidity shocks. Investors who anticipate greater redemption in the near future may need to obtain cash by selling part of their holdings in other countries. Second, a negative shock in one economy may lead to a deterioration in the value of leveraged investors' (i.e. hedge funds') collateral, leading them to liquidate assets in unaffected economies to meet margin calls. Banks from a common creditor country can also face liquidity problems when they experience a marked deterioration in the quality of their loans in one country, hence they attempt to reduce the overall risk of their loan portfolios by reducing their exposure in other high-risk investments in EMEs.

Portfolio rebalancing can also result from the cross-market hedging of macroeconomic risks. It is widely explained by standard portfolio theory that international investors decide how much to invest in a risky foreign country by weighting the expected return against the associated risks. If a structural-uncertainty parameter of an economy changes, investor portfolios shift to reflect the new equilibrium prices of risk. In other words, a wealth shock may make investors re-examine the riskiness of their portfolio and bring about a movement toward less risky investments. Schinasi and Smith (1999) theoretically prove that investors under a loss constraints rule (i.e. VaR) will find it optimal to reduce investments in many risky assets when there is an adverse shock affecting a single asset return pattern in one country or when return on the leveraged portfolio is less than the cost of funding. Kodres and Pritsker (2002) develop a multiple asset rational expectation model of asset prices and explain cross-market rebalancing. They suggest that contagion of financial crises occurs when investors optimally rebalance their portfolio exposures to macroeconomic risks through other countries' markets after they are hit by idiosyncratic shock in one country.

Information asymmetries and herding behaviour

The third group of theories explaining investor-based contagion focuses on herding behaviour in the presence of inefficient market and information asymmetries. In the absence of a perfect market and information, investors do not have a complete picture of a country's fundamentals and its true state of vulnerabilities. They, therefore make their investment decisions based on the actions of other investors, causing herding behaviour or financial panic. Such a phenomenon is often explained by information cascade models. Two basic assumptions for an information cascade are: (i) the cascade model relies on the significant difference in private information across agents, and (ii) the cascade model relies on significant transaction costs in order to generate sequential behaviour. Calvo and Mendoza (2000) present a model of herding behaviour and contagion effects in securities markets with three different groups of investors: informed investors, uninformed investors and less-informed investors. Given the fixed cost of gathering and processing country-specific information, less-informed and uninformed investors will obtain cost-effective benefits by observing and copying informed investors who act early in adjusting their portfolios. If informed investors move to a bad equilibrium, then uninformed investors, by following informed ones cause another bad equilibrium. Another explanation for herd behaviour relates to reputation cost. As fund managers are evaluated based on the performance of their portfolio relative to that of a specific index, they will find it less costly to follow the herd (Claessens and Forbes, 2004).

In conclusion, financial contagion caused by fundamental channels can in principle be predicted and manageable, while it is more challenging to predict and quantify investor-based contagion in a world of multiple equilibria, imperfect markets and information asymmetries. These kinds of investor behaviour do not exist during stable periods, but occur after an initial shock elsewhere, causing shifts in transmission mechanisms and the jumps in financial asset price distribution. In other words, the change in asset prices of the affected markets (relative to the change in prices in the market where the crisis originated) is exacerbated during the shifts between multiple equilibria. Forbes and Rigobon (2002) term this as "shift-contagion" and categorise the theories explaining the shifts as crisis-contingent theories. More specifically, crisis-contingent theories are those that explain why transmission mechanisms change during a crisis and contagion occurs only when there is a significant increase in cross-market linkages after a negative shock in an individual country (or group of countries). However, it is challenging to distinguish both conceptually and empirically whether investor behaviours are caused by reactions to the fundamentals of an economy at risk or to their predictions of herding behaviour. In fact, both these types of fundamental-based and investor-based contagions interact with each other to amplify financial inter-market dependences and facilitate shock propagation across countries. As financial integration continues to increase around the world, there is no way to fully isolate countries from a crisis elsewhere. This implies that countries should ensure that both their fundamentals are sound and are widely perceived to be sound by the global investors.

3.2.2. Empirical Tests and Evidence of Financial Contagion

While the theoretical explanation of financial contagion and its transmission mechanism is extensive, the empirical literature testing for the existence of contagion is even more diversified. A large number of methodologies have been developed, each subject to some specific statistical problems (e.g. heteroskedasticity, non-linearity, simultaneous equations, endogeneity, and arbitrary choice of crisis window), causing variability of results. This also leads to the difficulty in assessing evidence for contagion and its significant transmission of crises across countries. Depending on how contagion is specifically defined, empirical tests can be classified into following groups: (i) tests based on conditional probability of crisis and its transmission mechanism, (ii) tests measuring change in volatility and volatility spillovers, (iii) cross-country correlation and correlation breakdown tests, and (iv) multiple equilibria testing with the Hamilton switching model.

3.2.2.1. Conditional Probability of Crisis

The first group investigates fundamental-based contagion and aims to test the importance of several fundamental transmission mechanisms as well as their contributions to the probability of the occurrence of a crisis. Probability models such as probit and logit models are the most common methods to test contagion without assuming any structural break in cross-market linkages. The general form of probability model is expressed in equation 3.9.

$$(\mathbf{3.9})\ \boldsymbol{Crisis_{i,t} = A\left(Channel_{0,i,t}\right) + BX_{i,t} + \varepsilon_{i,t}}$$

In this model, $Crisis_{i,t}$ is a dummy variable (taking the value of one for the crisis period in economy i or extreme value of financial stress factor and zero otherwise); $Channel_{0,i,t}$ is a variable (or a set of variables) measuring the intensity of the transmission mechanisms between the identified "ground zero" economy and economy i, with A corresponding the coefficient matrix. The significance of A captures the significant transmission channels to be investigated. $X_{i,t}$ is a set of fundamentals and $\varepsilon_{i,t}$ is a random error term.

The seminal study of conditional probabilities in examining contagion is made by Eichengreen et al., (1996). They construct a binary crisis dummy variable from the exchange market pressure index (EMPI), which indicates whether or not a particular currency is experiencing extreme pressure. The EMPI[26] captures exchange rate depreciations, declines in international reserves and short-term interest rates. The extreme value of this index is the sample mean above its 1.5 standard deviation[27]. By estimating the probit model on a panel of 20 industrial countries for the period 1959-1993, they find that the occurrence of a currency crisis in one country raises the likelihood of a speculative attack on other countries by about 8%, and trade links appear to be a significant transmission channel after controlling for macroeconomic and other fundamental independent variables. This technique is then applied by Glick and Rose (1999) to examine five episodes of currency crisis for a set of 161 countries. They also add more evidence about the importance of trade links in shock propagation. Camamanza et al. (2004) use a panel probit regression in 41 EMEs to study the observed regional concentration of currency crises in the 1990s (Mexican, Asian, and Russian). The empirical

[26] The EMPI is expressed as follows:

$$EMPI_{i,t} = \alpha * \%\Delta e_{i,t} + \beta * \Delta i_{i,t} - \gamma * \%\Delta r_{i,i}$$

where $e_{i,t}$ denotes exchange rate; $i_{i,t}$ is short-term interest rate; $r_{i,t}$ denotes international reserves; and α, β, γ are weights.

[27] Currency crisis is defined as an extreme value of the EMPI such that:

$$Crisis_{i,t} = \begin{cases} 1 \; if \; EMPI_{i,t} > 1.5\sigma_{EMP} + \mu_{EMP} \\ 0 \; otherwise, \end{cases}$$

results reveal that financial links to crisis country through a common creditor substantially raise the possibility of contagion, while trade links via devaluation are only relevant for countries with weak account balances. Using the same methodology as Camamanza et al. (2004), Haile and Bozo (2008) test the effects of four crisis transmission channels simultaneously: trade, finance, macro-similarity and neighbourhood effect channels. They find that the probability of a currency crisis in one country is significantly increased given a crisis elsewhere. Among the four channels to be considered, the test results reveal the importance of trade links and neighbourhood effects. A very similar approach to the probit model is the Bayesian averaging of binary model, which is utilised in Dasgupta et al. (2011) to study the directions of contagion in EME currency crises in 1992, 1994, 1997 and 1998. They find persuasive evidence to support the role of trade competition, financial links and institutional similarity to the "ground-zero" country as key factors driving contagion effects. General results from the probability model suggest the dominance of trade links and confirm that contagion tends to be regional rather than global, as trade relationships are relatively intra-regional than inter-regional.

One of the attractive advantages of this methodology is that it can estimate the probability of spreads of financial crises and identify channels through which contagion occurs. However, this approach has several shortcomings. First, the ad hoc selection of fundamental variables may decrease the possibility of predicting future crises using this analysis. Second, contagion is investigated only under a crisis situation with a relatively small data sample, although it should be possible to conduct spillover effect analysis for non-crisis periods. Moreover, the loss of sample information from constructing crisis dummy variables may generate inefficient estimated parameters and reduce the power of the contagion test (Dungey et al., 2005).

3.2.2.2. Tests Measuring Volatility Spillovers

The second group of empirical studies identifies contagion as volatility spillovers from one market to another market and uses an ARCH or GARCH framework to estimate variance-covariance transmission mechanism. Specifically, the test examines whether conditional variances of financial variables are related to each other across asset classes and/or across countries. Multivariate GARCH models rather than univariate ones are widely in use. The model can be seen as an approximation to the data-generating process as follows:

$$(\mathbf{3.10})\ \boldsymbol{Y_t = A + Bf_t + U_t}, \quad \boldsymbol{U_t \sim N(0, H_t)}$$

$$\boldsymbol{H_t = C'C + D'H_{t-1}D + E'U'_{t-1}U_{t-1}E}$$

where $Y_t = [y_1, \dots, y_n]'$ is a vector of asset prices or returns for different countries; A is a vector of constants; $f_t = [f_1, \dots, f_k]$ is a (k *x 1*) vector of global factors with n *x* k matrix of factor loads B. $U_t = [u_1, \dots, u_n]'$ is a (*1 x* n) vector of country-specific shocks, which has a covariance matrix H_t, and C, D and E are matrices of estimable parameters in BEKK model. The BEKK representation measures not only the degree of innovation from market i to j but also the persistence in conditional volatility in each market.

Hamao et al. (1990) apply this approach to measure price changes and price volatility effects in international stock markets after the 1987 stock market crash. They find that unexpected changes in foreign market indices affect the conditional mean of the domestic market and justify volatility spillovers from the US and UK to JP. Edwards (1998) uses an augmented GARCH model on short term nominal interest rates to analyse the transmission of volatility across LA during the 1990s. The results show evidence of volatility contagion from Mexico to Argentina, but not from Mexico to Chile. Fleming and Lopez (1999) investigate US Treasury yield volatility spillovers across the three trading centres. The estimated GARCH parameters indicate that yield volatility in Tokyo and London is associated with cross-market spillover effects, while volatility in the US is characterised only by country-specific autocorrelation. Within asymmetric multivariate GARCH modelling framework, Maghrebi et al. (2006) examine the dynamic relationship between stock market volatility and foreign exchange rate fluctuation in Asia-Pacific countries. Their empirical results show evidence of volatility persistence and volatility linkages between stock market and currency market. Chancharoenchai and Dibooglu (2006) also use multivariate GARCH model with BEKK specifications to investigate volatility spillovers in six Southeast Asian stock markets around the time of the 1997 financial crisis. They stress the significant foreign influences on time-varying risk premium and volatility interactions in Asian markets. Using the same methodologies, Azis et al. (2003) measure the transmission of volatility shock to Asia's local bond markets during the Lehman and Eurozone crises. They show not only the volatility persistence of own-markets but also shock spillovers from the US and European high-yield corporate bond markets to those of Korea, Malaysia, Philippines, Thailand, China and India.

One of the advantages of GARCH models is that they tackle the problem of autoregressive and heteroskedastic dynamics and allow testing for contagion in the first and second moments of price changes. However, in line with conditional probability approach, GARCH models do not assume any kind of structural break in the data generating process caused by the crisis. Neither do authors using these testing approach control for fundamentals and thus do not distinguish between fundamental-based contagion and pure contagion.

3.2.2.3. Correlation Breakdown Tests

a. Unconditional Correlation Tests

Different from the two methodologies discussed above, correlation breakdown tests deal with the structural changes in cross-market linkages. Under this approach, one estimates the correlation coefficients of returns between assets across regimes and a significant increase in correlation in crisis periods compared to non-crisis periods is considered evidence for contagion. This test is not only the most common and straightforward one in testing for shift-contagion, but also provides a very important implication for the effectiveness of international diversification. King and Wadhwani (1990) are the first to apply this approach by analysing the changes in correlations of stock market returns in the US, UK and Japan after the 1987 stock market crash. They find some evidence to support the hypothesis that the contagion coefficients increased during and immediately after the crash in response to the rise in volatility. Their results suggest that there is a transmission mechanism which cannot be explained by a fully-revealing fundamental model. Calvo and Reinhart (1996) find a significant increase in the co-movement of weekly equity returns and Brady bonds for Asian and Latin America markets after the Mexican crisis. Bajn and Goldfajn (1998) find that the cross-country correlations of currencies and sovereign spreads of five East Asian countries (Thailand, Indonesia, Korea, Malaysia and Philippines) significantly increased during the period from July 1997 to May 1998 compared to other periods. Bazdresch and Wener (2000) use the correlation test along with other econometric techniques to measure the contagion suffered by Mexico in the time of the Asian and Russia crises from 1997 to 1999. Their results confirm the evidence of contagion in the sovereign debt and stock markets.

However, the traditional correlation breakdown tests are subject to the heteroskedasticity problem, since correlation coefficients between asset returns are affected by their volatilities, which are extremely high during the crisis (Forbes and Rigobon, 2002; Rigobon, 2003). Hence, testing contagion without handling this issue could generate spurious results. In order to tackle this problem, Forbes and Rigobon (2002) introduce an adjustment for the correlation coefficient during the crisis period. The adjusted correlation β^*_{crisis} is given by:

$$\mathbf{(3.11)}\ \boldsymbol{\beta}^*_{\boldsymbol{crisis}} = \frac{\boldsymbol{\beta}_{\boldsymbol{crisis}}}{\sqrt{\mathbf{1}+\left(\frac{\boldsymbol{\sigma}^2_{\mathbf{1},\boldsymbol{crisis}}}{\boldsymbol{\sigma}^2_{\mathbf{1},\boldsymbol{non-crisis}}}-\mathbf{1}\right)\left(\mathbf{1}-\boldsymbol{\beta}^2_{\boldsymbol{crisis}}\right)}}$$

where β_{crisis} is the correlation between the asset returns of country 1 (country of origin of crisis) and country 2 during the crisis period; $\sigma_{1,crisis}$, $\sigma_{1,non-crisis}$ are the standard deviations of asset returns in country 1 in the crisis period and non-crisis period, respectively. To test for contagion from one market to another market, the null hypothesis is: H_0: $\beta^*_{crisis} = \beta_{non-crisis}$,

against the alternative hypothesis of H_1: $\beta^*_{crisis} > \beta_{non-crisis}$,

where $\beta_{non-crisis}$ is correlation of asset returns between two countries during non-crisis period. The Forbes and Rigobon's test statistic (FR) is: $FR = \frac{\frac{1}{2}\ln\left(\frac{1+\beta^*_{crisis}}{1-\beta^*_{crisis}}\right)-\frac{1}{2}\ln\left(\frac{1+\beta_{non-crisis}}{1-\beta_{non-crisis}}\right)}{\sqrt{\frac{1}{T_{crisis}-3}+\frac{1}{T_{non-crisis}-3}}}$ (with T_{crisis} and $T_{non-crisis}$ are the respective sample sizes of crisis and non-crisis periods).

By analysing the daily stock market returns and short term interest rates of different industrial economies and EMEs in three financial crisis episodes (American stock market crash in 1987, Mexican crisis in 1994 and Asian crisis in 1997), Forbes and Rigobon (2002) find that after the correlations are adjusted for the increased volatility, the hypothesis of correlation breakdown is rejected in most of the cases. In line with Forbes and Rigobon (2002), Boschi (2005) estimates instantaneous correlation coefficients corrected for heteroskedasticity for Latin American countries following the Argentinian crisis, but find no evidence of shift-contagion. This leads to much criticism of many empirical works testing contagion without adjustment for heteroskedasticity, which may suggest the presence of contagion but in fact the transmission mechanism was fairly stable in most of the financial crises in the 1990s. Although cross-market linkages are surprisingly high in many parts of the world, they are simply a continuation of the strong linkages which existed in the stable period, interpretable as interdependence among economies. Therefore, shocks are mostly transmitted through non-crisis contingent channels, while a few studies support crisis-contingent theories.

Although being widely applied in the empirical literature on contagion, the Forbes and Rigobon adjusted correlation (unconditional correlation) has received some criticism. According to Corsetti et al. (2005), the increase in variance of the crisis market may be caused by both idiosyncratic component and the non-observable variables. Without capturing those effects, the measure of adjusted coefficients is biased. They, therefore introduce the corrected correlation to solve this problem by weighting the increasing factor for each component of shocks. Their empirical tests provide some evidence of contagion and some interdependence. However, this study prefers the measure suggested by Forbes and Rigobon since our support is consistent with their arguments that it is possible to identify the country which generates the crisis and the ones which receive it. Moreover, if there are common unobservable shocks, they have to be homoscedastic or their contribution to the increasing variance should be negligible comparing to that of the idiosyncratic shocks. Another caveat in the Forbes and Rigobon's approach is that this methodology is only suitable for bivariate testing. There is also problem with sample selection bias caused by an a priori identification of the crisis period. However, it is not always easy to have a clear and appropriate classification of crisis state against stable state. Moreover, Forbes and Rigobon defined non-crisis period as the total sample period, which leads to overlapping data and small crisis sample size, making the test's assumption becomes unrealistic. This study while applies the unconditional correlation test will try to handle those statistical issues.

Multivariate version of unconditional correlation test

Dungey et al. (2005) propose a multivariate version of the Forbes and Rigobon test in a regression framework scaling the asset returns and correcting for endogeneity bias. This test is equivalent to the Chow test for a structural break in the regression slope. For the bivariate version, the test can be conducted based on the following pooled regression equation across the entire sample:

$$\textbf{(3.12)} \quad \frac{y_2^t}{\sigma_{2,non-crisis}} = \boldsymbol{\theta_0} + \boldsymbol{\theta_1 d_t} + \boldsymbol{\theta_2}\left(\frac{y_1^t}{\sigma_{1,non-crisis}}\right) + \boldsymbol{\theta_3}\left(\frac{y_1^t}{\sigma_{1,non-crisis}}\right)\boldsymbol{d_t} + \boldsymbol{\vartheta_t}$$

where y_1, y_2 represent asset prices/returns of crisis country and affected country for whole period; ϑ_t is a disturbance term; d_t is a dummy variable taking the value of 1 for the crisis period and 0 otherwise. The parameter $\theta_3 = \beta^*_{crisis} - \beta_{non-crisis}$ captures the effect of contagion. Forbes and Rigobon's contagion test can now be implemented by estimating equation 3.12 with OLS and performing a one-sided t-test of $H_0: \theta_3 = 0$. The difference between Forbes and Rigobon's approach and Dungey et al.'s is that the standard errors of the former are based on a small sample asymptotic adjustment, while the latter uses least squares standard errors or a robust estimator. Mandilaras and Bird (2010) apply this approach in testing contagion effects of the exchange rate mechanism of the European Monetary System. They find some evidence of the shifts in cross market linkages between Denmark, Ireland and Belgium.

Rigobon (2002) suggests an alternative multivariate test of contagion that is also robust to the presence heteroskedasticity and omitted variables: the DCC test. This test is based on the comparison between covariance matrix (DCC) across non-crisis and crisis periods. The DCC statistics is defined as follows:

$$DCC = \frac{|\widehat{\Omega}_{crisis} - \widehat{\Omega}_{non-crisis}|}{\hat{\sigma}_{DCC}}$$

where $\widehat{\Omega}_{crisis}$ and $\widehat{\Omega}_{non-crisis}$ are variance/covariance matrices of asset returns in crisis and non-crisis regimes; and $\hat{\sigma}_{DCC}$ is an estimate of the pertinent standard error of the statistic. The problem of omitted variables is modelled as the unobservable common shock. The test is implemented under the null hypothesis of no change in covariance structure of asset returns across sample period, resulting DCC = 0. If DCC is positive (DCC>0), the null hypothesis of no contagion is rejected. However, like previous correlation tests, it is necessary to know the exact crisis window or clear classification of high volatility period. If the window is not well-defined, the test may lose its power. Moreover, according to Billio et al. (2002), this test is unable to cope with some types of heteroskedasticity and fails to capture the direction of changes (i.e. decrease in correlation or loss of interdependence).

b. *Nonlinearities Model of VAR*

A similar approach to the Forbes and Rigobon (2002) correlation test is that of Favero and Giavazzi (2002), who use the VAR model to control for the interdependence of asset returns and to identify unexpected shocks transmitted across countries by the distribution of residuals. The residuals that contribute to non-normality and heteroscedasticity in the data are controlled by dummy variables associated with "unusual" residuals for each country and the significance of these dummies gives a signal of unexpected shock from one country's returns to another, which is considered to be contagion. The dummy variable is constructed as follows: $d_{i,t} = \begin{cases} 1: |u_{i,t}| > 3\delta_i \\ 0: other\ wise \end{cases}$

where $u_{i,t}$ is the residual in a VAR(p) and δ_i is the standard deviation of the residual $u_{i,t}$.

Favero and Giavazzi (2002) share the same view as Forbes and Rigobon (2002) in terms of modelling non-linearities in shock propagation. However, Forbes and Rigobon use a single parameter to represent contagion, whereas Favero and Giavazzi assign different parameters to each dummy variable. Favero and Giavazzi's approach allows for the full-information estimation of a model for interdependence. Studying the propagation of devaluation expectations among seven European countries over the period 1988–1992, their empirical results indicate that a number of country-specific shocks that affected other European markets are significantly non-linear. However, such non-linearities sometimes imply a change in sign, for example a widening spread in interest rates in one country is associated with a closing spread in another, which explains the "flight to quality" phenomenon during the financial crisis. However, like the testing approach based on conditional probability of crisis, the construction of binary dummies amounts to a loss of sample information and results in inefficient parameter estimates. In addition, the result of contagion from using this methodology is found to be spurious due to weak instruments. By comparing alternative tests of contagion, Dungey et al (2005) find that the Favero and Giavazzi's (2002) test tends to reject the null hypothesis of no contagion too easily.

3.2.2.4. Multiple Equilibria Testing with Hamilton Switching Models

The theoretical arguments for currency crises and financial contagion stress the existence of multiple equilibria caused by the change in investors' expectations and hence their behaviour during a crisis. These changes reveal a very important implication that the underlying distribution of asset returns should in general be multimodal. In other words, the underlying asset return models yield two or more equilibria. In the N-equilibria case, these properties can be captured by a mixture of distributions:

$$(\mathbf{3.13})\ \boldsymbol{f(y_{i,t}) = \sum_{j=1}^{n} \theta_j f_j\,(y_{i,t})}$$

where $f(y_{i,t})$ is the probability density of asset return $y_{i,t}$; θ_j are weights of individual densities $f(y_{i,t})$ in the mixture such that $\sum_{j=1}^{n} \theta_j = 1$.

The jumps between multiple equilibria may lead to the discontinuities in data-generating process implied in "shift-contagion" and crisis-contingent theories. One approach for testing multiple equilibria is based on the Markov switching (MS) model developed by Hamilton (1988) [28]. The model specifies a number of regimes

[28] The MS model was developed by Hamilton (1988) in studies of the term structure of interest rates and Hamilton (1989) in studies of business cycle. This model was then applied to many economic phenomena: for example, the dynamics of floating of the exchange rates (Kaminsky and

for relevant financial variables and estimates the probabilities of switching from one regime to another. Jeanne and Masson (2000) demonstrate in their study of currency crises that the MS model performs significantly better in tracking episodes of speculation, interpretable as self-fulfilling jumps in the beliefs of foreign exchange market participants. Ismail and Rahman (2009) also evaluate the potential of the MS model in their study of the relationship between US and Asian stock markets and find evidence to support the pre-eminence of non-linear MS-VAR over linear VAR in modelling asset return interactions across countries. Using MS Error Correction Models, Billio et al. (2005) analyse the contagion effects in the period of the Hong Kong stock market crash in 1997. The empirical results reveal evidence of contagion defined as a break that produces non-linearities in the linkages among financial markets. Within an MS-VAR framework, Guo et al. (2011) investigate contagion effects between the stock market, real estate market, CDS market, and energy market in the US. The MS specifications show the presence of contagion effects from these markets, characterised by nonlinearity with two distinct regimes. The regime-dependent impulse response functions reveal that all financial markets respond more significantly to economic shocks when high volatile regime is dominant. Lopes and Nunes (2012) also apply MS-VAR model with time-varying transition probabilities to examine the case of Portuguese escudo and the Spanish peseta during the European Monetary System crisis. Their findings confirm that there are the shifts in volatility and an improvement in correlations when the two countries go into crisis regime.

Peruga, 1990; Van Norden, 1996) and currency crises (Jeanne, 1997; Martinez-Peria, 1998; Piard, 1997; Psaradaskis et al., 1998).

Although MS approach in testing contagion has a drawback in that the number of regimes is arbitrary fixed, empirical studies that employ the MS model can potentially overcome several drawbacks from other methodologies in testing contagion. First, the MS model is able to cope with theoretical arguments in terms of economic fundamentals associated with multiple equilibria and non-linearity in links between financial markets. Second, it takes into account several time-series properties of asset returns, such as non-normality and fat-tailedness, time-varying volatility or heteroskedasticity. Third, this model does not require an a priori breakdown of the sample data into crisis and non-crisis periods as the correlation test does; instead, crisis periods are endogenously determined. This feature is especially important when analysing the contagion effect in the context of the 2007-2008 global financial market turmoil, since it is difficult to decide the cut-off point of a crisis[29]. Finally, like the probit model, this methodology can provide an explicit measure of the probability of a crisis, and specifically enables us to calculate the probability of a shift between different regimes, as well as the duration of the shift.

In conclusion, the review of theoretical and empirical literature on financial contagion provides some important implications:

- As it is challenging to have a clear distinction between fundamental-based (or spillover effects) and investor-based contagion, and both these types of contagion interact with each other to amplify shocks, we are primarily interested in shift-

[29] Various studies propose different breakpoint times for the US subprime credit crisis. For example, Goodhart (2008) and Abbassi and Schnabel (2009) define August 9, 2007 as the beginning of the crisis. Kato (2008) stresses Lehman Brother's collapse on September 15, 2008 as the time the crisis spread all over the world. Many public releases (i.e. VOA) refer to the bail out of Bear Stearns on 16 March 2008 the start of the year's slide into financial crisis.

contagion testing approach. This approach helps to avoid direct measurement and differentiation between various transmission channels while still provides evidence to support or to be against certain theories of transmission (Forbes and Rigobon, 2002).

- The literature on currency crises and investor-based contagion implies the role of multiple equilibria and non-linearity in international shock propagation. Moreover, during periods of crises, financial markets exhibit a common characteristic of extremely high volatility in asset returns. Integrating these features in asset pricing and contagion modelling, we hypothesise that there is a simultaneous rise in asset return volatility in different markets, associated with the jumps between different volatility regimes and the consequent changes in cross-market linkages in times of financial turmoil.

- Empirical evidence of financial contagion appears to be very sensitive to the data sets and testing methods which are subject to a series of problems such as heteroskedasticity, simultaneous equations, omitted variables, non-linearity, time series and cross-sectional clustering (Paas and Kuusk, 2012). We try to accommodate all these statistical concerns in our empirical methodologies.

3.3. Empirical methodologies

In order to accommodate the theoretical and empirical implications discussed in the literature review, we employ two-step econometric assessment of financial contagion. First, the dynamic co-movement of financial asset prices and return volatility is explored to identify the extent to which East Asian financial markets become integrated with each other and with the mature markets of the US and Europe. Given the various advantages of the MS approach which captures both the theoretical assumption of multiple equilibria and empirical application of volatility linkages and spillover effects during financial stress, we integrate MS specifications with VAR models (MS-VAR framework) to assess the potential dynamic behaviour of East Asian financial markets in which asset price and return volatilities are expected to be subject to regime shifts following financial shocks in the US and Europe. Second, the analysis of shift-contagion is given by employing the Dungey et al. (2005) multivariate version of Forbes and Rigobon's (2002) unconditional correlation test to understand whether there are significant shifts in cross-market linkages after an initial shock in one country. This may help identify the driving forces behind the asset price volatility adjustments either from fundamental-based or investor-based contagion (shift-contagion).

Specifically, this chapter aims at testing the hypothesis of volatility spillovers and financial contagion as a situation in which:

(1) *A switch in regimes (from low volatility to high volatility) of crisis-originator markets (US and Europe) leads to a change in regime (from low volatility to high volatility) in the dominated markets of East Asia (with a lag).*

(2) *The contemporaneous correlations between US, European and East Asian asset prices and returns increase significantly when these countries switch to a high volatility regime (crisis regime) from a low volatility one (stable regime).*

The econometric testing will help answer the following research questions:

RQ1a - How do asset prices facilitate the transmission of volatility shock across borders?

RQ1b - How do empirical estimates of asset price volatility linkages relate to theoretical assumptions as generally used in the literature on shift-contagion which is caused by investor behaviour?

3.3.1. Markov-Switching Vector Autoregressions (MS-VAR)

MS-VAR was originally expanded from the Hamilton (1989) Markov-switching autoregressive model (MS-AR) by Krolzig (1997). The general idea behind the MS-VAR model is that the observed time series y_t depends upon the unobservable regime variable s_t, which represents the probability of being in a different state of the world. In an MS-VAR model, all the parameters of the vector autoregression can be specified to be conditioned on the state s_t of the Markov chain. Let M denote the number of feasible regimes, so that $s_t \in \{1, \dots, M\}$. In the most generalisation of the mean-adjusted VAR(p) model, MS-VAR process of M regimes can be expressed as follows:

$$(\mathbf{3.14})\ \boldsymbol{y_t - \mu(s_t) = A_1(s_t)(y_{t-1} - \mu(s_{t-1})) + \cdots + A_p(s_t)(y_{t-p} - \mu(s_{t-p})) + \varepsilon_t}$$

$$\boldsymbol{\varepsilon_t | s_t \sim NID\big(0, \Omega(s_t)\big)}$$

$$\boldsymbol{\Omega(s_t)} = \begin{pmatrix} \boldsymbol{\sigma_1^2(s_t)} & \cdots & \boldsymbol{\sigma_{1M}(s_t)} \\ \vdots & \ddots & \vdots \\ \boldsymbol{\sigma_{M1}(s_t)} & \cdots & \boldsymbol{\sigma_M^2(s_t)} \end{pmatrix}$$

where:

$y_t = (y_{1t}, \dots, y_{nt})$ is an n dimensional time series vector of variables which are, in this study, financial asset returns of the US, Europe and East Asian countries;

$\mu(s_t)$ is the vector of regime-dependent means;

$A_1(s_t), \ldots, A_p(s_t)$ are the matrices containing the p^{th} autoregressive parameters in the state s_t;

ε_t is a zero-mean white noise process with a variance-covariance matrix $\Omega(s_t)$, which is assumed to be Gaussian: $\varepsilon_t|s_t \sim NID\big(0, \Omega(s_t)\big)$.

The hidden Markov chain: the general assumption from the MS model is that the unobservable realisation of regime s_t is generated by a discrete time, discrete state Markov stochastic process.

$$p_{ij} = \Pr(s_{t+1} = j|s_t = i), \quad \sum_{j=1}^{M} p_{ij} = 1 \qquad \forall i, j \in \{1, \ldots, M\}$$

where p_{ij} is the transition probability from one regime to another. For M regimes, these transition probabilities can be collected in a ($M^x M$) transition matrix denoted as P. Each element (p_{ij}) in P represents the probability that event *i* will be followed by event *j*.

$$P = \begin{bmatrix} p_{11} & p_{12} & \cdots & p_{1M} \\ p_{21} & p_{22} & \cdots & p_{2M} \\ \vdots & \vdots & \cdots & \vdots \\ p_{M1} & p_{M2} & \cdots & p_{MM} \end{bmatrix}$$

where $p_{iM} = 1 - p_{i1} - \cdots - p_{i,M-1}\, for\ i = 1, \ldots, M$.

Transition probabilities also contain important information about the expected duration (D_j) the system will stay in a certain regime (j), such that:

$E(D_j) = \sum_{j=1}^{\infty} jPr[D = j]$

$= 1 \times \Pr[s_{t+1} \neq j|s_t = j]$

$+ 2 \times \Pr[s_{t+1} = j, s_{t+2} \neq j|s_t = j]$

$+ 3 \times \Pr[s_{t+1} = j, s_{t+2} = j, s_{t+3} \neq j|s_t = j]$

$+ \ldots$

$= 1 \times (1 - p_{ij}) + 2 \times p_{ij}(1 - p_{ij}) + 3 \times p_{ij}^2(1 - p_{ij}) + \cdots = \frac{1}{1 - p_{ij}}$

The data generating process: there are two components of MS-VAR models: (1) the Gaussian VAR model as the conditional data generating process; (2) the Markov chain as the regime generating process.

Following Krolzig (1997), denoting φ_t the unobserved state of the system, such that: $\varphi_t = \begin{bmatrix} I(s_t = 1) \\ \vdots \\ I(s_t = M) \end{bmatrix}$, where the indicator function $I(s_t = m)$ is defined as:

$I(s_t = m) = \begin{cases} 1\ if s_t = m \\ 0\ otherwise \end{cases}$ with $m = 1, \ldots, M$.[30]

The mean shift function is $\mu(s_t) = \sum_{m=1}^{M} \mu_m I(s_t = m) = M\varphi_t$, where $M = [\mu_1, \ldots, \mu_M]$.

The conditional expectation $E[\varphi_t]$, which represents the probability distribution of s_t can be expressed as follows:

$$E[\varphi_t] = \begin{bmatrix} \Pr(s_t = 1) \\ \vdots \\ \Pr(s_t = M) \end{bmatrix} = \begin{bmatrix} \Pr(\varphi_t = \iota_1) \\ \vdots \\ \Pr(\varphi_t = \iota_M) \end{bmatrix}$$

where ι_m is the m-th column of the identity matrix.

Let $p(y_t|\varphi_t, Y_{t-1})$ denote the conditional probability density function of y_t for given states φ_t and lagged endogenous variables $Y_{t-1} = \left(y'_{t-1}, y'_{t-2}, \ldots, y'_1, y'_0, \ldots, y'_{1-p}\right)'$. As the error term ε_t in equation (3.14) is assumed to follow the normal distribution, the conditional density of y_t for a given regime φ_t is normal as in the VAR model, thus:

[30] According to Krolzig (1997), it is useful to define the parameter shifts more clearly by formulating the system as a single equation by introducing dummy variables.

$$y_t|\varphi_t = \iota_m, Y_{t-1} \sim NID(\bar{y}_{mt}, \Omega_m)$$

where the conditional means $\bar{y}_{mt}$are summarized in the vector $\bar{y}_t$.

Assuming that the information set available at time *t-1* consists only of the sample observations and the pre-sample values collected in Y_{t-1} and the states of the Markov chain up to φ_{t-1}, the conditional density of y_t is a mixture of normals:

$p(y_t|\varphi_{t-1} = \iota_i, Y_{t-1})$

$= \sum_{m=1}^{M} p(\,y_t|\varphi_{t-1} = \iota_m, Y_{t-1})\,\Pr(\varphi_t|\varphi_{t-1} = \iota_i)$

$$= \sum_{m=1}^{M} p_{im}\,(\ln(2\pi)^{-\frac{1}{2}}\,\ln|\Omega_m|^{-\frac{1}{2}}\exp\{(y_t - \bar{y}_{mt})'\Omega_m^{-1}(y_t - \bar{y}_{mt})\})$$

if the densities of y_t conditional on φ_t and *Yt-1* can be collected to the vector

$$\eta_t = \begin{bmatrix} p(y_t|\varphi_t = \iota_1, Y_{t-1}) \\ \vdots \\ p(y_t|\varphi_t = \iota_M, Y_{t-1)} \end{bmatrix}$$

Thus: $p(y_t|\varphi_{t-1}, Y_{t-1}) = \eta_t' P' \varphi_{t-1}$

As the regime is unobservable, the information set available at time t-1 consists only of the observed time series until time t and the unobserved regime vector φ_t has to be replaced by the inference $\Pr(\varphi_t|Y_\tau)$. Given the information set Y_τ, the probabilities of being in regime m (denoted as $\varphi_{mt|\tau}$) are collected in the vector $\hat{\varphi}_{t|\tau}$ such that:

$$\hat{\varphi}_{t|\tau} = \begin{bmatrix} \Pr(\varphi_t = \iota_1|Y_\tau) \\ \vdots \\ \Pr(\varphi_t = \iota_M|Y_\tau), \end{bmatrix}$$

Due to the binary nature of the elements of $\varphi_t$which implies that $E[\varphi_{mt}] = \Pr(\varphi_{mt} = 1) = \Pr(s_t = m)$, there are two different interpretations for $\hat{\varphi}_{t|\tau}$. $\hat{\varphi}_{t|\tau}$

denotes the discrete conditional probability distribution of $\varphi_t$given Y_τ. $\hat{\varphi}_{t|\tau}$ is also equivalent to the conditional mean of φ_t given Y_τ.

Then, the conditional probability density of y_t based upon Y_{t-1} is given as:

$$p(y_t|Y_{t-1}) = \sum_{m=1}^{M} p(y_t, \varphi_{t-1} = \iota_m, Y_{t-1})$$

$$= \sum_{m=1}^{M} p(y_t\,|\varphi_{t-1} = \iota_m, Y_{t-1}) \Pr(\varphi_{t-1} = \iota_m|Y_{t-1}) = \eta_t' P' \varphi_{t-1|t-1}$$

The conditional probability density of the sample can be derived analogously.

Given the pre-sample value Y_0, the density of the sample $Y \equiv Y_T$ conditional on the states φ is determined by:

$$p(Y|\varphi) = \prod_{t=1}^{T} p(y_t\,|\varphi_t, Y_{t-1}).$$

The joint probability distribution of observations and states can be calculated by:

$$\boldsymbol{p(Y|\varphi) = p(Y|\varphi)\,\mathbf{Pr}(\varphi) = \prod_{t=1}^{T} p(y_t\,|\varphi_t, Y_{t-1}) \prod_{t=2}^{T} \mathbf{Pr}(\varphi_t|\varphi_{t-1})\,\mathbf{Pr}(\varphi_1)}$$

Model selection and estimation: the MS-VAR model allows for a variety of exogenous regime switches: Markov-switching mean (MSM), switching in intercept (MSI), switching in the autoregressive coefficients A_t (MSA), and Markov-switching heteroskedasticity (MSH). For empirical applications, it is useful to allow only for some of the parameters in the model to be conditioned on the state of the Markov chain while other parameters are regime-invariant (Krolzig, 1997). The stylised fact in international financial markets has implied a rise in asset price volatility that occurs during a period of financial turmoil. Therefore, we follow the literature that expresses the role of volatility to model financial contagion by incorporating the VAR models with the following MS specifications:

- MS-VAR with mean and variance that are allowed to switch simultaneously across regimes (i.e. the heteroskedastic mean switch model: MSMH(m)-VAR (p)). This is consistent with the observable behavior of asset prices which show an immediate jump to new level during the financial crises. This process leads to the differences in mean across regimes, which imparts an effect and contributes to increasing volatility. Difference in means also generates non-zero conditional skewness. In addition, the combined differences in means and variances can cause persistence in levels as well as squared value akin to volatility persistence observed in many return series (Guidolin, 2011).

- Two discrete regimes (s_1, s_2) represent: (i) regime 1: non-crisis regime with low volatility and (ii) regime 2: crisis regime with higher volatility. Although the choice of number of regime appears to be subjective, it is suitable for the analysis of crisis contagion, given that the observed time series of financial variables shows the prevalence of either a stable stage with relatively less volatile movement or a crisis state with strong adjustments. Moreover, the literature debates several caveats against particular statistical criteria in determining the number of regimes (Hamilton, 2008; Psaradakis and Spagnolo, 2003)[31].

[31] Determining number of regimes basing on hypothesis testing is problematic since it fails to satisfy the usual regularity conditions arising from unidentified parameters (Hamilton, 2008). On the other hand, state selection procedures using complexity-penalized likelihood criteria (AIC, BIC or HCQ) are subject to poor performance under small sample size and parameter changes, constant autoregressive coefficients and when the Markov chain is not persistent (Psaradakis and Spagnolo, 2003).

- The number of lag for VAR(p) is decided using Akaike Information Criteria (AIC)
- MS-VAR is set up in the analysis framework based on the assumption that the probability of switching from one state to another is not affected by exogenous variables (i.e. there is no fundamentals control)[32].
- The population parameters of the MS-VAR models are estimated using direct maximization of log likelihood function. The full log likelihood function of the model is given by:

$$lnL = \sum_{t=1}^{T} ln \sum_{j=1}^{2} (f(y_t | s_t = j, \Theta) Pr(s_t = j)$$

which $f(y_t|s_t = j, \Theta)$ is the likelihood function for state j conditional on a set of parameters (Θ). Although this method is disadvantageous when the number of estimated parameters increases, it is the most straightforward and simplest way to set up.

- The probabilistic inferences about the unobservable states are made using nonlinear filter and smoother. "Filtered" probabilities are inferences about s_t conditional on the information up to time t, while "smoothed" probabilities use all the information in the data. All computations were implemented by adapting the msvarsetup procedures in RATS.

3.3.2. Multivariate Unconditional Correlation Tests

If the MS-VAR system displays significant evidence of shifting regimes of East Asian markets following the shift in crisis-originator markets (US and EU), we

[32] King et al. (1994) argue that changes in asset price correlations across markets are driven primarily by unobservable variables.

could extend our analysis to investigate structural change in cross-market linkage between different regimes. We expect asymmetrical effects in market performances, including sign reversals or differential speeds of adjustment to the shocks. The regime classification allows us to pick up observations across crisis and non-crisis states to conduct an unconditional correlation test.

Applying the Dungey et al. (2005) extended multivariate regression framework of the Forbes and Rigobon (2002) unconditional correlation test, we develop the following system of equations:

$$\textbf{(3.15)}\quad \frac{y_{Ai,t}}{\sigma_{1,Ai}} = \alpha_i + \gamma_i d_t + \sum_{j\neq i} \beta_{Aj}\left(\frac{y_{Aj,t}}{\sigma_{1,Aj}}\right) + \beta_{US}\left(\frac{y_{US,t}}{\sigma_{1,US}}\right) + \beta_{EU}\left(\frac{y_{EU,t}}{\sigma_{1,EU}}\right)$$
$$+ \sum_{j\neq i} \theta_{Aj}\left(\frac{y_{Aj,t}}{\sigma_{1,Aj}}\right)d_t + \theta_{US}\left(\frac{y_{US,t}}{\sigma_{1,US}}\right)d_t + \theta_{EU}\left(\frac{y_{EU,t}}{\sigma_{1,EU}}\right)d_t + \omega_{Ai,t}$$

where y_t represents asset returns at time t, a pooled data set by stacking the non-crisis and crisis observations. The subscript A, US and EU denote Asian countries, the US and European country, respectively. y_t is scaled by the non-crisis standard deviation σ_1 (standard deviation of low volatility regime 1), which is derived from MS-VAR estimation;

d_t is a dummy variable taking the value of 1 for the crisis observations and 0 for non-crisis observations obtained from MS-VAR regime classification;

$\omega_{i,t}$ are disturbance terms.

β and θ are the vectors of coefficients, while θ captures the additional contribution of information on asset returns in Asian country i to the non-crisis regression and conveys the ideas of contagion effects. If there is no change in the relationship, the dummy variables provide no new additional information during the crisis state, resulting in $\theta = 0$.

Therefore, the Forbes and Rigobon (2002) correlation test of shift contagion can be implemented by estimating equation 3.15 with OLS and performing a one-side t-test of: $\boldsymbol{H_0}: \boldsymbol{\theta_{i,j}} = \mathbf{0}$.

When we apply the models to test shift-contagion for the FOREX series, we add two variables to control for external shocks which triggered the jumps in East Asian foreign exchange rates. They are: (i) the S&P500 volatility index (VIX), and (ii) 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. A higher value of VIX corresponds to more volatile market expectations. 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. The higher spreads reflect the increase in risk of default on interbank loans and global liquidity strain. We assume that volatility in global financial markets and liquidity tension trigger massive sell-offs by international investors, causing capital outflows and depreciation pressure on local currencies. VIX and TED enter the regression with a lag.

Testing contagion based on dummy variables and regression approach of Dungey et al. (2004) corrects for simultaneous bias problem in Forbes and Rigobons (2002) whose correlation test is conducted on pairs of countries with source country being exogenous. Moreover, this approach links to a range of other tests of contagion, for example Favero and Giavazi's (2002). As a structural model is specified where each return is expressed as a function of other returns and the full set of dummy variables, the test will identify "shift-contagion" if returns in dependent variable is matched with returns in other variables during crisis regime.

3.4. Data and Preliminary Analysis

3.4.1. Data Sample

We analyse contagion effects in different financial market segments: equity markets, foreign exchange markets and sovereign debt markets, given that they experienced a strong volatility following the collapse of Lehman Brothers in September 2008. The different sets of asset price variables entered into our models are as follows:

Equity markets:

Composite stock price indices of the sample countries were chosen from the national leading markets: US: Standard and Poor's 500 Index (S&P500); Eurozone: EURO STOXX Index[33] ; Hong Kong: Hang Seng Index (HSI); Singapore: Straits Times Index (STI); Korea: Korea Composite Stock Price Index (KOSPI); Malaysia: Kuala Lumpur Composite Index (KLCI); Philippines: Philippines Stock Exchange Index (PCOMP); Indonesia: Jakarta Composite Index (JCI) and Thailand: Stock Exchange of Thailand Index (SET). We also use the price indices of the banking sector in each market as banks were severely affected during the crisis. US-dollar denominated indices are used to facilitate analysis of contagion effects from global investors' perspectives and to disentangle the overlapping effects of currency risks. The

[33] The EURO STOXX Index represents large, mid and small capitalisation companies of 12 Eurozone countries: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal and Spain

indices are simple average weekly data calculated from daily closing prices for the period from 1st January 2004 to 31st December 2011.

Foreign exchange markets: We use weekly nominal foreign exchange rates of domestic currencies against the US dollar, namely the Singapore dollar, Thai baht, Malaysian ringgit, Philippine peso, Indonesia rupiah and Korean won. The Hong Kong dollar is not included in the estimation as Hong Kong has fixed its currency to the USD since 1983 and the average return on its exchange rate is close to zero. The remaining East Asian countries pursue a managed float exchange rate system, which is subject to varying degrees of central bank intervention. The data sample is from 1st January 2005 to 31st December 2011.

The composite stock prices, bank stock indices and foreign exchange rates are converted into returns series by taking the logarithms of the indices ratio between two consecutive sessions multiplied by 100, such that:

$$\boldsymbol{R_{i,t} = 100 \times ln\left(\frac{P_{i,t}}{P_{i,t-1}}\right)}$$

Sovereign debt markets*:* Weekly data on changes in sovereign CDS spreads (CDS) on five-year sovereign bonds for nine selected markets were collected from 1st September 2006 to 30th September 2010. The US is considered as the originator of the subprime mortgage crisis and Greece as the originator of the European debt crisis. We use CDS with maturities of 5 years since they are the most liquid contracts and constitute over 85% of the entire CDS market. However, seven-year CDS spreads are used for the US since the five-year CDS data are only available from 11th December 2007, and also the level and movement of the seven-year CDS are almost identical to those of five-year ones[34]. The CDS spreads are preferable to bond yield as proxy variables to analyse the contagion effect in sovereign debt market because they are a very important variable in the context of the global financial crisis. The literature has pointed out that the unregulated multi-trillion dollar OTC CDS market triggered the US subprime mortgage crisis, followed by the credit crisis and finally the systematic financial crisis (Greenberger, 2010). Moreover, credit derivatives create a huge web of exposures across financial institutions, which easily lead to a large jump in value of these contracts and consequently the collapse of the whole financial system if one of the counterparties defaults. CDS also allows for more direct comparison of credit risk interlinkage across countries. Longstaff et al. (2005) show that while the majority of bond spread relates to default risk, there is a significant non-default component attributed to illiquidity. Additionally, new information is incorporated into CDS spreads faster than into bonds (Blanco et al., 2005). Last but not least, analysis of the bond yield may be subject to distortion created by other factors such as tax, maturities and particular covenants inherent in bond contracts (e.g. early call-feature). For example, Elton et al. (2002) find that different tax treatments generate substantial effects on bond spreads. Alexander and Kaeck (2008) indicate that while CDS spreads are usually quoted as a constant maturity, bond yields are not directly comparable when maturities of the underlying bonds differ.

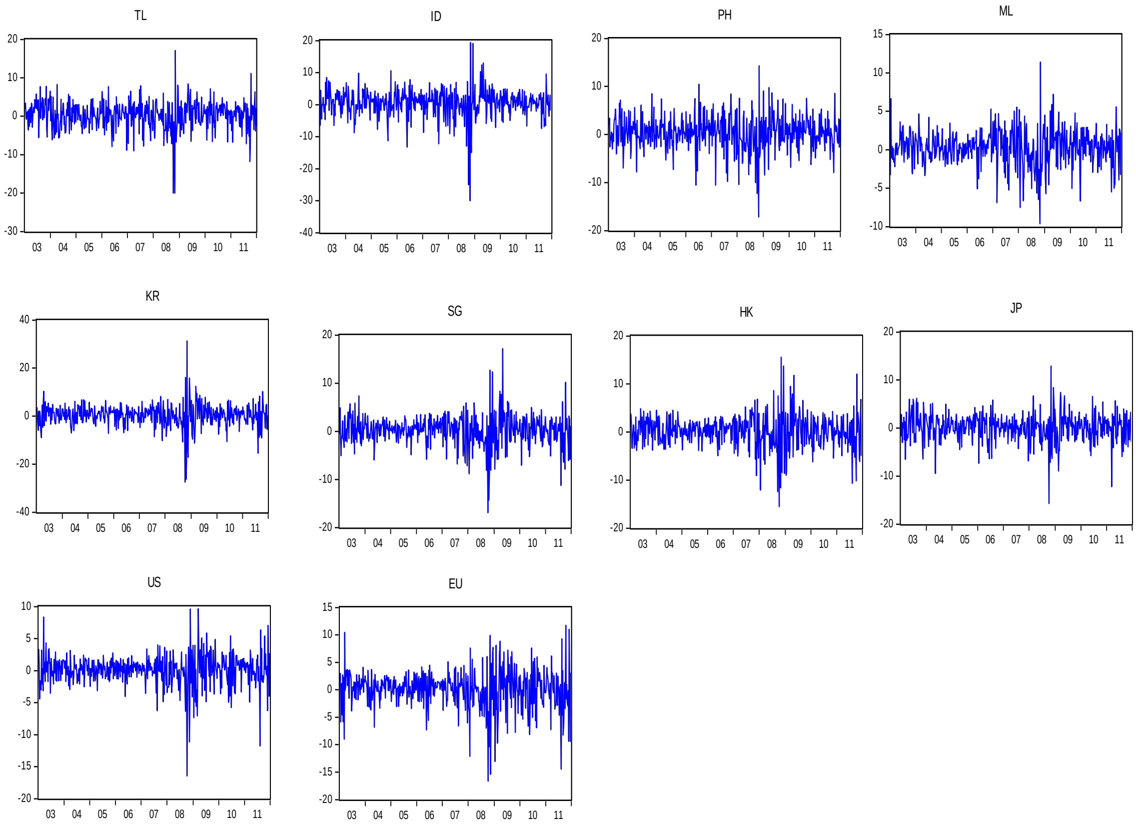
The data are mostly retrieved from Datastream International. Although a higher frequency of daily data is available from Datastream, weekly data are chosen in this study since the daily data contains too much noisy information, which tends to

[34] According to Wang and Moore (2012), the US five-year and seven-year CDS spreads have nearly perfect correlations (0.998) over the crisis period from December 2007 to November 2009. Therefore, the difference in degree of shock transmission of either five-year or seven-year CDS spreads would be very marginal.

produce less powerful results. Additionally, weekly price and return analysis helps avoid non-synchronous trading time horizons among countries[35].

Figures 3.3 – 3.6 show the behaviour of return series on stock price indices, foreign exchange rates and CDS of all countries in the sample. There are large negative stock returns and volatility clusters which occurred during the global financial crisis of 2008-2009. Meanwhile, there is cross-country heterogeneity in the behaviour of the foreign exchange rates and CDS series, which may be caused either by common global shock or country-specific risk characteristics.

Figure 3-3 - Composite stock return series



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35 Kaminsky and Reinhart (2003) find significant time zone effects in equity markets. Forbes and Rigobon (2002) use moving average of returns to control for different in time zones. However, this approach has a drawback that the moving-average filtering may potentially introduce spurious dynamics into the relationships among asset returns.

Figure 3-4 – Bank stock return series

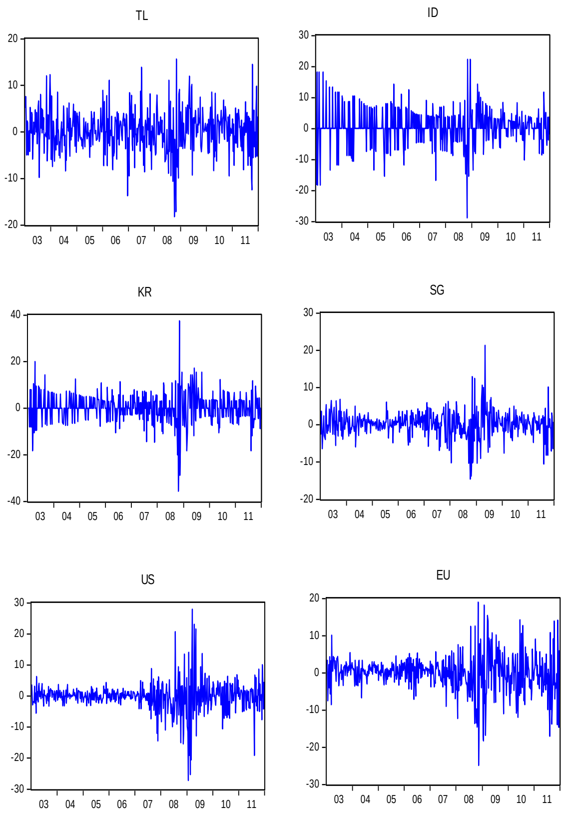


Figure 3-5 – Returns of foreign exchange rates

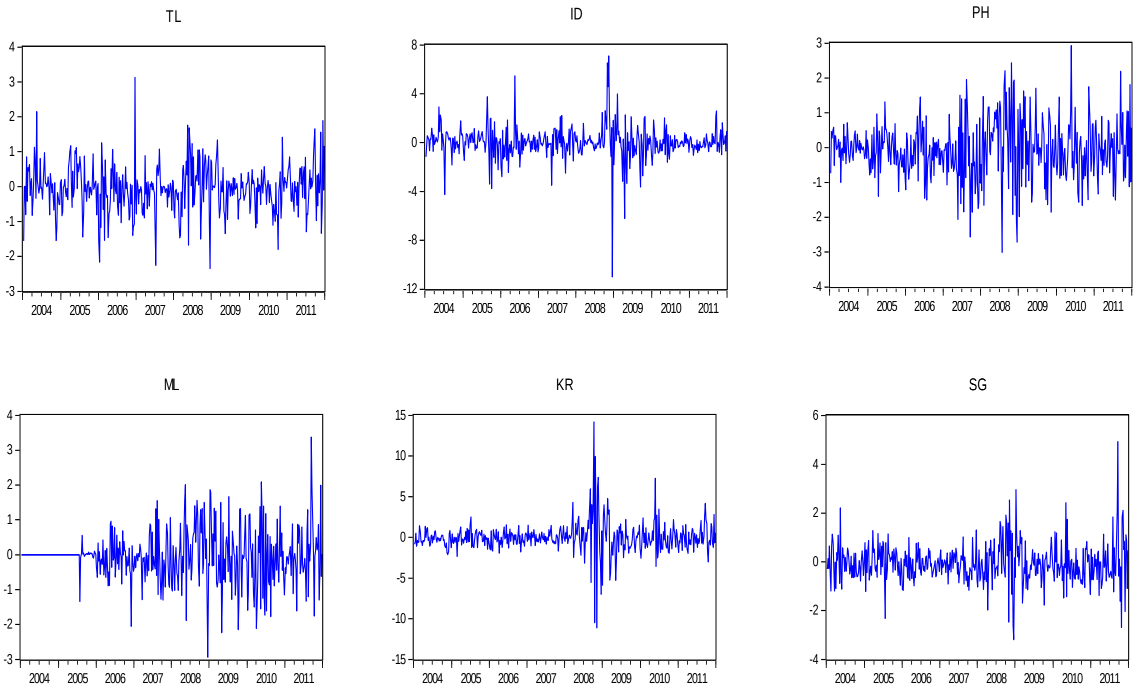
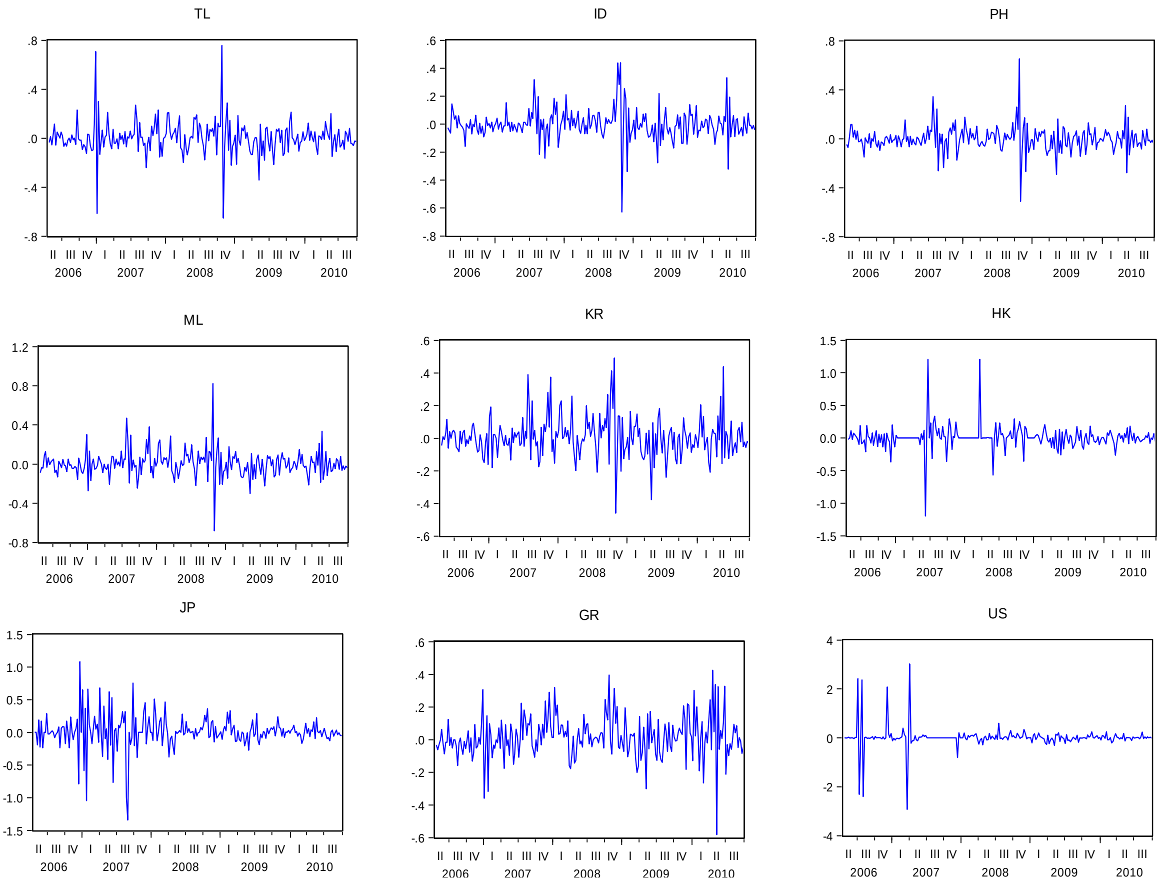


Figure 3-6 - CDS series



3.4.2. Preliminary Analysis

Summary statistics and the correlation structure of variables for sample countries are reported in Tables 3.1, 3.2, 3.3 and 3.4, corresponding to different financial market segments. It is clear from Table 3.1 that the mean values of market return vary significantly across countries. EMEs have higher returns than AEs, and the highest one goes to Indonesia with its mean of 0.394. Euro Stoxx is the only one with a negative average return, implying that the stock index faced a downward trend over the period (bearish stock market). Standard deviations are higher in Korea and Indonesia (4.84 and 4.53 respectively), indicating the existence of higher risk in those countries than the others in the region. Stock returns of all countries are negatively skewed. A distribution with a kurtosis value of more than 3 is described as leptokurtic relative to normal. This indicates that the distribution of stock returns in all analysed markets tend to have extreme values. The stock markets in East Asian countries are all positively correlated with US and European markets at a similar magnitude of between 0.5 and 0.8. However, simple correlations merely provide insight into short run market linkages.

Table 3.1 - Descriptive statistics of stock returns series

	TL	ID	PH	ML	KR
Mean	0.139	0.394	0.321	0.202	0.209
Median	0.449	0.905	0.288	0.317	0.69
Maximum	17.061	19.358	14.304	11.407	31.309
Minimum	-20.001	-29.974	-17.143	-9.608	-27.4
Std. Dev.	3.761	4.539	3.664	2.404	4.84
Skewness	-0.655	-1.148	-0.383	-0.257	-0.512
Kurtosis	7.104	11.038	5.055	4.874	11.988
Jarque-Bera	323.24	1216.93	83.79	65.79	1425.37
Probability	0	0	0	0	0
Observations	418	418	418	418	418
Correlations					
with US	0.448	0.451	0.444	0.51	0.522
with EU	0.53	0.541	0.532	0.615	0.629

	SG	HK	EU	US
Mean	0.174	0.095	-0.011	0.032
Median	0.514	0.331	0.376	0.207
Maximum	17.188	15.575	11.734	9.639
Minimum	-16.899	-15.524	-16.609	-16.451
Std. Dev.	3.29	3.532	3.656	2.521
Skewness	-0.369	-0.264	-0.759	-1.139
Kurtosis	7.799	6.19	5.79	9.803
Jarque-Bera	410.62	182.09	175.67	896.34
Probability	0	0	0	0
Observations	418	418	418	418
Correlations				
with US	0.676	0.618	0.801	1.000
with EU	0.764	0.675	1.000	0.801

Table 3.2 shows descriptive statistics of bank stock return data. Compared with composite stock returns, the banking industry has lower mean values but higher standard deviations in most of the countries, except Thailand, Indonesia and

Malaysia. This implies that the banking sector suffered relatively more devaluation than other industries as a consequence several banks' and financial institutions' failure and bailout during the period 2007-2009. Banks in the large developed markets of the US, Europe and Hong Kong have negative average returns and again the Indonesian banking sector has the highest value, 0.429. It is interesting that East Asian bank returns are more correlated with those of the European banks rather than the US ones. Negative skewness coefficients indicate these series are exposed to an asymmetric distribution, which is inclined to the left.

Table 3.2 - Descriptive statistics of bank stock returns series

	TL	ID	PH	ML	KR
Mean	0.146	0.429	0.245	0.221	0.08
Median	0.307	0	0.221	0.318	0
Maximum	15.631	22.314	15.135	13.113	37.469
Minimum	-18.2	-28.768	-15.924	-10.277	-35.667
Std. Dev.	4.527	5.356	3.703	2.693	6.321
Skewness	-0.172	-0.322	-0.227	-0.145	-0.343
Kurtosis	4.294	6.218	5.442	5.315	9.29
Jarque-Bera	31.25	187.53	107.42	94.84	697.31
Probability	0	0	0	0	0
Observations	418	418	418	418	418
Correlations					
with US	0.307	0.264	0.508	0.382	0.403
with EU	0.475	0.477	0.53	0.569	0.581

	SG	HK	EU	US
Mean	0.142	-0.009	-0.23	-0.221
Median	0.429	0.088	-0.035	0.272
Maximum	21.351	15.653	27.928	18.982
Minimum	-14.592	-14.842	-27.152	-24.843
Std. Dev.	3.53	3.686	5.132	5.322
Skewness	-0.015	-0.166	-0.163	-0.385
Kurtosis	8.219	7.186	11.213	5.74
Jarque-Bera	474.33	307.09	1176.64	141.11
Probability	0	0	0	0
Observations	418	418	418	418
Correlations				
with US	0.343	0.515	0.652	1.000

with EU	0.708	0.661	1.000	0.625

The descriptive statistics of return on nominal foreign exchange rates are reported in Table 3.3, which shows that the mean values vary across countries. While most of the East Asian countries' currencies have negative average returns, which reflect an overall appreciation trend, Korean won shows downward pressure on the local currency over the period, evidenced by a positive mean value. Korean won also has the highest standard deviations, implying they are more volatile than the others in the group. The skewness and kurtosis statistics indicate that none of the data series have normal distribution. As the region has close links through intra-regional and inter-regional trade, all the currencies show high pair-wise correlations, with the highest correlations belonging to Singapore dollar and Malaysian ringgit, Malaysian ringgit and Indonesian rupiah, Malaysian ringgit and Philippine peso, and Philippine peso and Korean won (above 0.5).

Table 3.3 - Descriptive statistics of return on foreign exchange rate series

	TL	**ID**	**PH**	**ML**	**KR**	**SG**
Mean	-0.057	-0.004	-0.067	-0.049	0.025	-0.063
Median	-0.034	0.000	-0.072	-0.014	-0.053	-0.134
Maximum	3.128	7.087	2.927	3.373	14.182	4.927
Minimum	-2.346	-11.006	-3.004	-2.942	-11.113	-3.182
Std. Dev.	0.670	1.385	0.877	0.790	2.025	0.830
Skewness	0.100	-0.777	0.052	0.149	0.603	0.666
Kurtosis	4.930	17.977	3.558	4.394	15.744	7.630
Jarque-Bera	57.43	3457.76	4.91	30.99	2499.00	354.03
Probability	0.00	0.00	0.09	0.00	0.00	0.00
Observations	366	366	366	366	366	366
	TL	**ID**	**PH**	**ML**	**KR**	**SG**
TL	1.000					
ID	0.361	1.000				
PH	0.330	0.403	1.000			
ML	0.448	0.524	0.509	1.000		

KR	0.297	0.347	0.505	0.458	1.000	
SG	0.416	0.377	0.277	0.607	0.319	1.000

CDS data series of all countries are very highly volatile. It is noticeable from Table 3.4 that Greece experienced the highest average change in CDS spreads, which is consistent with the sovereign debt crisis, which has occurred in this country from 2009. The distributions are not normal – they are leptokurtic and positively skewed (except Indonesia, US and Greece, which are negatively skewed). The CDS spreads in East Asian are all correlated with the US market at a similar magnitude around 0.2. While Indonesia and Philippines report low correlations with the US, these series tend to show higher correlations with the Greece.

Table 3.4 - Descriptive statistics of CDS spreads series

	TL	**ID**	**PH**	**ML**
Mean	0.308	-0.093	-0.148	0.249
Median	-0.06	-1.115	-0.7	0
Maximum	240	446.3	382.5	261.7
Minimum	-216.7	-586.7	-319.5	-230.9
Std. Dev.	26.532	64.834	40.748	27.838
Skewness	0.924	-1.877	1.541	1.229
Kurtosis	53.765	45.768	55.616	60.13
Jarque-Bera	22902.3	16358.4	24654.5	29019.8
Probability	0	0	0	0
Observations	213	213	213	213
Correlations				
with US	0.223	0.089	0.157	0.201
with GR	0.145	0.15803	0.195	0.169
	KR	**HK**	**GR**	**US**
Mean	0.361	0.183	3.588	0.251
Median	0.2	0	0.3	0
Maximum	235.4	40.8	314.94	17.59
Minimum	-222.9	-32.6	-414.45	-17.05
Std. Dev.	29.712	7.053	52.857	4.377
Skewness	0.456	0.247	-0.505	-0.044
Kurtosis	35.529	11.932	31.317	8.573

Jarque-Bera	9398.16	710.28	7125.53	275.75
Probability	0	0	0	0
Observations	213	213	213	213
Correlations				
with US	0.239	0.24	0.277	1.000
with GR	0.19	0.167	1.000	0.277

Note: The descriptive statistics are conducted on the difference of CDS series (rather than log difference) to capture the behaviour of variables during the examined period.

In summary, the descriptive statistics imply several key features. First, the asset price correlations between East Asian countries, and correlations between Asian and the US, European countries, are relatively high, which justifies our preference for modelling the relationships and interactions between markets with multivariate VAR. Second, the proxy variables in the four analysed financial market segments appear to be highly volatile, especially in the CDS series. The largest reductions in prices or returns (minimum value) occur simultaneously in all markets during the time of the global financial market turmoil, which may be due to interdependence or contagion effects. Third, the high level of kurtosis evidences the existence of large shocks (of either sign) in all markets. The low probability values of the Jarque-Bera statistics in all cases reject normality of the data at any level of statistical significance and the presence of non-linearities. Therefore, we incorporate regime switching in VAR models to capture the role of volatility shocks and non-linear interactions caused by the shocks. Finally, there is considerable cross-country heterogeneity in market performance and in response to shocks. The combination of MS-VAR and the correlation breakdown tests of Dungey et al. (2005) and Forbes and Rigobon (2002) will deal with the time-series and cross-sectional clustering that is commonly found in the literature.

Prior to proceeding with the model estimations, the stationarity in time series data are checked with the Augmented Dickey Fuller (ADF) test at level and first difference. The unit root test results are reported in Table 3.5 which suggests that the null hypothesis of a unit root in market stock returns, bank stock returns and foreign exchange rates is rejected in both the level and first difference. However, the CDS series are non-stationary on their levels, while they are stationary on their first differences. Therefore, the log differenced series of CDS are used in the estimation of the MS-VAR model.

Table 3.5 - Stationarity ADF test results

	Market stock returns		**Bank stock returns**	
	Level	1st diff	Level	1st diff
TL	-20.962	-11.319	-22.105	-14.430
ID	-9.798	-17.847	-22.509	-17.769
PH	-21.205	-13.649	-21.362	-10.872
ML	-18.778	-12.784	-18.707	-16.050
KR	-11.026	-11.196	-23.101	-14.261
SG	-9.809	-13.835	-9.446	-13.667
HK	-21.274	-14.049	-20.989	-13.156
US	-21.241	-13.757	-24.645	-15.082
EU	-21.872	-11.143	-22.414	-11.075
	Foreign exchange rates		**CDS spreads**	
	Level	1st diff	Level	1st diff
TL	-16.018	-13.111	-1.716	-17.705
ID	-8.481	-12.175	-1.450	-15.703
PH	-18.452	-13.653	-1.510	-17.550
ML	-17.863	-10.638	-1.356	-16.970
KR	-10.821	-10.372	-1.285	-14.107
SG	-19.285	-11.204		
HK			-1.452	-12.803
US			-2.857	-15.348
GR			-0.028	-15.701
Test critical values		10%: -2.57;	5%: -2.87;	1%: -3.46

Note: The choice of lag length is based on the Schwarz Information Criterion.

3.5. Empirical Results

3.5.1. Structural Break in Volatility and Volatility Spillovers with MS-VAR Estimations

This section explores the nonlinear interactions between East Asian financial markets and those of the US and Europe by assuming that all the series are regime-dependent. A two regime multivariate MS-VAR model with switches in both mean and variance is applied. We first use AIC to select the optimal lag length in the models, which suggests 1 lag for stock return and CDS series, and 3 lags for foreign exchange rate series. Tables 3.6, 3.7, 3.8 and 3.9 show the estimated parameters of MSMH(2)-VAR(p) for different financial market segments, which include the switching means $\mu_1,\ \mu_2$; variances of two regimes σ_1^2, σ_2^2; the probability of state in each regime p_{11}, p_{22}as well as regime-switching probabilities p_{12}, p_{21}; and the expected duration D_{s_1}, D_{s_2}. We also report the autoregressive parameters (up to lag 1) to view the dynamic relationship between variables. In all cases, the statistical results indicate that the data sets fit the model specifications. The LR-test statistics show that the hypotheses of linear specification are rejected at a significant level of 1%, which supports our hypothesis of the regime-switching behaviour in time-series data of stock returns, foreign exchange rates and sovereign CDS spreads. This may also imply the better fit of MS model compared with the existing linear models, which have been widely used to study the relationships and linkages between financial markets.

3.5.1.1. Equity Markets

As can be seen in Table 3.6, volatility breaks are one of the defining characteristics of the stock markets in every East Asian country as a consequence of the global financial crisis during the period 2007-2011. The models significantly differentiate two trends in stock returns series: (i) state 1, with positive means and low variances, corresponding to a stable regime; and (ii) state 2, with negative means and high variances, representing a crisis regime. Negative means in the crisis regime in all countries in the sample evidence the sharp trend of decline in stock prices following the US shock. The jump in mean is also associated with the switch in variances, marked with especially high σ_2^2 (around 2 to 8 times higher than σ_1^2), varying across countries. Korea is the country in East Asia which experienced the highest volatility during the crisis, as well as the highest variation in volatility between the two regimes, even higher than the crisis-trigger, the US. This result is fairly consistent with the stylised fact that Korea had accumulated a very large portfolio flows before the crisis. Non-resident investors have accounted for one-half of market capitalisation, making this country highly susceptible to changes in global market sentiments and the consequent deleveraging effects. The jump in means and variance is also quite drastic in Hong Kong and Singapore, as these two developed markets have a high proportion of foreign factors and tend to have stronger integration with AEs in North America and Europe. This is consistent with the financial literature, which proves that the higher the globalisation of an economy, the greater the incidence of volatility transmission as a result of the information generating process (Arago-Manzana et al., 2006). On the contrary, the degree of international integration is weaker for emerging East Asia (Thailand, Indonesia, Philippines and Malaysia), partly due to the limitations on capital flows.

The probabilities for the countries to stay in the same state (normal or crisis) are much higher than the probabilities of switching between different states, which implies that countries that remained in a stable state in a previous period intend to stay in that stable situation now, while countries where crises broke out in a previous period find themselves dragged into deeper turmoil. In addition, the probability of staying in regime 2 is lower than in regime 1, which suggests that regime 1 is more persistent than regime 2. The expected durations indicate that on average all the series stay longer in regime 1 (25 weeks) than in regime 2 (6 weeks). This may imply the short-lived effect of volatility spillovers. Indeed, the equity markets in Asia resumed quickly after the second quarter of 2009. The results also show strong lead-lag interactions in stock returns between East Asia and the US. All East Asian stock market returns are significantly affected by the previous one week return in the US market, but there is less significant evidence of interactions with European markets.

Table 3.6 - Estimated parameters of the MSMH(2)-VAR(1) model for composite stock returns

	TL	ID	PH	ML	KR	SG	HK	US	EU
Mean (μ_1)	0.323**	0.789***	0.662***	0.436***	0.678***	0.508***	0.394***	0.271***	0.295***
	(0.145)	(0.166)	(0.157)	(0.106)	(0.151)	(0.118)	(0.126)	(0.079)	(0.131)
Mean (μ_2)	-0.478	-0.860	-0.913**	-0.631*	-1.424**	-1.035**	-0.906*	-0.855**	-1.141**
	(0.519)	(0.712)	(0.413)	(0.347)	(0.656)	(0.507)	(0.512)	(0.334)	(0.493)
Variance ($\sigma^2{}_1$)	8.727***	9.948***	9.912***	3.408***	7.7918***	4.571***	5.490***	2.577***	6.371***
	(0.554)	(0.710)	(0.734)	(0.246)	(0.571)	(0.377)	(0.389)	(0.194)	(0.531)
Variance ($\sigma^2{}_2$)	30.531***	53.640***	20.451***	12.710***	67.188***	31.018***	33.824***	19.345***	36.104***
	(2.587)	(4.672)	(2.005)	(1.205)	(6.588)	(1.599)	(2.832)	(1.757)	(2.189)
TL(-1)	-0.100**	0.025	0.004	0.002	-0.067	-0.022	-0.038	-0.021	-0.055
	(0.047)	(0.050)	(0.049)	(0.029)	(0.043)	(0.033)	(0.034)	(0.024)	(0.039)
ID(-1)	0.032	-0.112**	-0.008	-0.019	-0.071	-0.023	-0.056	-0.027	0.033
	(0.044)	(0.054)	(0.045)	(0.028)	(0.045)	(0.035)	(0.036)	(0.024)	(0.040)
PH(-1)	0.016	-0.074	-0.143***	-0.044	-0.006	-0.016	-0.030	-0.021	-0.103*
	(0.051)	(0.061)	(0.056)	(0.034)	(0.055)	(0.042)	(0.044)	(0.030)	(0.049)
ML(-1)	-0.278***	-0.313***	-0.108	0.003	-0.243***	-0.012	-0.089	0.011	-0.100
	(0.083)	(0.100)	(0.089)	(0.058)	(0.091)	(0.070)	(0.073)	(0.054)	(0.082)
KR(-1)	0.127***	0.097*	-0.081*	-0.046	-0.098**	-0.005	0.012	-0.039	-0.039
	(0.047)	(0.052)	(0.044)	(0.029)	(0.050)	(0.036)	(0.037)	(0.044)	(0.044)
SG(-1)	0.285***	0.411***	0.247***	0.193***	0.357***	0.089	0.194**	0.162***	0.246***
	(0.098)	(0.112)	(0.094)	(0.065)	(0.109)	(0.081)	(0.084)	(0.061)	(0.093)
HK(-1)	-0.234***	-0.104	-0.022	-0.043	-0.206***	-0.112*	-0.156***	-0.131***	-0.051
	(0.068)	(0.075)	(0.067)	(0.046)	(0.079)	(0.057)	(0.055)	(0.040)	(0.063)
US(-1)	0.437***	0.331***	0.347***	0.173***	0.457***	0.263***	0.398***	-0.054	0.145*

	(0.083)	(0.096)	(0.083)	(0.052)	(0.091)	(0.064)	(0.064)	(0.054)	(0.082)
EU(-1)	-0.172***	-0.032	-0.052	-0.010	0.123**	-0.001	0.030	0.051	-0.108**
	(0.063)	(0.070)	(0.061)	(0.039)	(0.061)	(0.044)	(0.047)	(0.037)	(0.054)
P_{11}									0.959***
									(0.281)
P_{21}									0.041***
									(0.012)
P_{12}									0.169***
									(0.008)
P_{22}									0.831***
									(0.042)
Expected duration of "stable" regime (Ds_1)									24.39
Expected duration of "crisis" regime (Ds_2)									5.917
Log Likelihood									-7970

Notes: *, ** and *** indicate 10%, 5% and 1% significant levels, respectively

Standard errors in parentheses.

The number of lag for MS-VAR is 1, which is decided based on AIC

The same inference for the banking sector is shown by the estimated parameters reported in Table 3.7. There are also positive means and lower variances for the stable regime, but negative means and higher variances for the crisis regime. As the epicentres of the global financial crisis were the US and European banking sectors, who had wide exposure to securities backed by US subprime mortgages, they consequently incurred significant unexpected losses. Bank returns in those countries have higher variances than those of the aggregate markets during volatile regimes. These two crisis-originators also show the biggest variation of variances between the two regimes, around 8-12 times. In East Asia, volatilities in returns are not as sharp and persistent as those of the shock sources. σ_2^2 significantly double or triple σ_1^2 in emerging markets, while the variation between σ_2^2 and σ_1^2 are much higher in Hong Kong and Singapore as the two financial centres have a large incidence of foreign-owned bank presence and therefore tend to follow the crisis-originators. In general, East Asian banks' direct exposures to toxic assets are quite limited, therefore the banking system only suffered from indirect effects of the turmoil caused by bank deleverage. Among emerging East Asia, Korea is more vulnerable to a systematic banking crisis because of the highly leveraged banking sector and remarkable increase in foreign short-term debts before the crisis period. This gives a good explanation for the extremely high variance in bank stock return series in this country during the crisis regime. The transition matrix shows that both regimes are quite stable and the probabilities of staying in the crisis regime are as high as in the stable regime (0.92 and 0.96, respectively). The duration of crisis regime is 12 weeks, which is double that of the returns on composite stock market indices. This may suggests the greater volatility persistence and greater sensitivities in prices of the banking sectors compared to other industries in the equity markets.

MS-VAR models also provide smoothed regime probabilities, as shown in Figures 3.7 and 3.8. There are signs that shock from the US stock market in 2007-2008 significantly affected the stock return structure in East Asian countries. We observe major shifts occurring at three important points of time. There is one that happened in late 2007, around the event of the suspension of the three funds of Banque Nationale de Paris (BNP) Parisbas in August 2007. The major shift, which appears to be the most persistent one, followed the collapse of Lehman Brothers in September 2008. The third one occurred in mid-2011, at the height of the European debt crisis. This may suggest integration between international stock markets and rapid transmission of information, which cause structural changes in prices in many markets simultaneously. However, it is interesting to examine the relative differences in responses to shocks between composite return series and bank return series. To confirm the analysis above, the overall market returns are more prone to shifts in regimes, while bank return series have tended to stay persistently in regime 2 since late 2007. It seems that a very significant adverse shock in the US might have destabilising impacts on the stock markets of many Asian economies via a deleveraging process. This process continues to have a greater impact on the banking sector following the massive European bank deleveraging in response to the rising turmoil in the euro zone area.

Table 3.7 - Estimated parameters of the MSMH(2)-VAR(1) model for bank stock returns

	TL	**ID**	**PH**	**ML**	**KR**	**SG**	**HK**	**US**	**EU**
Mean (μ_1)	0.362**	0.711***	0.603***	0.445***	0.496**	0.504***	0.183*	-0.029	0.202
	(0.218)	(0.241)	(0.173)	(0.135)	(0.227)	(0.129)	(0.110)	(0.114)	(0.152)
Mean (μ_2)	-0.346	-0.138	-0.107	0.113	-0.324	-0.608*	-0.111	-0.362	-1.050**
	(0.345)	(0.405)	(0.235)	(0.201)	(0.395)	(0.215)	(0.247)	(0.367)	(0.348)
Variance ($\sigma^2{}_1$)	13.959***	20.419***	7.639***	3.961***	15.228***	4.077***	3.382***	4.621***	8.074***
	(1.134)	(1.176)	(0.627)	(0.307)	(1.268)	(0.353)	(0.321)	(0.567)	(0.997)
Variance ($\sigma^2{}_2$)	30.876***	37.990***	22.500***	12.747***	79.784***	27.844***	32.570***	64.865***	64.068***
	(3.079)	(3.343)	(2.004)	(1.221)	(7.487)	(2.706)	(3.294)	(7.074)	(5.539)
TL(-1)	-0.084	-0.008	0.067	0.052*	-0.039	0.045	0.045	-0.007	-0.023
	(0.051)	(0.060)	(0.042)	(0.029)	(0.060)	(0.028)	(0.028)	(0.033)	(0.042)
ID(-1)	0.024	-0.207***	-0.027	-0.002	0.011	0.034	-0.006	-0.002	0.032
	(0.037)	(0.040)	(0.030)	(0.019)	(0.040)	(0.021)	(0.020)	(0.026)	(0.029)
PH(-1)	0.068	-0.043	-0.165***	-0.038	-0.002	-0.001	0.012	-0.056	-0.055
	(0.054)	(0.059)	(0.041)	(0.027)	(0.055)	(0.027)	(0.027)	(0.042)	(0.041)
ML(-1)	0.036	0.016	0.046	0.049	-0.181*	-0.015	-0.109**	0.045	-0.094
	(0.084)	(0.095)	(0.068)	(0.045)	(0.098)	(0.054)	(0.048)	(0.062)	(0.070)
KR(-1)	0.053	0.109**	-0.030	-0.036*	-0.102**	0.014	0.017	0.049*	0.066**
	(0.039)	(0.043)	(0.031)	(0.022)	(0.046)	(0.026)	(0.024)	(0.028)	(0.033)
SG(-1)	0.241***	0.283***	0.252***	0.137***	0.318***	0.017	0.071	-0.003	0.155**
	(0.082)	(0.093)	(0.063)	(0.045)	(0.045)	(0.053)	(0.049)	(0.065)	(0.069)
HK(-1)	-0.228***	-0.014	-0.017	-0.016	-0.229***	-0.043	-0.034	-0.076	0.005
	(0.069)	(0.079)	(0.057)	(0.043)	(0.085)	(0.052)	(0.049)	(0.061)	(0.069)
JP(-1)	-0.043	-0.078	-0.037	-0.006	-0.205***	-0.057*	-0.110***	-0.051	-0.159***

	(0.059)	(0.067)	(0.045)	(0.032)	(0.066)	(0.034)	(0.031)	(0.039)	(0.044)
US(-1)	0.082**	0.125**	0.143***	0.073**	0.161**	0.108**	0.117***	-0.064*	0.090**
	(0.041)	(0.057)	(0.043)	(0.031)	(0.068)	(0.043)	(0.043)	(0.037)	(0.057)
EU(-1)	-0.99**	-0.013	-0.071	-0.032	0.109*	-0.047	0.009	-0.072*	-0.119**
	(0.048)	(0.064)	(0.045)	(0.032)	(0.064)	(0.041)	(0.040)	(0.043)	(0.049
P_{11}									0.964***
									(0.329)
P_{21}									0.036***
									(0.012)
P_{12}									0.077***
									(0.002)
P_{22}									0.923***
									(0.025)
Expected duration of "stable" regime (Ds_1)									25.641
Expected duration of "crisis" regime (Ds_2)									12.987
Log Likelihood									-9182

Notes: *, ** and *** indicate 10%, 5% and 1% significant levels, respectively

Standard errors in parentheses.

The number of lag for MS-VAR is 1, which is decided based on AIC

Figure 3-7 - Smooth Probabilities of crisis regime for market stock returns

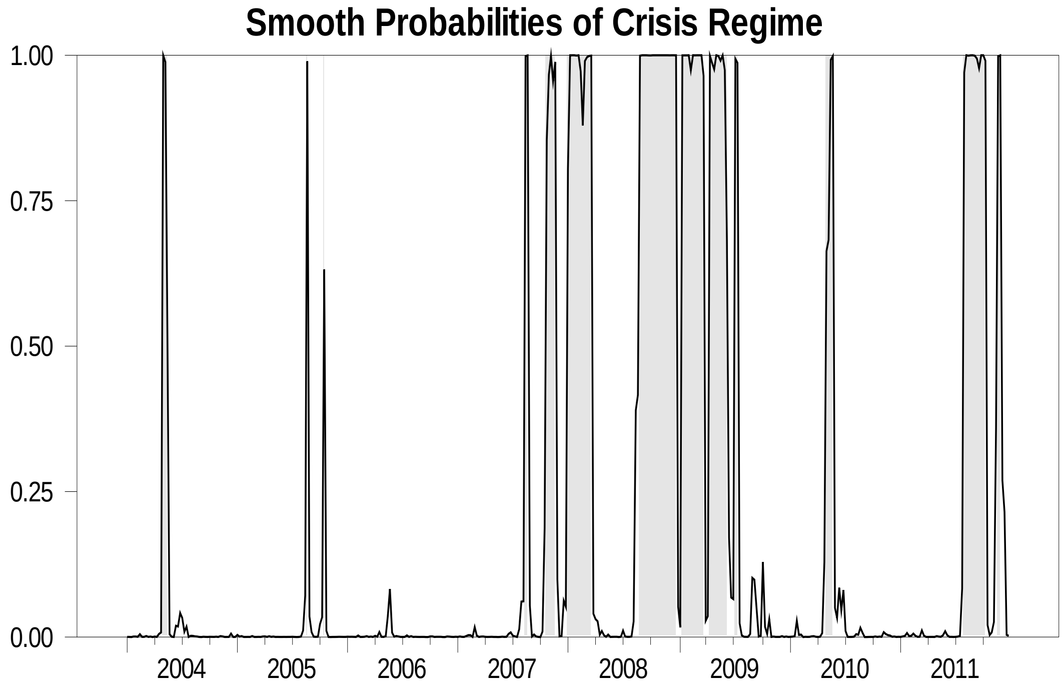
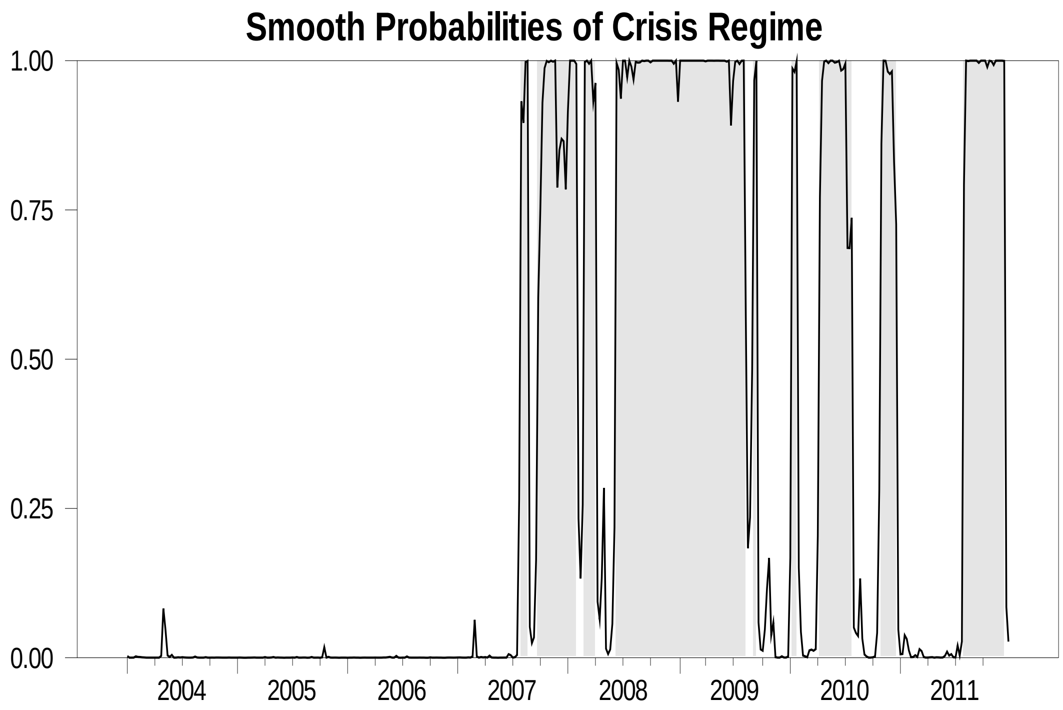


Figure 3-8 - Smooth Probabilities of crisis regime for bank stock returns



3.5.1.2. Foreign Exchange Markets

The returns in nominal foreign exchange rates are also shown by two different regimes. Regime 1 (stable state) is characterised by negative means and low variances, implying a slight appreciation of the domestic currency against the US dollar. The switch to regime 2 (crisis state) is associated with positive average returns accompanied by a higher level of volatility, suggesting mounting pressures on the foreign exchange rates. Capital flows out of the region as a consequence of massive sell-offs by international investors and the continued reversal of the carry trade leads to the sharp depreciation of local currencies across countries, although to a different extent. Currency volatility shocks appear to be more serious in Korea as the shift in the Korean won is the most drastic, marked by the highest difference in mean and an especially high variance in regime 2, as well as the largest spread between σ_2^2 and σ_1^2 (more than 14 times). Indonesia is also a country with high variation in volatility between the two regimes (more than 10 times). There is a persistence to stay in regimes rather than to switch, since p_{11} and p_{22} are all high (more than 0.8) and significant at the level of 1%.

The expected duration in the stable regime is around 20 weeks and in the crisis regime for around 5 weeks. As the parameters of the exchange rate series appear to be consistent with those of the composite stock return series, this may indicate the interrelation between the stock market and foreign exchange market. There may be volatility spillovers between these two market segments. This is consistent with the findings of Maghrebi et al. (2006), who provide evidence for the dynamic relationship between stock market volatility and foreign exchange fluctuation in

Asia Pacific countries[36]. The estimated results in Table 3.9 also confirm the lead-lag interaction of Asian local currencies. In particular, the strength of the Singapore dollar has some predictive power on other currencies in the region, as its lagged coefficients with the others are all positive and significant at a level of 1%. The regime smooth probabilities in Figure 3.9 capture well the period of global financial market turbulence. The most obvious shift occurs on the depth of the US subprime crisis in late 2008 (i.e. after the collapse of Lehman Brothers). In general, this picture shows the coherence in behavioural responses with that of the stock returns. There is also a jump in late 2005, which may be caused by local shock but it is not particularly persistent. However, compared to equity markets, foreign exchange rates appear to be more stable after the first half of 2009. The reason is that immediately after the Lehman affair, authorities in East Asian countries had time-line intervention to stabilise foreign exchange markets, such as use of official reserves, arranging stand-by loans from the World Bank and ADB, introducing foreign exchange swap facilities and lowering reserve requirements in foreign currency deposits.

[36] Maghrebi et al. (2006) show that "bad news about equity accompanied with currency depreciation is likely to generate higher volatility in foreign exchange markets and that such depreciations have also the potential of whittling down the leverage effects" (Maghrebi et al., 2006, p.253).

Table 3.8 - Estimated parameters of the MSMH(2)-VAR(3) model for foreign exchange rates

	TL	**ID**	**PH**	**ML**	**KR**	**SG**
Mean (μ_1)	-0.091**	-0.077*	-0.160***	-0.120***	-0.106**	-0.121***
	(0.038)	(0.046)	(0.038)	(0.031)	(0.046)	(0.027)
Mean (μ_2)	0.065	0.214	0.299***	0.223**	0.579**	0.151
	(0.087)	(0.210)	(0.093)	(0.091)	(0.234)	(0.101)
Variance ($\sigma^2{}_1$)	0.338***	0.566***	0.546***	0.410***	0.854***	0.329***
	(0.021)	(0.046)	(0.036)	(0.021)	(0.066)	(0.021)
Variance ($\sigma^2{}_2$)	0.529***	6.530***	1.128***	0.991***	12.058***	1.883***
	(0.080)	(0.971)	(0.156)	(0.130)	(1.180)	(0.283)
TL(-1)	0.011	-0.135*	-0.009	-0.041	-0.082	-0.041
	(0.040)	(0.072)	(0.048)	(0.042)	(0.082)	(0.045)
ID(-1)	-0.022	-0.085**	-0.017	-0.035*	0.004	0.042*
	(0.020)	(0.036)	(0.023)	(0.020)	(0.043)	(0.022)
PH(-1)	0.060*	-0.133**	-0.095**	-0.084**	-0.046	-0.097***
	(0.032)	(0.054)	(0.037)	(0.035)	(0.069)	(0.036)
ML(-1)	-0.104***	-0.072	-0.002	-0.157***	-0.093	-0.069
	(0.041)	(0.075)	(0.048)	(0.048)	(0.082)	(0.047)
KR(-1)	-0.001	0.048	-0.017	0.005	-0.224***	0.043
	(0.017)	(0.035)	(0.022)	(0.022)	(0.040)	(0.024)
SG(-1)	0.271***	0.208***	0.268***	0.347***	0.732***	-0.094**
	(0.037)	(0.063)	(0.047)	(0.042)	(0073)	(0.044)
P_{11}						0.951***
						(0.012)

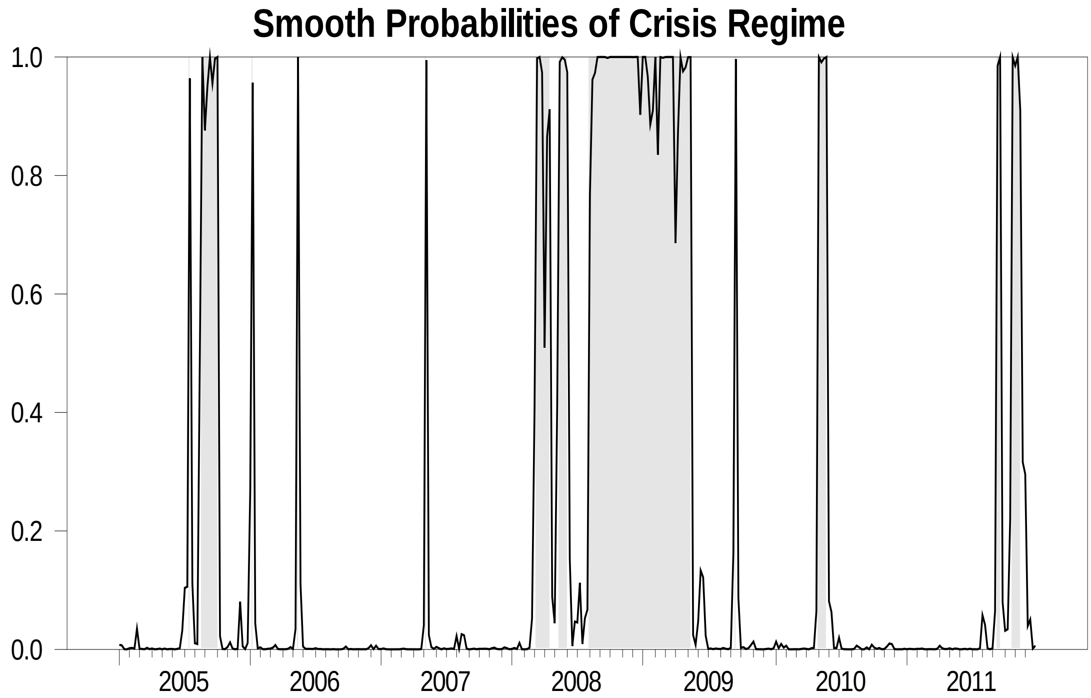
P_{21}	0.049***
	(0.0005)
P_{12}	0.189***
	(0.044)
P_{22}	0.811***
	(0.188)
Expected duration of "stable" regime (Ds_1)	20.408
Expected duration of "crisis" regime (Ds_2)	5.291
Log Likelihood	-2368

Notes: *, ** and *** indicate 10%, 5% and 1% significant levels, respectively

Standard errors in parentheses.

The number of lag for MS-VAR is 3, which is decided based on AIC

Figure 3-9 – Smooth Probabilities of crisis regime for foreign exchange rates



3.5.1.3. Credit Derivative Markets

The estimated parameters shown in Table 3.9 provide evidence of structural breaks in the volatility of CDS spread series, while the mean parameters are not always significant at conventional levels. The variances in regime 2 are significantly higher than those of regime 1 in all countries. We can observe the remarkable variation in variances between the two regimes in the crisis generator, the US, where σ_2^2 is 82 times higher than σ_1^2. The variations are around 8 to 10 times in emerging East Asia, while they are quite limited in Hong Kong (around 1.5 times). As a net creditor economy supported by strong fundamentals, Hong Kong has been highly rated and suffered moderate increases in sovereign CDS spreads (less than 100 basis points according to the data) in the aftermath of the bankruptcy of Lehman Brothers. On the other hand, emerging East Asia are net debtor economies, which have been evaluated as being more risky and therefore saw an unprecedented surge in CDS spreads during the period. For example, spreads increased by approximately 885 basis points in Indonesia and 500 basis points in Thailand, Malaysia and Korea. The model estimation delivers 88.5% for p_{11} and 32.8% for p_{22}. This implies that there is a higher probability for regime 2 to switch to regime 1 than to stay in that regime. On average, the market spends 8.5 successive weeks in the stable regime, while time in the crisis regime would end after about 1.5 weeks. The smooth probabilities also confirm that during the period from September 2007 to the end of 2008, the high volatility regime rose steeply; therefore it was not particularly persistent. Weeks with positive means and high volatilities cluster with weeks with negative means and low volatilities. The high volatility regime returns in mid-2010, which coincides with the debt crisis in Greece. However, it occurs over a very short period of time and then rapidly switches to a stable regime. The estimated autoregressive parameters show no significant evidence of lead-lag interactions between CDS markets in East Asia and those of the US and Greece.

Table 3.9 - Estimated parameters of the MSIH(2)-VAR(1) model for CDS

	TL	**ID**	**PH**	**ML**	**KR**	**HK**	**US**	**GR**
Mean (μ_1)	-0.006	-0.008	-0.007	-0.006	-0.005	-0.008	0.005	0.011
	(0.007)	(0.005)	(0.005)	(0.007)	(0.008)	(0.007)	(0.007)	(0.008)
Mean (μ_2)	0.089**	0.031	0.028	0.075*	0.054	0.075	0.205	0.075***
	(0.036)	(0.033)	(0.031)	(0.040)	(0.036)	(0.066)	(0.139)	(0.031)
Variance (σ^2_1)	0.008***	0.005***	0.004***	0.009***	0.009***	0.009***	0.009***	0.011***
	(0.008)	(0.005)	(0.004)	(0.009)	(0.009)	(0.001)	(0.001)	(0.001)
Variance (σ^2_2)	0.069***	0.046***	0.040***	0.070***	0.045***	0.160***	0.744***	0.043***
	(0.014)	(0.009)	(0.007)	(0.013)	(0.008)	(0.036)	(0.169)	(0.010)
TL(-1)	0.089	0.141*	0.167**	0.149	0.189*	-0.108	0.131	0.225*
	(0.093)	(0.079)	(0.073)	(0.099)	(0.097)	(0.133)	(0.127)	(0.128)
ID(-1)	-0.281	-0.093	-0.063	-0.312	-0.175	0.277	-0.192	-0.486**
	(0.182)	(0.160)	(0.147)	(0.194)	(0.188)	(0.222)	(0.216)	(0.222)
PH(-1)	0.450**	0.056	0.064	0.479**	0.331	-0.203	0.432*	0.202
	(0.210)	(0.182)	(0.167)	(0.219)	(0.215)	(0.253)	(0.242)	(0.259)
ML(-1)	-0.476***	-0.299***	-0.257**	-0.437***	-0.539***	0.316	-0.404**	-0.015
	(0.128)	(0.112)	(0.103)	(0.137)	(0.135)	(0.202)	(0.192)	(0.202)
KR(-1)	0.361***	0.199**	0.117	0.274**	0.362***	-0.042	0.148	0.192
	(0.109)	(0.093)	(0.086)	(0.117)	(0.115)	(0.141)	(0.139)	(0.143)
HK(-1)	-0.036	0.008	-0.001	-0.028	-0.015	-0.070*	-0.031	-0.011
	(0.037)	(0.029)	(0.028)	(0.038)	(0.038)	(0.039)	(0.039)	(0.045)
US(-1)	-0.028	-0.004	-0.002	-0.018	-0.016	0.008	-0.021	-0.005
	(0.018)	(0.014)	(0.013)	(0.018)	(0.018)	(0.020)	(0.020)	(0.022)
GR(-1)	-0.040	-0.034	-0.010	0.009	0.001	-0.010	0.063	-0.103

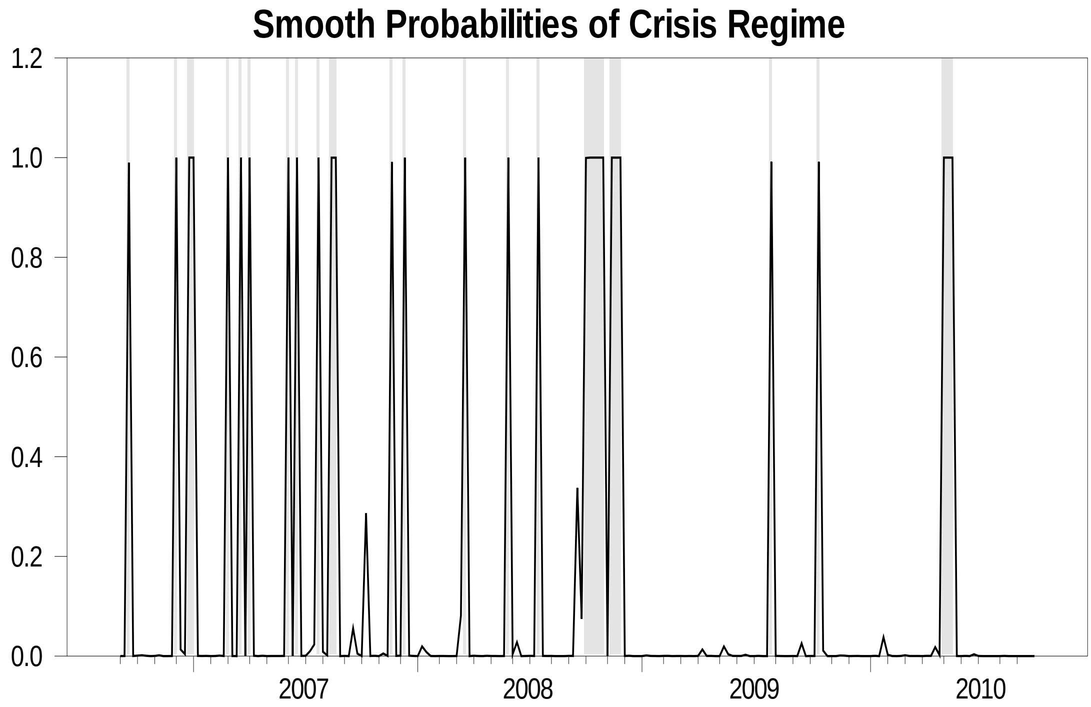
	(0.057)	(0.045)	(0.042)	(0.060)	(0.060)	(0.067)	(0.065)	(0.061)
P_{11}								0.885***
								(0.024)
P_{21}								0.115***
								(0.003)
P_{12}								0.671***
								(0.078)
P_{22}								0.329***
								(0.038)
Expected duration of "stable" regime (Ds_1)								8.695
Expected duration of "crisis" regime (Ds_2)								1.488
Log Likelihood								2199

Notes: *, ** and*** indicate 10%, 5% and 1% significant levels, respectively

Standard errors in parentheses.

The number of lag for MS-VAR is 1, which is decided based on AIC

Figure 3-10 – Smooth Probabilities of crisis regimes for CDS



3.5.2. Testing for "Shift – Contagion" Effects

Although the volatility regime switching analysis with MS-VAR analysed in 3.5.1 provides insight into the impact and volatility spillovers from the US subprime credit crisis to East Asian financial markets, it does not persuasively indicate the presence of a shift-contagion effect. The reason behind these abnormally high variance episodes may be the continuality of financial interdependence which existed in the tranquil period or the common shock that simultaneously leads to deterioration in the fundamentals in several economies. Moreover, the MSMH-VAR specifications also deliver covariance matrices which vary across regimes (see Appendices 3.1-3.4). However, the change in covariance and the implied correlations is conditional on the increase in volatility during the turmoil and is not relevant for detecting the presence of shift contagion. Therefore, in order to justify the contagion effects, we develop our arguments with a cross-market unconditional correlations analysis.

We apply the extended multivariate regression framework of the unconditional correlation tests to our analysis of the contagion effect and estimate the system of equation 3.15 as seemingly unrelated regression (SUR) while controlling for heteroscedasticity and contemporaneous correlations. Tables 3.10, 3.11, 3.12 and 3.13 show the estimated parameters for coefficient vectors $\boldsymbol{\theta}$ which capture contagion effects for composite stock return series, bank stock returns, foreign exchange rates and sovereign CDS spreads series[37]. They all indicate that there is no robust evidence of "shift contagion" from the US and Europe to East Asian countries. Instead, East Asian asset return volatility regimes following the US and European shocks are more likely to be caused by normal interdependence, common shock and/or country-specific risk factors.

Three exceptional cases are observed in stock returns' estimations in Thailand, Korea and Malaysia. The simultaneous (unconditional) correlations between S&P500 and SET; Euro Stoxx and KLPI; Euro Stoxx and KOSPI increased significantly in high volatility regime, which justifies the shift-contagion from the US to Thailand and from European to Malaysian and Korean equity markets. The outcome of "shift-contagion" in Thailand following volatility shock in the US lends supports to Mullainathan (2002) who explains that investors may imperfectly recall past events. A negative shock triggers investors' memories, inducing them to assign a higher probability of a bad state for countries which used to experience financial crises even their current fundamentals are not correlated with the crisis-originator. Turning into Korea, it is consistent with the analysis in MS-VAR which

[37] The full results for equation 3.15 regressions are presented in the Appendices 3.5-3.8.

shows a drastic jump in Korea's asset return volatilities. Due to the large proportion with foreign factor in domestic market, this country appears to be very sensitive to global investors' sentiments, as it experienced a structural shift in its interdependence with the US, EU and Thailand. However, it is surprising to find that unconditional correlations between Thailand and EU, Philippines and US and Korea and US decline significantly when they all enter a high-volatility period. As proved by Dungey et al. (2006), the sign of correlation change can be ambiguous. Negative correlation during a crisis period may be due to the "flight home effect", when domestic investors tend to repatriate their funds after facing with financial turmoil in AEs. This may explain why cross-country portfolio diversification strategies are still attractive.

Although our results have not provided convincing support of structural changes in transmission mechanisms between AEs in the US and Europe and East Asia, there is some evidence to confirm that regional equity market integration intensifies during crisis period. As can be seen in the Table 3.10, the unconditional correlations in contemporaneous stock returns between Malaysia and Thailand, and Hong Kong and Indonesia are significantly strengthened in the highly volatile regime compared to the normal regime. Thai volatility shock is also contagious to Korea, while pressure on the Philippine stock market may trigger a significant downward trend in stock returns in Indonesia and Malaysia. With regard to Asian financial centres, our results suggest that Hong Kong tends to export its volatility shock to Singapore, while it may suffer some contagion effects from Indonesia via transmission channels that did not exist during the tranquil period. Previous papers discover equity market contagion in East Asia during the 1997 financial crisis (Sebastien, 2003; Yang and Lim, 2004; Chiang et al., 2007); our empirical results confirm that this effect may also happen with an external shock and that financial contagion seems to be more regional than global.

For bank stock returns series, estimated results in Table 3.11 indicate that correlation structures between AEs and East Asian countries are constant over the analysed period, as verified by the estimated coefficients θ_{US} and θ_{EU}, which are either negative or positive but without any conventional significant level. Therefore, there is no additional change in the transmission mechanisms during the crisis regime. The increased co-movement observed following major corrections from leading markets may be a consequence of an adjustment in the covariance structure of returns. In other words, the increased magnitude in the covariate structure is offset by an equivalent magnitude of volatility. Similar to the composite return series, bank stock returns appear to be more responsive to regional than global factors. For example, Hong Kong bank returns increase their dependence on Thailand's and Singapore's during a high volatility regime. But the opposite directions have not been obvious; i.e., shock in Hong Kong bank returns has not yielded significant effects on those of Singapore and Thailand. Bank returns in Malaysia depend on shocks in Indonesia and Thailand. This may suggest that local investors may look to their neighbours for any signal as to whether or not global financial turmoil in North America and Europe may affect Asia. On a completely contradictory picture, transmission mechanisms between Singapore and Malaysia become weaker after the breakout of a crisis elsewhere.

Table 3.10 - Unconditional correlation tests (Dungey et al., 2004) for composite stock returns

	TL	ID	PH	ML	KR	SG	HK
$\boldsymbol{\theta_{TL}}$		-0.055	0.081	0.259**	0.424**	0.013	0.029
		(0.109)	(0.103)	(0.100)	(0.124)	(0.082)	(0.099)
$\boldsymbol{\theta_{ID}}$	-0.140		0.080	0.044	0.194	-0.078	0.315***
	(0.107)		(0.094)	(0.096)	(0.122)	(0.078)	(0.091)
$\boldsymbol{\theta_{PH}}$	0.125	0.295**		0.262**	-0.121	0.023	-0.228**
	(0.130)	(0.120)		(0.113)	(0.149)	(0.095)	(0.113)
$\boldsymbol{\theta_{ML}}$	0.229**	0.034	0.073		-0.186	-0.132	-0.159
	(0.114)	(0.110)	(0.101)		(0.131)	(0.081)	(0.099)
$\boldsymbol{\theta_{KR}}$	-0.027	0.036	-0.091	-0.101		-0.010	-0.112
	(0.086)	(0.085)	(0.081)	(0.080)		(0.064)	(0.075)
$\boldsymbol{\theta_{SG}}$	-0.042	-0.229*	-0.067	-0.296**	0.084		0.153
	(0.139)	(0.132)	(0.126)	(0.121)	(0.156)		(0.105)
$\boldsymbol{\theta_{HK}}$	-0.006	0.335***	-0.189*	-0.176*	-0.026	0.167**	
	(0.117)	(0.110)	(0.106)	(0.104)	(0.130)	(0.074)	
$\boldsymbol{\theta_{US}}$	0.199**	0.114	-0.190**	-0.083	-0.476***	0.095	0.008
	(0.095)	(0.092)	(0.086)	(0.085)	(0.099)	(0.068)	(0.082)
$\boldsymbol{\theta_{EU}}$	-0.244**	-0.210	0.111	0.189*	0.304**	0.029	-0.098
	(0.115)	(0.111)	(0.105)	(0.103)	(0.126)	(0.081)	(0.100)
R2	0.571	0.690	0.580	0.674	0.701	0.848	0.774
F-Statistic	31.295	52.471	32.494	48.583	55.122	131.673	80.498
p-value	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]

Notes: SUR estimates of a system of equation 3.15 . *, ** and *** denote significance at 1%, 5%, and 10% levels, respectively

Table 3.11 - Unconditional correlation tests (Dungey et al., 2004) for bank stock returns

	TL	ID	PH	ML	KR	SG	HK
$\boldsymbol{\theta_{TL}}$		-0.044	0.045	0.165*	-0.04	0.084	0.239*
		(0.098)	(0.105)	(0.099)	(0.126)	(0.093)	(0.123)
$\boldsymbol{\theta_{ID}}$	-0.027		0.011	0.235**	0.124	0.088	0.126
	(0.111)		(0.111)	(0.106)	(0.135)	(0.101)	(0.134)
$\boldsymbol{\theta_{PH}}$	0.014	-0.093		0.118	-0.111	0.151*	-0.037
	(0.099)	(0.092)		(0.094)	(0.120)	(0.088)	(0.118)
$\boldsymbol{\theta_{ML}}$	0.111	0.133	0.101		-0.217*	-0.128**	0.015
	(0.103)	(0.097)	(0.103)		(0.125)	(0.090)	(0.123)
$\boldsymbol{\theta_{KR}}$	-0.141*	-0.066	-0.131	-0.151*		0.081	0.029
	(0.085)	(0.080)	(0.086)	(0.082)		(0.076)	(0.101)
$\boldsymbol{\theta_{SG}}$	0.006	-0.004	0.097	-0.235**	0.206		0.254**
	(0.111)	(0.105)	(0.111)	(0.103)	(0.134)		(0.124)
$\boldsymbol{\theta_{HK}}$	0.054	0.008	-0.035	-0.046	0.003	0.015	
	(0.089)	(0.085)	(0.091)	(0.086)	(0.107)	(0.076)	
$\boldsymbol{\theta_{US}}$	0.026	-0.062	-0.146**	-0.013	0.131	0.051	-0.069
	(0.073)	(0.069)	(0.074)	(0.071)	(0.089)	(0.066)	(0.087)
$\boldsymbol{\theta_{EU}}$	-0.042	0.024	0.095	0.002	-0.028	-0.088	-0.133
	(0.091)	(0.086)	(0.923)	(0.087)	(0.109)	(0.081)	(0.108)
R2	0.432	0.468	0.527	0.562	0.535	0.778	0.706
F-Statistic	17.889	20.698	26.19	32.482	27.019	82.655	56.552
p-value	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]

Notes: SUR estimates of a system of equation 3.15 . *, ** and *** denote significance at 1%, 5%, and 10% levels, respectively

In foreign exchange markets, the estimated parameters demonstrate comprehensive evidence of strong regional transmission effects. This suggests distinctive features of local currency integration and competitive adjustments in exchange rates. Table 3.12 shows the overall improvement in correlation coefficients in the crisis regime between many pairs of local currencies. For example, Thai baht and Malaysian ringgit appeared to have a causal relationship with each other. Malaysian ringgit also has a significant influence on Singapore dollar, whereas the depreciation of the Philippine peso may trigger the depreciation of the Korean won. The Indonesian rupiah significantly strengthens its correlation with the Thai baht when the market encounters volatility shock. Central bank interventions may play an important role in the collective behaviours in regional exchange rate networks (Feng et al., 2010). Generally speaking, given highly intra-regional and inter-regional trade integration, some of the economies in East Asia monitor their neighbours' exchange rates and attempt to keep the relative value of their currencies in line with the values of selected regional currencies to maintain the competitiveness of a nation's exports in global markets.

Table 3.12 - Unconditional correlation tests (Dungey et al., 2004) for FOREX

	TL	**ID**	**PH**	**ML**	**KR**	**SG**
$\boldsymbol{\theta_{TL}}$		0.435**	0.069	0.224**	-0.247	-0.049
		(0.186)	(0.116)	(0.097)	(0.214)	(0.136)
$\boldsymbol{\theta_{ID}}$	0.011		-0.103	-0.160***	-0.103	-0.123
	(0.076)		(0.071)	(0.059)	(0.132)	(0.084)
$\boldsymbol{\theta_{PH}}$	0.058	0.185		0.115	1.268***	-0.290**
	(0.126)	(0.189)		(0.098)	(0.197)	(0.138)
$\boldsymbol{\theta_{ML}}$	0.257*	0.255	0.093		-0.137	0.596***
	(0.139)	(0.209)	(0.130)		(0.243)	(0.136)
$\boldsymbol{\theta_{KR}}$	-0.184**	-0.067	-0.102	-0.242***		0.092
	(0.073)	(0.112)	(0.065)	(0.057)		(0.082)
$\boldsymbol{\theta_{SG}}$	-0.235**	-0.171	-0.081	0.002	0.239	
	(0.094)	(0.145)	(0.089)	(0.068)	(0.166)	
R2	0.292	0.363	0.412	0.600	0.415	0.446
F-Statistic	11.167	15.387	18.950	40.633	19.150	21.820
p-value	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]

Notes: SUR estimates of a system of equation 3.15 . *, ** and *** denote significance at 1%, 5%, and 10% levels, respectively

The estimated parameters in Table 3.13 also confirm that there is no shift-contagion from the rising sovereign risks of the US to East Asian economies. In other words, international transmission mechanisms remain unchanged and volatility spillovers via the CDS market are just a reaction to common shock. However, it is interesting to see that the shift-contagion occurred in Indonesia, Malaysia and Hong Kong following the sovereign debt crisis in Europe, as their contemporaneous correlations with Greece significantly intensify in the high volatility regime. Moreover, we also observe shift-contagion appearing in the cluster of countries with similar fundamentals. For example, the correlation structure between Indonesia and Thailand, Indonesia and Korea, and Philippines and Malaysia improves following the volatility shock. Philippines and Korea also show the evolution of integration with Malaysia during the crisis. This may reflect that markets have the same assessment of country credit risk in the region and external shocks seem to have strengthened the correlation structures between markets within the region.

Table 3.13 - Unconditional correlation tests (Dungey et al., 2004) for CDS

	TL	ID	PH	ML	KR	HK
θ_{TL}		0.513***	-0.563***	0.088	-0.738***	0.354
		(0.119)	(0.102)	(0.063)	(0.102)	(0.513)
θ_{ID}	0.581***		-0.066	-0.443***	0.597***	-0.001
	(0.146)		(0.075)	(0.097)	(0.117)	(0.564)
θ_{PH}	-0.908***	0.098		0.478***	-0.567***	0.098
	(0.163)	(0.098)		(0.103)	(0.146)	(0.650)
θ_{ML}	1.154***	-1.229***	1.108***		0.529***	-0.779
	(0.134)	(0.187)	(0.148)		(0.147)	(0.867)
θ_{KR}	-1.117***	0.836***	-0.536***	0.012		-0.148
	(0.141)	(0.131)	(0.128)	(0.087)		(0.166)
Θ_{HK}	0.048	-0.002	-0.008	-0.017	-0.061	
	(0.046)	(0.041)	(0.036)	(0.031)	(0.039)	
Θ_{US}	0.059	0.051	-0.042	-0.047	-0.059	-0.059
	(0.046)	(0.042)	(0.037)	(0.031)	(0.039)	(0.166)
Θ_{GR}	-0.113	0.137**	-0.108*	0.103**	-0.121*	0.597**
	(0.077)	(0.068)	(0.060)	(0.052)	(0.065)	(0.270)
R2	0.892	0.914	0.931	0.994	0.895	0.1393
F-Statistic	109.38	140.79	176.80	222.728	112.08	2.126
p-value	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.01]

Notes: SUR estimates of a system of equation 3.15 . *, ** and *** denote significance at 1%, 5%, and 10% levels, respectively

3.6. Conclusions

This chapter empirically investigates financial contagion via asset prices during the 2007-2011 global financial crisis. It focuses on the US and Europe as the source countries (US as the subprime crisis originator and Europe as the epicentre of the sovereign debt crisis) which exported their financial volatility to East Asia. Although empirical literature on asset price volatility linkages and contagion is extensive, the methodologies are subjective to some specific statistical problems, making it difficult to assess its significance in shock transmission. For example, the conditional correlation test (e.g. King and Wadhwani, 1990) does not take into account the presence of heteroskedasticity, while unconditional correlation (Forbes and Rigobon, 2002) has sample selection bias and works only with bivariate testing. The GARCH models is more likely to deal with time series properties of asset prices and volatility modelling, but fails to capture theoretical arguments of multiple equilibria associated with asset return behaviour during the financial crisis. The DCC and DCC-GARCH can only identify the overall trend in dynamic covariance but are unable to detect the breakpoint times that the jumps to crisis state may happen and duration of the shift between states.

Using MS-VAR model and multivariate unconditional correlation test in testing contagion, this study not only addresses the theoretical assumptions about multiple equilibria and nonlinear linkages, but also handles the problems of heteroskedasticity, endogeneity, simultaneous equation and sample selection bias. The empirical results within the MS-VAR framework evidence the structural changes in volatility across different regimes in all variable series, for all countries in the sample, and confirm that the increase in financial market volatility coincided with the global financial crisis of 2007-2011. Specifically, when the US and European financial markets switched from a normal regime (low volatility) to a crisis one (high volatility), this was followed by the increasing volatility of the East Asian financial markets. Despite the strong fundamentals and more resilient financial systems that have been built up since the 1997 financial crisis, East Asia is still very vulnerable to external financial shock. However, there is cross-country heterogeneity in the nature and severity of the spillovers to East Asia financial markets, depending on either their economic situation or the level of financial openness. In particular, Korea and the financial centres of Hong Kong and Singapore, which have a higher degree of financial openness and a large share of foreign participation in their domestic markets, tend to suffer more from volatility spillovers from AEs in the US and Europe.

The estimated parameters from unconditional correlation multivariate testing explain that international volatility spillovers are more likely caused by real linkages or interdependence rather than shift contagion. This means that transmission mechanisms remain unchanged and the observed increased co-movement of asset returns after major market corrections arise due to the change in covariate structure. However, there is some evidence of significant increase in cross-market linkages in some pairs of East Asian countries after volatility shock elsewhere. There may be also directional transfer of shocks. For example, the stock return volatility in the US and EU did not have direct contemporaneous effects on all East Asian countries at the same time, but it may have exported its volatility first to Hong Kong via direct financial linkages, and then Hong Kong volatility shock may have caused shift-contagion in Singapore and Indonesia. Another example is that turbulence in the global financial market may trigger investors' memory of the past crisis in Thailand, leading them to withdraw from this country. Shock in Thailand stock market may then be exported to its neighbours such as Malaysia and Korea. Some evidence of regional contagion has been also reflected in foreign exchange markets and credit derivative markets. While the stronger intra-regional linkages in exchange rates may reflect inter-regional and intra-regional trade links, the interactions between equity markets, and sovereign debt markets in the region may be due to the fact that markets have the same assessment of country credit risk in the region, making those countries more vulnerable to wake-up call effects. In some cases, asset return correlations between markets even decrease significantly during the crisis regime, which implies that the international portfolio diversification still benefits international investors, but they need to take a different kind of risk into account for their portfolio choices after negative shocks.

In general, fundamental-based contagion is more common than investor-based contagion (or shift-contagion) which may imply that the most important strategy to mitigate the contagion effect is to strengthen domestic economies. There are several possible reasons for the minimal shift-contagion effects during the global financial crisis:

- Investors had improved their approach to risk analysis, learning from the series of financial crises in the 1990s. They appear to be better at discriminating between different economies, especially EMEs, based on the improved information systems of individual country characteristics and policies.

- The development of early-warning models made investors, international financial institutions and governments more adept at predicting countries' vulnerability to financial crises. Despite the fact that most of the 1990s' EME financial crises came as surprises, these models, although far from perfect, still have some power in monitoring and predicting risks in individual countries.

- The most important reason is the significant economic and financial reforms in East Asian countries after the regional financial crisis of 1997-1998, which helped to reduce regional vulnerability to external shocks. Such reforms contributed to the shift in current accounts from deficit to surplus, higher international reserves, more flexible exchange rates, lower rates of inflation, more responsible fiscal policies, and stronger corporate and banking sector financial positions. Furthermore, the government, central banks and other authorities in these countries have implied timeline measures to support equity and other asset prices such as restrictions on short sales of equities (in Hong Kong, Singapore, Korea and Indonesia), tax incentives for investors to hold mutual funds for longer periods (in Korea), capital injection into special purpose vehicles for investment in undervalued companies (in Malaysia), and easing conditions on regulations and taxations to boost the markets (in Philippines and Thailand).

CHAPTER FOUR – CROSS-BORDER BANKING AND TRANSMISSION OF INTERBANK MARKET TENSIONS FROM AEs TO EAST ASIA

4.1. Introduction

Cross-border banking has expanded dramatically since the 1990s and has been dominated by a few AEs and financial centres, which form "core nodes" in the international banking system (IMF, 2011). In EMEs, despite the fact that cross-border exposure remains relatively small, international banks have started to play an important role as active investors during the last two decades. The expansion of international bank operations in EMEs is a consequence of financial liberalisation, the introduction of sophisticated new financial services and the search for higher yields in the environment of low global interest rates (Herrmann and Mihaljek, 2010). Emerging Asian countries lag behind the CEEs[38] and Latin America in foreign bank penetration and cross-border banking activities (Hohl et al., 2006). After experiencing a sharp reversal following the 1997-1998 regional financial crisis, cross-border banking flows recovered in 2003 and helped to stimulate growth in certain market segments, particularly in consumer finance.

The turmoil in international credit markets and large write-downs[39] by some of the major international financial institutions during the 2007-2011 global financial crisis have raised questions about the role of multinational banks in transmitting

[38] CEE: Croatia, Czech Republic, Bulgaria, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovenia and Turkey.

[39] The IFM (2010) estimates that banks' worldwide credit-related write-downs were around US$ 1.6 trillion between mid-2007 and end-2009.

liquidity shocks to EMEs through various channels such as reductions in their cross-border claims on public, private, and banking sectors; sales or scaling down of non-core, non-domestic businesses in host countries; deleveraging by subsidiaries and branches of foreign banks with reduced funding flows from parents; and increased costs of borrowing for subsidiaries (Feyen et al., 2012). Evidence from BIS data reveals that after adjusting for changes in exchange rates, from the peak in March 2008, cross-border claims of BIS reporting banks vis-à-vis East Asia as well as other EMEs fell sharply, which had negative spillover effects for domestic real economies and intensified the tensions in many financial market segments in the region. Further deepening of the euro debt crisis, accompanied by the deleveraging process by European banks, continued to challenge the credit environment in Asia. Anecdotal information suggests that trade financing experienced a significant decline in Hong Kong and Singapore at the end of 2011. According to a lending survey by the Institute of International Finance, emerging Asia, CEE and Latin America faced tighter credit standards in 2011 and the deterioration in lending conditions continued for the third consecutive quarter in 2012. All of this has brought back the picture of a repeated episode of the credit squeeze suffered by the region during the height of the 1997-1998 financial crisis.

This chapter analyses the magnitude of cross-border banking exposure in East Asia and the cross-border contagion in loan provision by multinational banks. The cross – border banking discussed in this study most refers to cross-border capital flows and cross-border entry by banks (i.e. foreign establishment in a host market) and relates to the first and the third form under the GATS framework (Claessens, 2006)[40]. Using the BIS consolidated banking statistics, we first characterise the evolution of cross-border banking activities in East Asia and explore how these exposures may facilitate shock propagation. Next, we utilise locational bank statistics[41] to analyse the sudden stop in international lending associated with (i) liquidity shock in international credit markets that affects the supply of bank loans, (ii) host country aggregate productivity shock that diminishes bank loan demand, (iii) the contagion effect via the common lender and wake-up call channels, and (iv) adverse feedback from the sudden stop in international lending flows to the tension in host countries' interbank markets. We relate our analysis to the theoretical literature on international bank behaviour and its important role in the transmission of shocks across countries via common lender and wake-up call effects. The existing empirical literature explains the push (home) and pull (host) factors of capital flows and uses traditional methodologies of gravity models and base regression to measure the waves in gross cross-border banking flows. In contrast to this literature, the approach here is to employ the univariate and recursive bivariate probit models to quantify the marginal effects of several global and country-specific risk factors on the probability of sudden stop and the link between the sudden stop and the host country interbank market tensions. Moreover, this research is part of the very limited literature to document the contagion effect in cross-border lending flows in EMEs, taking into account the

[40] Claessens (2006) reviews four forms of cross-border use or provision of financial services as follows: (i) the first mode is cross-border supply of traditional trade in goods and services (i.e. in the context of finance this means capital flows); (ii) the second mode is consumption abroad, e.g., obtaining some financial services while travelling; (iii) the third mode relates to the production of a good or service within the country, which means foreign establishment in a host market; and (iv) the fourth mode is delivery by the presence of persons in the host country, e.g., solicitation of insurance products by agents travelling to the country.

[41] The use of BIS locational statistics instead of consolidated data to analyse cross-border shock transmission in international lending is more relevant because they measure cross-border lending consistent with the principles underlying national accounts and balance payment statistics.

"flight-home effect" caused by the active repatriation of funds invested abroad by host country residents during financial crises. The panel regressions are estimated based on quarterly data of external assets and liabilities from BIS reporting banks to seven East Asian economies from 1996 - 2011, the period involving both the 1997-1998 regional financial crisis and the 2007-2011 global financial crisis.

The remainder of this chapter is organised as follows. Section 4.2 reviews the theoretical literature and empirical evidence for the sudden stop in cross-border banking flows during the financial crisis. Section 4.3 highlights various stylised facts of cross-border banking involvement in East Asia and the potential vulnerability to funding shock transmission. In section 4.4, the probability of the reversal in international bank lending flows associated with financial stress at the global, home and host country levels is tested. The link between the sudden stop and the interbank market tensions is also assessed. Section 4.5 offers some conclusions and policy implications.

4.2. Literature Review: Cross-border Banking and the Sudden Stop in International Lending

4.2.1. Theoretical Framework

The theoretical literature investigating the systematic risk of financial contagion associated with cross-border banking has strongly focused on the "sudden-stop" in international lending flows during period of financial crises. The episodes are explained and supported by two hypotheses: the common lender hypothesis and the wake-up call hypothesis.

4.2.1.1. Common Lender Hypothesis

The common lender channel of contagion arises when a bank creditor withdraws its exposures from one country to rebalance its portfolio after experiencing a marked deterioration of the loan quality in another country. The assumption for this hypothesis is that the accumulated losses of international banks exposed to a crisis country are substantial enough for them to call in their loans. The more the countries rely on external funding from the same creditors, the more vulnerable they are to a systematic sudden stop. The motivation behind banks' responses to negative shocks comes from the need to restore bank capital adequacy, to meet margin calls, or to reduce risk exposure (as dictated by the VaR models or similar models used by banks) (Van Rijckeghem and Weder, 2003).

It is widely explained by bank lending channel theory that the reduction in credit availability is associated with the shocks from both borrowers' and lenders' balance sheets (Bernanke and Gertler, 1989; Bernanke et al., 1994; Holmstrom and Tirole, 1997). Deterioration of both borrowers' and banks' net worth will increase the external finance premium for loans, which in turn adversely affects the demand for and supply of credit. Peek and Rosengren (1997) and Van den Heuvel (2002) give further reasons why shocks to bank capital affect bank lending from regulatory requirement perspectives. The crisis not only deteriorates the level of bank capital but also increases risk-weighted asset; banks are therefore faced with higher capital needs to meet regulatory requirements or to satisfy investors that they are taking measures to decrease the risk of insolvency. Given the increasing difficulty in raising new capital during periods of financial distress, banks are likely to reduce certain types of assets, such as lending, which have higher risk weights.

In short, economic and financial shocks that decrease banks' risk-based capital ratios will be translated into a significant decline in the total loan supply.

Another theoretical explanation refers to liquidity problems and other constraints on lenders. This mechanism indicates that a negative shock in one country that diminishes banks' asset values (i.e. collaterals) leads banks to liquidate a part of their holdings in other countries to meet margin calls (Claessens and Forbes, 2004). In addition, banks may also foresee future redemptions following an adverse shock and therefore need to raise cash by selling off assets in other economies. In light of the global crisis, the literature on the liquidity channel has emphasised that systematic risk can originate at the nexus of funding liquidity and market liquidity (BIS, 2011). Funding liquidity refers to a bank's ability to obtain funding (via new borrowing) and market liquidity is defined as the ease with which a bank's assets are traded. Brunnermeier and Pedersen (2009) present a model explaining that traders' funding (i.e. their capital and margin requirements) not only depends on but also impacts market liquidity itself. Therefore, the declines in both funding and market liquidity can culminate in liquidity shortages and lead even healthy banks to refrain from lending.

From standard portfolio theory, common lender effects arise as an optimal portfolio rebalancing response to a realised loss on a specific position. Specifically, a shock to asset-return pattern in one country usually leads to wealth allocation across countries. For example, the theoretical model of Schinasi and Smith (1999) indicates that in the presence of leverage, investors' optimal response to a crisis in one market is deleveraging and reducing their risky asset positions in all other markets. Their explanation is simply based on portfolio diversification, without any recourse to market imperfections.

4.2.1.2. Wake-Up Call Hypothesis

The wake-up call effects explain the withdrawal of international banks from EMEs related to a sudden shift in the perceptions of an entire loan portfolio due to the reinterpretation of existing information or a general increase in risk aversion following an initial shock in one country. One strand of theoretical literature focuses on the reassessment of macroeconomic fundamentals. Under this approach, a crisis in one country induces investors to take a closer look at countries with similar conditions with the crisis originator. Contagion occurs if the process of information update leads them to recognise problems or risks they failed to see before even if the fundamentals in these countries remain unchanged. In other words, they become aware of the existing problems and therefore decide to sell assets, call in loans, or stop lending to these vulnerable countries. This kind of investor behaviour indeed reflects an efficient correction as a result of more accurate assessment of fundamentals (Moser, 2003). A crisis in one country may also lead to a loss of public confidence, inducing investors to revaluate countries and assign more risks in international investments, setting off runs in financial markets around the world.

Another strand of theories relates this hypothesis to the imperfect market and information asymmetries. In the presence market imperfection and costs of acquiring and processing information, investors are uncertain about the true state of a country's vulnerability. Therefore, they tend to derive information from the actions of other investors, causing herding behaviour, financial panic and multiple equilibria, which have already been discussed in chapter 3 of this thesis. These kinds of investor behaviour may be rational or irrational, while irrational behaviour is caused by signal extraction failures. For example, investors falsely assume interdependence of fundamentals or overestimate the extent of interdependence when they misinterpret a country-specific shock as a common shock. Irrational investor behaviour is usually associated with an inaccurate assessment and inefficient revision of fundamentals.

Tornell (1999) combines the two groups of wake-up call theories in a theoretical model that explains a cross-country variation in the severity of the crisis. The key point in this model is that a currency crisis in an emerging market will act as a coordinating device, alerting each investor to a coming attack on vulnerable countries by all other investors. Country vulnerability is measured by the likelihood of depreciation associated with weak banks, low reserves and severe real appreciation. In other words, investors concentrate their attacks in countries that are more likely to respond to an attack with an excessive depreciation, which is directly related to weakness in macroeconomic fundamentals.

4.2.2. Empirical Evidence

Empirical evidence for the systematic risk of cross-border banking is extensive. A number of studies explain the volatility in cross-border banking flows, especially the adjustment in international lending during crisis episodes, with various pull and push factors. The pull factors deal with the reduction in lending from international banks' reactions to the economic and financial disturbances in the host country. This was witnessed by simultaneous withdrawals of global banks from EMEs during the financial crises of the 1990s (Mexico in 1994, East Asia in

1997-1998, Brazil and Russia in 1999, Turkey in 2000 and Argentina in 2002). The push factor corresponds to the spillovers from home country shocks through credit contraction by parent banks or foreign affiliates and branches. Many of the recent studies of the global financial crisis of 2008-2009 stress the importance of global push factors; in particular, risk, liquidity, interest rates and growth. Herrmann and Mihaljek (2010) provide strong evidence for spillover effects on bank lending flows from AEs to EMEs via different channels, such as the weak performance of banks in AEs, global financial market volatility (VIX index) and global risk aversion, measured by the spreads between US corporate bond yields and 10-year Treasury bond yields. Bruno and Shin (2012) address the links between the fluctuation in global liquidity, risk premiums, the leverage cycle of global banks and cross-border capital flows, as well as domestic private credit in 47 developed and developing countries. Kamil and Rai (2010) investigate the effect of the global credit crunch on foreign banks' lending to EMEs. The empirical results suggest that weakening of parent banks' financial health and decreases in economic growth of the home country consistently lead to slower growth in international banks' lending to Latin America. Specifically, a rise in one standard deviation in parent banks' EDF (Expected Default Frequency) is associated with a 1.5 percentage point average decrease in the growth rate of foreign banks' lending in the subsequent quarter. These results are consistent with the findings of Cihak and Brooks (2009) that bank loan supply in euro area moves in line with parent banks' financial soundness. Likewise, Popov and Udell (2010) confirm the hypothesis that the credit crunch was transmitted to CEE following the contraction in parent and foreign banks' balance sheets caused by losses on financial assets and deterioration of their equity positions.

On the contrary, other papers emphasise the "pull factors" as key drivers of cross-border banking flows, especially domestic fundamentals, fiscal position, country-specific risks, financial policies and external exposure through trade and financial links. Derviz and Podpiera (2007) establish that host country factors, instead of home country ones, are particularly important as a source of cross-border lending contagion. Influential host economic development variables include inflation, long-term interest rates, and exchange rate volatility, while the equivalent variables for the home country appear to be insignificant. Hawkins (2002) shows that international bank lending to EMEs is subject to the strength of both home (source) and host (user) countries, which is captured by their respective expected returns. However, the pull factors are generally stronger than the push ones. Papaioannou (2005) focuses more on the legal aspects of borrower countries and empirically shows that foreign banks tend to prefer to invest and allocate credit to countries with a well-functioning legal system, banking law harmonisation policies and minimisation of exchange rate risks. Jeaneau and Micu (2002) discuss the dominant influences of economic growth in host countries, their exchange rate variance, changes in foreign reserves and current accounts. However, there is only one push factor of real short-term interest rates which significantly contributes to the reversal of capital flows. Herrmann and Mihaljek (2010) also find the combined effects of both global risk factors and country-specific risks as key drivers for the reduction in cross-border loan flows to EMEs, while the latter is represented by fiscal deficits, exchange rate depreciation, and deterioration in domestic bank performance.

In addition to global and country-specific risks, another strand of literature emphasises regional contagion factors and the structure of cross-border banking flows as determinants of the sudden reversals in international lending. For example, the importance of the common lender effect of contagion was empirically investigated by Kaminsky and Reinhart (2000), Caramazza et al. (2000), Hernandex and Valdes (2001), Van Rijckeghem and Weder (2003), Peria, et al. (2005) and Pontines and Siregar (2012). They all indicate that vulnerability to the risk of sudden stop can spread among clusters of countries that depend on the same lenders. In addition, Caramazza et al. (2000) show that countries which are more important to the common lenders are more likely to experience financial crises than those which only receive a very small proportion of the common lenders' total lending. Van Rijckeghem and Weder (2003) investigate the withdrawals of common lenders, which led to remarkable capital outflows from EMEs during the Mexican, Asian and Russian crises. However, in the Russian crisis, a more general reversal of bank flows was due to the wake-up call effect caused by a sudden increase in banks' risk aversion, even if financial links via common lenders were weak among these EMEs. De Haas and Van Horen (2010) provide more evidence on the importance of the wake-up call effect. They show empirically that the sub-prime mortgage problem in mid-2007 acted as a wake-up call for banks to review their screening and monitoring standards, which lead to a significant shrinking of syndicated loans in both AEs and EMEs.

Contagion factors have also been considered in terms of the structure of cross-border banking flows. Besides the existence of common lenders, Gersl (2006) analyses two other main factors that increase the vulnerability in the CEE banking system. They are maturities of cross-border exposures and funding concentration. As suggested by the BIS data, banks' short-term claims fell much more during the crisis than long maturity claims, which suggests the dominant effect of bank deleveraging. Moreover, if the foreign bank claims of a country are concentrated with one large creditor, when that creditor is hit by a shock which forces it to liquidate foreign investments, the impact on the debtor country will certainly be greater than if the domestic economy uses foreign capital from several countries. Kamil and Rai (2010) argue that the size of foreign banks' lending response to shocks depends on their lending structure. Cross-border lending flows, which are largely denominated in foreign currencies and funded in wholesale markets, experience much higher volatility. Lending flows from foreign affiliates and branches are less volatile because they are mostly denominated in local currencies and financed by domestic deposits. Hoggarth et al. (2010) examine the dynamic international bank capital flows from the perspectives of borrowers and conclude that withdrawals were much greater with bank funding flows to non-related banks than the banking sector, with cross-border lending than lending from foreign subsidiaries, and over a shorter period of time. A possible reason is that banks are more likely to reduce exposures in markets where they have less knowledge of their customers.

In general, the growing literature focuses on analysing pull and push factors driving international lending to EMEs or the determinants of the volatility of cross-border banking flows. There is a consensus from these studies which confirms the significant effects of pull, push and contagion factors, but their relative importance vary substantially over time and across countries. While empirical work implicitly or explicitly confirm international bank behaviour of calling in their foreign claims during the financial crisis, very limited literature is found to directly test the probability of the sudden stop in lending behaviour associated with different kinds of shocks. Additionally, none of the studies investigates the feedback of the sudden stop to the financial tensions in the host countries. There is also little work to document the contagion effect in cross-border lending flows in EMEs, taking into account the "flight-home effect" caused by the active repatriation of funds invested abroad domestic investors during financial crises. In terms of methodology, a majority of the literature use the traditional gravity models or base regression. Nevertheless, the base regression technique is subject to model uncertainties due to the nonlinear nature of international capital flows, as verified by low R^2 in the estimated results in many empirical papers on this topic. Therefore, this study's approach and its econometric procedure aim at bridging the literature gaps.

4.3. Stylised facts on Cross-border Banking and Potential Vulnerability to Systematic Risk in East Asia

4.3.1. Data Description

In this section, we analyse various stylised facts about the pattern of cross-border banking flows and the possible vulnerabilities to cross-border shock transmission in loan provision using BIS consolidated and locational banking statistics. The consolidated data aggregate foreign claims of banking groups based on the nationality of the parent banks. These data therefore exclude intragroup claims. On the other hand, locational data comprise the gross international claims and liabilities of bank residents in given countries on banks and non-bank sectors in other countries (including intragroup). The combination of consolidated and locational data in our analysis arises from the limitations in BIS reporting statistics, which make our assessment challenging. First, few EMEs report their international banking statistics with BIS and the intra-regional credit within emerging East Asia is also not available to the public. Second, the consolidated data report total foreign claims based on creditor nationality with a breakdown of maturities and currencies. Therefore, these data are relevant for assessing the size of cross-border banking activities of one country and the liquidity risk exposures. However, the lack of reporting of the exchange rate adjusted change basis makes it difficult to interpret the underlying dynamic behaviours of cross-border banking flows.

On a locational basis, there is no breakdown in maturity, currency and creditors, which are considered to be important factors contributing to the volatility of cross-border banking flows. The advantages of locational data are the availability of exchange rate adjusted changes in banking flows, and the fact that flows between parent banks and subsidiaries are not netted out. Therefore, locational data measure cross-border lending consistent with the principles underlying national accounts and balance of payments statistics[42] and are more relevant for analysis of cross-border shock transmission in international lending when funding shocks arise from a particular country or region.

We therefore utilise consolidated data to address the involvement of East Asian countries to cross-border banking and the concentration of creditors and debtors. However, data on a locational basis is used to measure changes in external lending flows to facilitate the analysis of systematic risk and contagion effects caused by the sudden stop during financial crises.

4.3.2. Cross-border Banking Exposures and Potential Vulnerability to Systematic Risk in East Asia: A Cross-Country Heterogeneity Analysis

Foreign bank participation and cross-border banking flows expanded in East Asia in the early 1990s, reflecting the pursuance of a liberalisation policy in the

[42] External loans are equivalent to the "other investment" category of capital flows in the balance of payments.

domestic banking sectors. By the end of 1995, total foreign claims (assets and liabilities) of BIS reporting banks to the region rose to more than US$ 700 billion, much of which involved the growth in trade financing and the creation of off-shore banking centres (Siregar and Choy, 2009). However, the region suffered a drastic "cut and run" from international banks during the 1997-1998 financial crisis. The hardest hit economies were Thailand, Indonesia, Korea, Malaysia and Philippines, which experienced a drop in total foreign liabilities by around 45% in 1998. During the period from 1997 to 2000, international bank claims to Thailand and Korea contracted by average annual rates of around 14% and 8% respectively. After experiencing substantial unwinding, cross-border banking activities started to recover in 2003. However, there is considerable cross-country heterogeneity.

Hong Kong and Singapore are regional financial centres who have actively participated in circulating foreign money throughout emerging Asia by hosting the regional operations of many foreign banks. These two countries had a relatively large amount of external assets and liabilities as a share of GDP, at around 200% in Hong Kong and 150% in Singapore during the period before the global financial crisis of 2003 to 2008. These figures are even somewhat higher than Japan's. It appears that Japanese banks have not offered a place in the intermediation of global money and that they have become more cautious after experiencing serious domestic banking sector problems in the 1990s. Among emerging East Asia, Malaysia and Korea had higher proportion of foreign claims held by international banks (around 40-60% of GDP), while this percentage in Thailand, Philippines, Indonesia, Malaysia and Vietnam were very small (see Table 4.1).

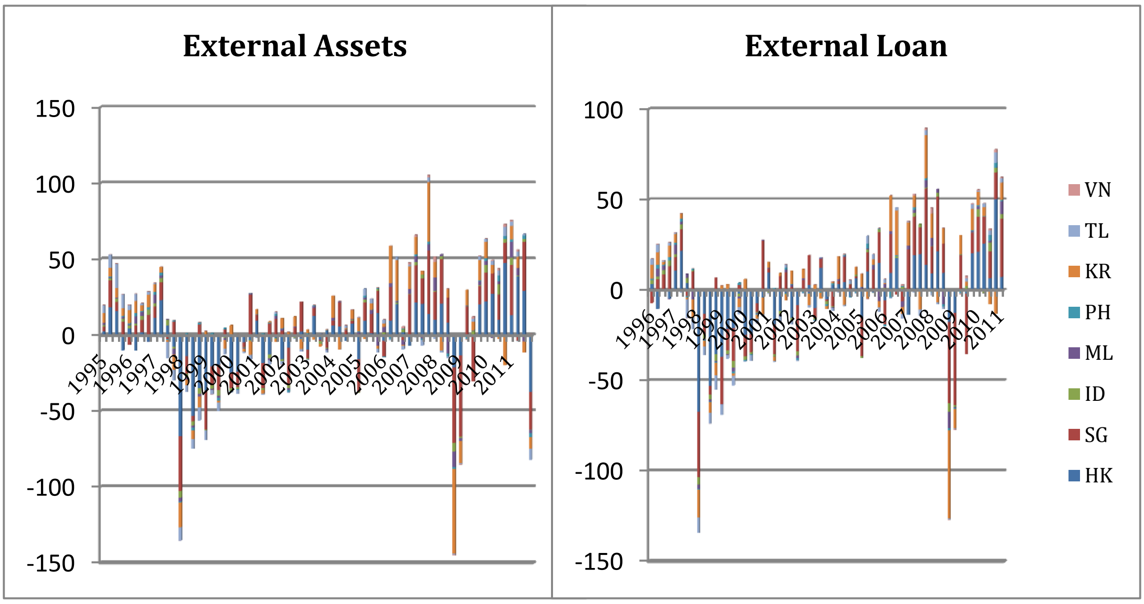
Table 4.1 - Foreign Claims of BIS reporting banks vis-à-vis East Asian countries (Amount outstanding in USD billion and % of GDP)

	1995	1998	2003	2007	2008	2009	2010
HK	336.74	275.49	267.54	375.16	387.23	448.56	561.24
	2.33	1.65	1.69	1.81	1.80	2.14	2.49
SG	214.32	165.90	131.95	259.47	248.49	261.77	328.94
	0.78	1.95	1.38	1.46	1.31	1.43	1.48
KR	85.83	79.56	103.61	374.63	299.79	350.04	339.56
	0.99	0.22	0.16	0.36	0.32	0.42	0.34
TL	68.28	58.05	39.07	54.93	55.82	66.64	87.05
	0.41	0.52	0.27	0.22	0.21	0.25	0.27
ID	48.12	49.55	34.52	67.08	66.51	75.83	99.95
	0.22	0.47	0.15	0.16	0.13	0.14	0.14
ML	20.98	27.95	61.21	110.25	103.73	106.59	127.77
	0.23	0.38	0.56	0.59	0.47	0.55	0.54
PH	9.75	20.03	24.13	31.02	24.71	27.40	34.54
	0.13	0.30	0.30	0.22	0.15	0.17	0.18
VN	1.15	2.11	3.48	15.29	15.10	16.95	21.05
	0.06	0.08	0.09	0.22	0.17	0.18	0.20

Source: BIS Consolidated Banking Statistics, immediate borrower basis; IMF-WEO

Nearly 80% of the external assets and liabilities of BIS reporting banks vis-à-vis East Asian countries consist of loans and deposits. The remainder include investments in bonds, money market instruments and equities issued by bank and the non-bank sectors. The region has not been very engaged in investment in structural credit assets or off-balance sheet activities, which were at the heart of the global financial crisis. Therefore, losses associated with the damage in the US subprime mortgage credit market were negligible (less than 1% of total assets of the regional banking system, according to the IMF). However, Asia suffered the systematic risk of contagion from the simultaneous funding withdrawals of international banks. The sharp reversals in international lending flows stimulate the transmission of funding shock throughout the global banking network.

Figure 4-1 - External assets and loans of BIS reporting banks vis-à-vis East Asian countries (Exchange rate adjusted changes, in $US billion)



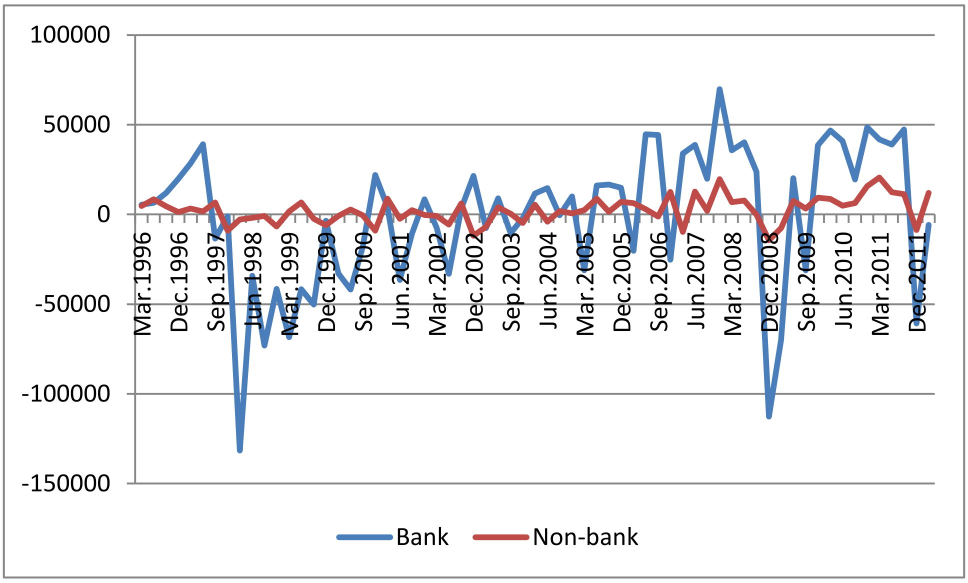
Source: BIS Locational Banking Statistics

As in other EMEs, international lending became an important source of funding to finance the rapid economic growth in East Asia, especially during the 1980s and 1990s (Levine, 2005). East Asian borrowing from the international credit markets grew in the early 1990s, but then experienced a large run-up from Japanes, US and European banks on the rise of the 1997 crisis. Consistent with the total foreign claims in consolidated data, external loan flows to the region started to boom in 2003 and peaked in the period from 2007 Q1 to 2008 Q1; however, following the collapse of Lehman Brothers, these flows fell sharply in the third quarter of 2008. Figure 4.1 shows the dynamic behaviour of external assets and loans from BIS reporting banks vis-à-vis East Asia during the period 1996 to 2011. The sharp fall in the flows in the wake of the two crisis episodes (the 1997-1998 Asian crisis and the 2007-2008 US subprime crisis) reflects both local currency depreciation and the unwinding of loan flows. The largest reductions took place in 2008 Q4 and 2009 Q1, at the peak of the disruption to international credit markets. The flows quickly recovered in 2010, nearly reaching the peak of 2007 but once again reversing in the last quarter of 2011, when the euro-related tension persisted, which led to massive deleveraging from European banks.

One of the distinct features in the composition of cross-border banking flows in East Asia compared to other EMEs is that around 80% of the flows go to the banking sector (both inter and intragroup). However, in CEE international banks have roughly equal claims vis-à-vis banks and non-bankers and in Latin America claims against the non-banking sector are somewhat higher (60% vs. 40%) (Mihaljek, 2008). External loan flows to the banking sector suffered much higher level of volatility during the crisis periods (Figure 4.2) because international banks tended to cut back their interbank exposure much more than their intragroup exposure (Hoggarth, 2010). On the contrary, international lending to the non-banking sector appeared to be more stable, as most was provided by foreign affiliates and branches in local currencies. After the 1997 crisis, foreign banks in East Asia tried to expand their local positions, while this process started earlier in CEE and Latin America. According to the BIS report of 2005, local currency claims booked by BIS reporting banks' local affiliates grew from about 15% of their total foreign claims on emerging Asia in 1996 to nearly 40% in 2004. Loans themselves shifted away from the traditional customer base (i.e. manufacturers) toward consumer finance (i.e. credit card loans) and mortgage lending in these countries.

Figure 4-2 – Cross-border loan flows to East Asia by sector

(Exchange rate adjusted changes, in millions of US dollars)

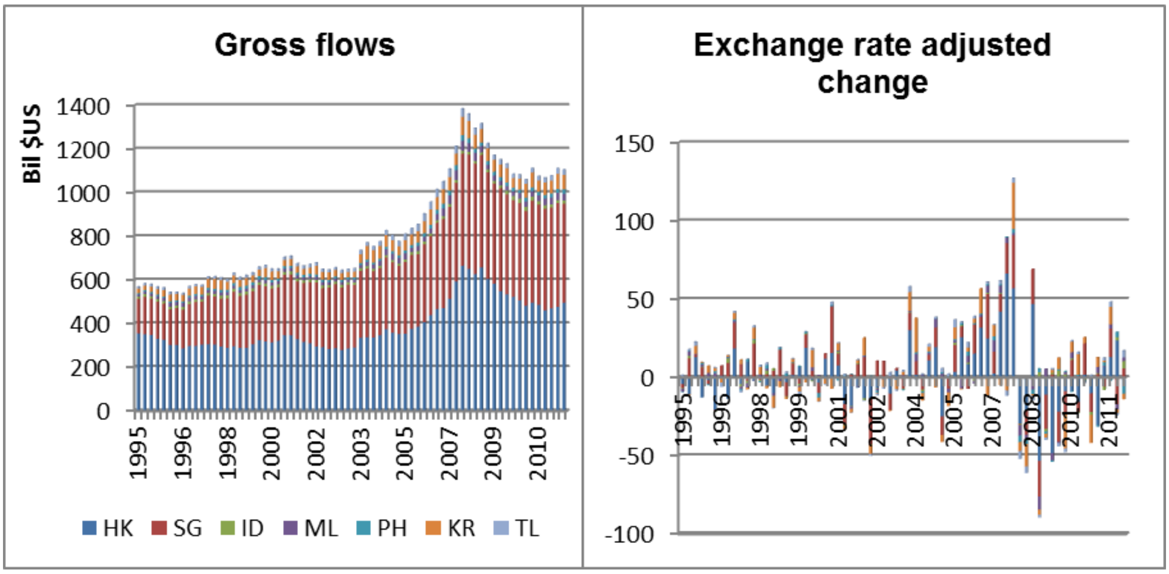


Source: BIS Locational Banking Statistics

After the 1997-1998 crisis, the shift in current account balances from deficit to surplus in East Asian countries encouraged domestic investors to place deposits in and extend loans to international banks. In other words, their operations in cross-border banking changed from net receiver to provider of foreign claims from (against) international banks (Shirai, 2009). Like external loans (assets), external liabilities of BIS reporting banks vis-à-vis East Asia experienced a dramatic rise in the past 15 years. From $US 550 billion in 1995, the gross flows increased to a peak of nearly $US 1,400 billion at the end of 2007 (Figure 4.3, left panel). These flows also underwent a strong adjustment in crisis episodes. The right panel in Figure 4.3 shows substantial negative changes in cross-border flow of liabilities from 2008 to 2011. It appears that East Asian residents tended to retrench their investments from foreign markets and bring money home. Many domestic investors move their deposits from international banks to local ones as they still believe in the protection provided by the domestic deposit insurance scheme (flight to quality by depositors)[43] and their trust in domestic economies has been restored after a successful crisis resolution. This flight-home behaviour contributed to the stabilisation of net cross-border banking flows and to alleviation of the stress in the host-country interbank markets. However, IMF (2011) present data to show that in general EMEs experienced a sharp reversal in net flows because the sudden stop in capital inflows was relatively more substantial than capital outflows. Given the low levels of interconnection and flexibility, EMEs were more likely to be subject to the higher one-way risk of deleverage[44].

Figure 4-3 – External liabilities of BIS reporting banks vis-à-vis East Asia

(Gross flows in million USD and exchange rate adjusted changes)



Source: BIS Locational Banking Statistics

In terms of source of countries, Table 4.2 shows that more than half of total foreign claims of BIS reporting banks to East Asian economies come from European banks.

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[43] The episode is different from the 1997-1998 regional financial crisis, when depositors in ID, ML, KR, PH and TL moved out of the domestic banking market and deposited their money abroad (Ding et al., 1998).

[44] In AEs, the shifts in gross inflows are normally offset by changes in outflows because AEs are more connected both in terms of inward and outward dimensions and hence are more flexible in offsetting the change in one linkage with another adjustment elsewhere in the network (IMF, 2011).

Among them UK banks take a very high share, which confirms the very active role of the banking system in the UK in cross-border banking business around the world (Shirai, 2009). Before the 1997-1998 crisis, banks in Japan held a very large amount of East Asian foreign assets and liabilities (more than a 25% in total) and provided more than 65% of loans from OECD banks (Siregar and Choy, 2009) to this region. Among East Asian countries, Thailand is notable, with half of its external liabilities to international banks provided by Japanese banks. However, Japanese banks' dominant role in East Asian credit markets changed slightly as they ran out of the region after the 1997-1998 crisis. From 2003, US and EU banks' claims to East Asia started to grow, while the lengthy retrenchment by Japanese banks has only recently bottomed out. In 2004, new Japanese bank loans to East Asian countries were barely 30% of their level at the end of 1996. In the 10 year period from 1997 to 2007, Japanese banks' share of total foreign claims declined by more than 50% (from 25.12% to 11.95%). Before the global credit crisis of 2008 to 2011, US and Japanese banks shared the same position in East Asian markets, but US banks dominated Japanese banks in Philippines and Korea, and Japanese banks outshone the others in Thailand. The role of European banks has been reinforced with their increasing holdings of East Asian assets and they remain in a dominant position. However, the concentration of foreign claims and the similarities in creditor structure in these countries increase the risk of cross-border contagion via the common lender and wake-up call effects.

Table 4.2 - Foreign claims of BIS reporting banks by nationality vis-à-vis East Asian countries (as percentage of total foreign claims)

	US banks		EU banks (excluding UK)		UK banks		JP banks	
	1997	2007	1997	2007	1997	2007	1997	2007
HK	7.68	5.7	27.4	22.06	36.33	44.76	20.97	11.73
SG	5.16	13.12	43.31	34.95	15.28	20.94	25.26	15.09
ID	10.74	14.23	32.38	36.61	7.00	11.4	35.56	14.32
ML	17.03	11.88	40.85	22.27	5.92	26.37	27.25	7.69
PH	25.91	15.75	48.71	42.73	6.88	16.44	11.61	12.31
KR	14.32	19.73	29.08	33.8	7.28	24.39	19.86	7.96
TL	8.47	10.09	23.98	21.65	3.21	14.64	47.73	31.63
VN	15.17	9.32	57.68	36.75	6.52	22.5	13.00	11.75
Total	**8.95**	**12.71**	**32.91**	**29.56**	**20.66**	**28.47**	**25.15**	**11.95**

Source: BIS Consolidated Banking Statistics, immediate borrower basis.

As can be witnessed in the regional crisis in 1997-1998, when Thailand was first hit by a shock, Jaopanse banks, who were the biggest and common lender in the region, tried to withdraw from neighbouring East Asian countries such as Indonesia, Philippines, Malaysia and Korea. Consequently, the crisis spread throughout the region. Given their high exposure to European banks as shown in Table 4.2, such concern was intensified on the escalation of the problems in euro area and the accelerating deleveraging process of European banks. According to the World Bank report of 2012, the cross-border banking flows from European banks (excluding claims of local offices in the given host country) have declined since 2008, especially in the last quarter of 2011, amounting to US$ 48 billion in Asia, US$ 40 billion in CEE and US$ 6 billion in Latin America (Feyen et al., 2012). Trade financing experienced significant declines in some countries such as Hong Kong and Singapore, which had a large number of European bank cross-border claims relative to the size of their domestic economies. Moreover, a number of European and US subsidiaries in East Asia saw their credit ratings downgraded following rating actions on the parent banks (e.g. HSBC, Santander, BBVA, Citigroup, Goldman Sachs, KBC, and Unicredit).

In order to capture the potential vulnerability through the common lender channel, we follow Gersl (2006) and construct a common lender index to measure the similarity in patterns of creditors between two countries. This index is bounded between 0 and 1; 0 indicates no common creditors and 1 indicates the same composition of creditors. The formula is expressed as follows:

$$I = \sum \frac{(FC_{c,i} + FC_{c,j})}{(FC_i + FC_j)} \left[1 - \frac{\left| \left(\frac{FC_{c,i}}{FC_i} \right) - \left(\frac{FC_{c,j}}{FC_j} \right) \right|}{\left(\frac{FC_{c,i}}{FC_i} \right) + \left(\frac{FC_{c,j}}{FC_j} \right)} \right]$$

where $FC_{c,i}$, $FC_{c,j}$ denotes foreign claims of a common creditor on East Asian countries i and j, respectively; FC_i, FC_j denote total foreign bank claims on countries i and j. The index is made up of two terms. The first term equals the common creditor's share of total foreign claims on the two East Asian countries. The second term weights the first term – a higher weight reflects greater similarity between the shares of total foreign claims held by the common creditor. Summing is done across several common creditors: US, Japanese, Canadian, UK and other European banks (from France, Germany, Switzerland, Sweden, the Netherland and Denmark).

Table 4.3 provides common creditor indices for East Asian countries at pair-wise levels for two periods of time, 1993-1997 and 2003-2007. The results indicate that all countries studied share to some extent common creditors with each other, represented by high indicators (over 0.5) for both periods of time. This reflects the results of the expansion strategy of many creditors (mainly from Europe and the US) in East Asia. Singapore's creditor structure is broadly similar to all other East

Asian countries (all indicators are especially higher than 0.77), which is due to the significant role of foreign banks in this country and its diversification in cross-border banking business.

Table 4.3 – Common creditor indices

For the period 1993 -1997

	HK	SG	ID	ML	PH	KR	TH	VN
HK	1.000							
SG	0.805	1.000						
ID	0.708	0.792	1.000					
ML	0.684	0.773	0.775	1.000				
PH	0.514	0.655	0.559	0.714	1.000			
KR	0.655	0.676	0.663	0.686	0.542	1.000		
TH	0.660	0.691	0.809	0.685	0.451	0.614	1.000	
VN	0.554	0.666	0.622	0.662	0.653	0.575	0.534	1.000

For the period 2003-2007

	HK	SG	ID	ML	PH	KR	TH	VN
HK	1.000							
SG	0.679	1.000						
ID	0.514	0.777	1.000					
ML	0.711	0.808	0.507	1.000				
PH	0.538	0.772	0.764	0.523	1.000			
KR	0.630	0.822	0.670	0.685	0.737	1.000		
TH	0.620	0.853	0.625	0.538	0.608	0.647	1.000	
VN	0.594	0.789	0.724	0.519	0.755	0.699	0.596	1.000

Source: Calculated by author based on BIS data

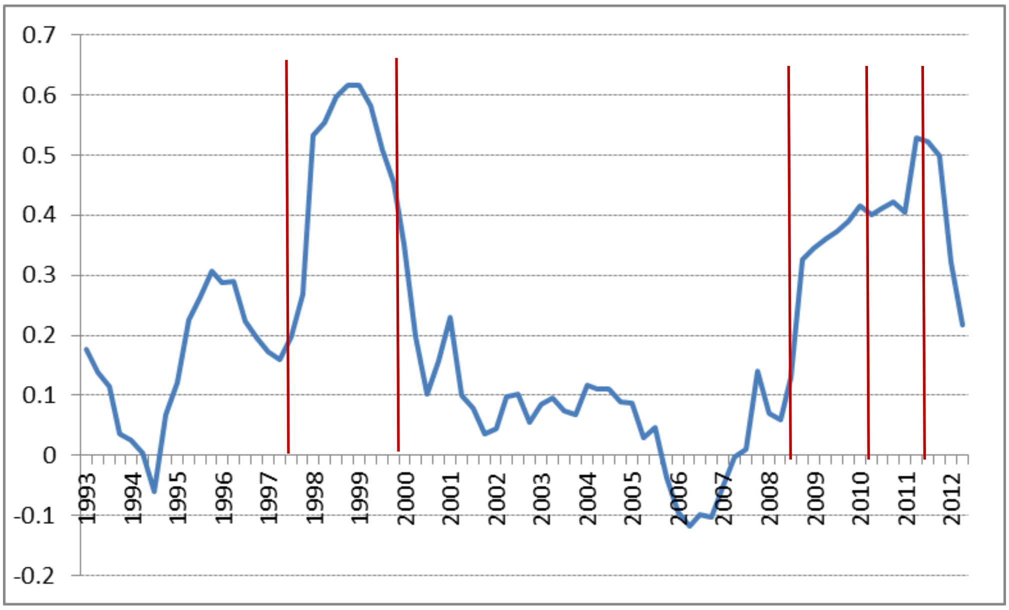
The concentration of foreign claims and the high degree in similarity in creditor structure explain the synchronisation in the adjustment of cross-border loan flows to East Asian countries, especially at the time of financial stress. As seen from Table 4.4, bilateral correlations of changes in international loan flows between two countries for the whole period from 1993-2011 are all positive. Hong Kong appears to have higher correlations with Singapore and Indonesia, whereas loan flows to Malaysia are more correlated with those of Korea (bilateral correlations are more than 0.5). Thailand shows a highly synchronised shift in external loan flows with Hong Kong and Indonesia.

Table 4.4 - Correlation matrix of cross-border loan flows (exchange rate adjusted changes) to East Asian countries

	HK	SG	ID	ML	PH	KR	TL	VN
HK	1.000							
SG	0.539	1.000						
ID	0.556	0.445	1.000					
ML	0.201	0.353	0.397	1.000				
PH	0.314	0.376	0.485	0.286	1.000			
KR	0.288	0.444	0.365	0.534	0.151	1.000		
TL	0.483	0.250	0.425	0.285	0.357	0.267	1.000	
VN	0.293	0.316	0.366	0.396	0.149	0.285	0.139	1.000

Source: Calculated by author based on BIS data

Figure 4-4 – Correlation of (exchange rate adjusted) changes in cross-border loans flows to East Asia (3 year moving average)



Source: Calculated by author based on BIS data

The time series correlations presented in Figure 4.4 are constructed based on the method of Van den End and Tabbae (2012) by averaging the bilateral correlations in the matrix and calculating over a rolling window of 12 quarters. This measures the commonality in loan flow adjustments across East Asian countries, which was low during stable periods because it depended on the country-specific circumstances and pull factors but peaked during the financial stress of 1997-1998 and 2008-2009 due to global risk aversion (wake-up call effect) and the common credit structure (common lender effect).

In general, analysis of the BIS data on international banking business in East Asian countries reveals some evidence of increased integration of the region in international financial markets. The analysis focuses on the external position, foreign borrowing and structure of cross-border banking flow, which may generate the vulnerability of East Asia to foreign shocks and foster greater susceptibility to systematic sudden stop. However, this descriptive analysis with illustrated figures does not represent an overall assessment of the financial or macroeconomic vulnerability and stability of the individual countries studied. The actual vulnerability of a country depends on its macroeconomic fundamentals, capitalisation, liquidity and the general soundness of its banking system, financial sector fragilities, and policy response to external shocks (Goldstein and Xie, 2009; Árvai et al., 2009).

4.4. Transmission of Funding Shock to East Asia: Empirical Analysis

4.4.1. Empirical Models

The empirical investigation in this section estimates the probability of systematic sudden stop in cross-border banking flows in East Asian associated with:

(i) *Liquidity shocks in international credit markets that affect the supply of bank loans*

(ii) *Aggregate productivity shocks in host countries that lower the demand for bank loans*

(iii) *A contagion effect via the common lender and wake-up call channels*

(iv) *The link between the sudden stop in international lending flows and the tensions in interbank markets*

(v) *Domestic investors' retrenchment from foreign markets to mitigate interbank market tensions.*

Together with the analysis in section 4.3.2, the test for the sudden stop probability relating to different kind of shocks mentioned in (i), (ii) and (iii) will help to answer the following research questions:

RQ2a - How can cross-border banking expose domestic financial markets to the risk of a sudden stop in international lending?

RQ2b - Do international bank withdraw their exposures across the board or do they discriminate between countries, and if so, how?

The analysis in (iv) and (v) aims at addressing the research question 2c.

RQ2c – Was the sudden stop in international lending linked to the tensions in host countries' interbank market?

The sudden stop in cross-border banking flows is denoted as an event when an East Asian country experiences a negative foreign exchange rate adjusted change in gross external loan flows (*Exloan*) from BIS reporting banks. Figure 4.1 shows the identification of the sudden stop which occurred simultaneously in many East Asian countries and mostly at the height of the 1997-1998 regional crisis and the 2007-2011 global crisis. This is considered as cross-border contagion in loan provision (or systematic sudden stop), which may stimulate the transmission of money market tensions from AEs to the East Asia (Fung and Yu, 2009)[45]. However, at the same time as the synchronous withdrawals of international banks during the crisis, East Asian domestic investors tended to liquidate their foreign investments and bring money home (Figure 4.3), which contributed to mitigate the volatility in net cross-border bank flows and reduced stress in local interbank markets. Appendices 4.1 and 4.2 illustrate the reversal in external loan flows in many East Asian countries and the accompanying significant increase in TED spreads. Interbank market stress is measured as an episode when the local TED spreads (LTED) in an East Asian country exceeds one standard deviation of its historic average, calculated by the rolling windows of 8 consecutive quarters. For Thailand and Philippines, due to data limitation the change in interbank call rate instead of TED is used and assumed that interbank stress occurs when interbank call rate increases more than one standard deviation above its mean calculated for 8 consecutive quarters. Given the binary nature of two interested variables, the univariate and recursive bivariate probit models are employed, which allow for a joint estimation of the two equations 4.1 and 4.2 as follows:

$$\mathbf{(4.1)}\ \boldsymbol{y^*_{1,it} = \alpha_1 + \varphi_1 X_{it} + \gamma_1 Z_{1,it} + \theta_{1i} D_i + \varepsilon_{1,it}}$$

$$\mathbf{(4.2)}\ \boldsymbol{y^*_{2,it} = \alpha_2 + \varphi_2 y^*_{1,it} + \gamma_2 Z_{2,it} + \theta_{2i} D_i + \varepsilon_{2,it}}$$

where:

$$y_{1,it} = \begin{cases} 1\ if\ y^*_{1,it} = Exloan_{it} < 0 \\ \quad 0\ otherwise, \end{cases} \quad (\textit{Sudden stop event: S-Stop})$$

$$y_{2,it} = \begin{cases} 1\ if\ y^*_{2,it} = LTED_{it} > \sigma_{LTED} + \mu_{LTED} \\ \quad 0\ otherwise, \end{cases} \quad (\textit{Interbank stress event: IB-Stress})$$

[45] However, Fung and Yu (2009) study the transmission of money market tension in terms of volatility co-movement between interbank stress of the US dollar and that of local currencies in Asia.

$E[\varepsilon_1] = E[\varepsilon_2] = 0\,; Var[\varepsilon_1] = Var[\varepsilon_2] = 1$

φ, γ and θ are vectors of regression parameters to be estimated;

X_{it} is a set of variables representing different kinds of shocks that cause the sudden stop event;

$Z_{1,it}$ is a set of variables to control for additional pull and push factors driving international bank lending flows;

$Z_{2,it}$ is a vector of exogenous factors that may affect the probability of stress event in interbank markets;

D_i are country dummies to control for country-specific fixed effects.

The empirical analysis has two-step econometric approaches: we first utilise the univariate probit model for panel data to test the probability of sudden stop (equation 4.1); and then apply recursive bivariate probit model to jointly test the risk of sudden stop and its impact on interbank market in host countries (a simultaneous regression of equations 4.1 and 4.2). In the following, the general specifications of univariate probit and recursive bivariate probit model are introduced.

Univariate probit model for panel data:

$$\textbf{(4.3)}\quad \boldsymbol{y^*_{it} = \beta x'_{it} + v_{it} + u_i, \quad i = 1, \ldots, n, t = 1, \ldots, T_i,}$$

$y_{it} = 1 \; if \; y^*_{it} > 0, and \; 0 \; otherwise,$

where u_i is the unobserved, individual specific heteroskedasticity and v_{it} is error term.

It is necessary to identify the relationship between u_i and x_{it} to distinguish between random and fixed effects. The literature suggests that there are many geographical and demographical factors driving international lending flows. Therefore, the assumption that u_i are uncorrelated with x_{it}, which produces the random effects model appears to be unreasonable. Nevertheless, the fixed effect specifications may encounter incidental parameter problem, especially in a panel with small T and large N (N is number of cross-sections)[46](Greene, 2012). The panel regression in this study is based on a sample of quarterly data of seven East Asian countries during the period from 1996 to 2011, which gives T = 64 and N = 7. In that case, the incidental parameter problem is not too severe. The fixed effects model would be:

$$\textbf{(4.4)}\quad \boldsymbol{y^*_{it} = \beta x'_{it} + \theta_i D_i + \varepsilon_{it},\quad i = 1, \dots, n, t = 1, \dots, T_i,}$$

$$y_{it} = 1 \; if \; y^*_{it} > 0, and \; 0 \; otherwise,$$

with D_i is a dummy variable that takes the value of one for individual country i and zero otherwise. The log-likelihood function for the fixed effects model is given by:

$$\boldsymbol{lnL = \sum_{i=1}^{n}\sum_{t=1}^{T_i} lnP(y_{it}|\beta x'_{it} + \theta_i)}$$

where $P(\cdot)$ is the probability of the observed outcome.

Recursive bivariate probit model:

The recursive bivariate probit model is an extension of the basic bivariate probit with a simultaneous estimation of two equations for y^*_1 and y^*_2, while y_2 depends on the observed variable y_1. The general specification of the model would be:

[46] When T is small and fixed, estimators of the constant terms are not consistent because they do not converge at all. The estimation of explanatory variable coefficient is, therefore, not consistent (Greene, 2012).

$(\mathbf{4.5})\ \boldsymbol{y_1^* = \beta_1 x_1 + \varepsilon_1}$, $\qquad y_1 = 1\ if\ y_1^* > 0, 0\ otherwise,$

$(\mathbf{4.6})\boldsymbol{y_2^* = \beta_2 x_2 + \beta_3 y_1 + \varepsilon_2}$, $\qquad y_2 = 1\ if\ y_2^* > 0, 0\ otherwise,$

$$\begin{pmatrix}\varepsilon_1 \\ \varepsilon_2\end{pmatrix} |x_{1,}x_2 \Big) \sim N\left[\begin{pmatrix}0\\0\end{pmatrix}, \begin{pmatrix}1 & \rho \\ \rho & 1\end{pmatrix}\right]$$

where ε_1 and ε_2 are jointly standard normally distributed with correlation coefficient ρ. The recursive bivariate probit is estimated using the log-likelihood function, which is the same for the usual bivariate probit as the endogenous nature of variable y_2 can be ignored in formulating the log-likelihood (Greene, 2012).

To construct the log-likelihood, let $q_{i1} = 2y_{i1} - 1\ and\ q_{i2} = 2y_{i2} - 1$. Thus, $\mathrm{q_{ij}} = 1$ if $\mathrm{y_{ij}} = 1$ and -1 if $\mathrm{y_{ij}} = 0$ for $\mathrm{j} = 1$ and 2. Denoting that:

$z_{ij} = \beta_j x_{ij}, w_{ij} = q_{ij} z_{ij}$ (with $\mathrm{j} = 1{,}2$ and i indicates the observations); and

$\rho_{i^*} = q_{i1} q_{i2} \rho$.

The probability terms that enter the likelihood function are:

$$Prob(Y_1 = y_{i1}, Y_2 = y_{i2} | x_1 x_2) = \Phi_2(w_{i1}, w_{i2}, \rho_{i^*})$$

Specifically, there are four cell probabilities in the recursive bivariate probit model such that:

1. $Pr(y_2 = 1, y_1 = 1) = \Phi_2(\beta_1 x_1, \beta_2 x_2 + \beta_3, \rho) = P_{11},$
2. $Pr(y_2 = 1, y_1 = 0) = \Phi_2(-\beta_1 x_1, \beta_2 x_2, -\rho) = P_{10},$
3. $Pr(y_2 = 0, y_1 = 1) = \Phi_2(\beta_1 x_1, -\beta_2 x_2 - \beta_3, -\rho) = P_{01},$
4. $Pr(y_2 = 0, y_1 = 0) = \Phi_2(-\beta_1 x_1, -\beta_2 x_2, \rho) = P_{00}$

where Φ_2 is the cumulate distribution function (CDF) of the bivariate normal distribution.

Thus, the log-likelihood is given by:

$$\boldsymbol{logL} = \sum_{\boldsymbol{i=1}}^{\boldsymbol{n}} \boldsymbol{ln}\Phi_{\boldsymbol{2}}(\boldsymbol{w_{i1,}w_{i2},\rho_{i^*}})$$

Interpreting the magnitudes of bivariate probit coefficients is not straightforward, because it depends on the slope of the CDF. We, therefore compute the marginal effects of explanatory variables on the probabilities, i.e. the changes in the response probabilities as a result of one unit change in the explanatory variables. The marginal effects in the first equation y_1 can be defined exactly as that of univariate probit model (but with the parameters estimated from recursive bivariate probit):

$E[y_1|x_1] = Prob[y_1 = 1] = \Phi(\beta_1 x_1)$, where Φ is the univariate CDF.

- For a continuous variable z_i, marginal effect is measured by:

$$\frac{\partial E[y_1|x_1]}{\partial z_i} = \frac{\partial \Phi(\beta_1 x_1)}{\partial z_i} = \phi(\beta_1 x_i) \times \beta_z$$

where $\phi(\cdot)$ is the density function of the standard normal distribution and β_z is the coefficient on variable z.

- The appropriate way to calculate marginal effect for a binary variable z_i is to use: Effect on $E[y_1|x_1] = E[y_1|x_1 z = 1] - E[y_1|x_1 z = 0]$

In the recursive bivariate probit model, computation of the marginal effect is complicated because the explanatory variable which appears in both equations of y_1 and y_2 should have a direct effect on y_2 as well as indirect effects on y_2 via y_1, therefore the marginal effect of this variable will be the sum of direct and indirect effects. In particular, we will measure the change in variable z on the probability of the occurrence of interbank market tension and the indirect effect of the change in this variable on the probability of sudden stop event, which in turn affects the probability that interbank market tension equal to one. Following Greene (1998), marginal effects are computed as follows:

- ***For a continuous variable, z that might appear in either equations***

$$\partial E[y_2|x_2x_1]/\partial z = [\Phi(\beta_1x_1)\phi(\beta_2x_2+\beta_3)+\Phi(-\beta_1x_1)\phi(\beta_2x_2)]\beta_2^z \text{ (Direct effect)}$$

$$+[\phi(\beta_1x_1)\Phi(\beta_2x_2+\beta_3)+\phi(-\beta_1x_1)\Phi(\beta_2x_2)]\beta_1^z \text{(Indirect effect)}$$

where β_1^z, β_2^z are the coefficients on variable z in two equations.

- ***For endogenous binary variable y_1,***

$$E[y_2|x_2,x_1,y_1=1]-E[y_2|x_2,x_1,y_1=0]=\Phi(\beta_2x_2+\beta_3)-(\beta_2x_2)$$

In all cases, standard errors are computed using the delta method[47].

The identification by the function form is present in the recursive bivariate probit in the absence of exclusion restrictions (Wilde, 2000), but common practice imposes restrictions when they improve the identification of the model (Baslevent and El-hamidi, 2009). Therefore, we decide all the exclusion in the models by including the variables in both equations first and then eliminating them from the equation(s) in which they are jointly insignificant.

The definition of variables that enter the estimation of equations (4.1) and (4.2) is presented in Table 4.5. $X_{i,t}$ includes different variables to represent different kind of shocks that may affect the probability of a sudden stop.

(i) Liquidity shock in the international credit market that drives shifts in international loan supply, is proxied by the spreads between three-month U.S. dollar LIBOR and 3-month US Treasury bill rates (TED spreads). The

[47] See Greene (1998) for further explanation of the computation of standard errors.

widening TED spreads signal the deterioration in global liquidity conditions. We therefore expect a positive coefficient on TED variable.

(ii) Host-country productivity shock is represented by the percentage change in quarterly real GDP in borrower countries (GDP-host). A decline in real GDP implies weakening economic conditions and lower returns in these countries, which may diminish credit demand and in turn have a negative effect on the reversals of international lending.

(iii) Shocks are also amplified by the contagion effect via the common lender and wake-up call channels. The common lender effect is captured by the potential spillover of changes in international bank flows among East Asian countries, given that they share the same creditor structure. Following Peria et al (2005), the common lender factor is calculated as the changes in loan flows from international banks to all the East Asian host countries in our sample, except that of the individual East Asian country i. The sign of common lender coefficient should be negative, as a decrease in cross-border lending to other countries will lead to potential withdrawals from the other recipient country.

To measure wake-up call effect, VIX variable which is generally considered as the barometer of investment sentiment and market volatility is used. A high value of the VIX indicates more volatile market expectations and hence higher international investor risk aversion. If the wake-up call effect works, the coefficient on VIX would be positive and significant. Furthermore, the wake-up call hypothesis is also tested by including two further variables: changes in lending flows to EMEs in Latin America (Co-LA) and in CEE (Co-CEE). When international investors are risk-averse, they have incentives to withdraw from many EMEs, even without any fundamental relationship.

Variables representing the changes in external loan flows such as Exloan, Co-lender, Co-LA and Co-CEE are expressed as logarithms based on the method proposed by Papaioannou's (2009). Specifically, for negative observations, it takes logarithms of the absolute value and assigns them with a negative sign. This transformation preserves the sign in the original variable and retains the symmetry between increases and decreases in capital flows.

The set of pull and push factors $Z_{1,it}$ that may influence international bank lending decisions includes: economic performance in the home country (GDP-home) and economic and financial risks in the host countries (inflation, foreign exchange rates, stock market volatility, bank stock return and financial integration). Stock market volatility is a time-varying measure of volatility obtained from GARCH (1,1) specification, using weekly real stock returns and modelled as an autoregressive process with five lags. Financial integration is defined as a host country's exposure to cross-border banking and measured by the ratio of external assets and liabilities of BIS reporting banks vis-à-vis recipient country i relative to that country's GDP. Large external exposure represents a potential source of external vulnerability (Mihaljek, 2008). However, some of the literatures argue that this relationship is nonlinear; as a country becomes more integrated with the global financial market, capital flow volatility initially increases but will then decrease as the integration exceeds the threshold (Milesi-Ferretti and Tille, 2011; Calvo et al., 2008; Aghion et al., 2004). Therefore, the expected sign of this variable is very ambiguous.

Table 4.5– Description of variables and source of data

Variables	**Definition (and source)**	**Expected sign of coef. (for equation 4.1)**
S-Stop	$S - Stop = \begin{cases} 1\ if\ Exloan_{it} < 0 \\ 0\ otherwise, \end{cases}$	
Exloan	Exchange rate adjusted change in external loan flows from BIS reporting banks vis-à-vis East Asian country i (from BIS locational statistics)	
IB-stress	Interbank market tension is measured by the episode when the LTED exceeds one standard deviation above its historic mean. $IB - stress = \begin{cases} 1\ if\ LTED_{it} > \sigma_{LTED} + \mu_{LTED} \\ 0\ otherwise, \end{cases}$	
TED	The spreads between 3-month LIBOR and 3-month US Treasuries bill rates. (Datastream)	**+**
LTED	TED spreads for East Asian countries to be measured by the difference between 3-month interbank rates and yield of 3-month government securities, or change in interbank call rates. (Datastream)	
VIX	The S&P100 Volatility Index of the Chicago Board Options Exchange (in logarithm). (Datastream)	**+**
GDP-home	Real GDP growth rate of AEs since most BIS reporting banks come from AEs. (IMF-IFS)	**+/-**
GDP-host	Real GDP growth rate of Asian countries (IMF-IFS)	**-**
Inflation	Percentage change in CPI (IMF-IFS)	**+**
FOREX	Nominal exchange rate of local currency against US dollar (in logarithm). (IMF-IFS)	**+**
CVSR	Conditional variance of stock market return obtained from GARCH(1,1) estimation on autoregressive model of weekly stock market returns with five lags.	**+**
BR	Domestic bank stock return. (Datastream)	**-**
Fin-open	Financial integration is measured as the ratio of external assets and liabilities of BIS reporting banks vis a vis East Asian country relative to that country's GDP. (BIS locational statistics and IMF-IFS)	**+/-**
Co-lender	Changes in external loan flows to all East Asian countries in our sample except that of the individual East Asian country i. (BIS locational statistics)	**-**
Co-LA	Changes in external loan flows to Latin American countries (BIS locational statistics)	**-**
Co-CEE	Changes in external loan flows to CEE (BIS locational statistics)	**-**

4.4.2. Estimation Results and Discussion

Table 4.6 – Univariate and Recursive Bivariate Probit Estimations

	Univariate probit (Equation 4.1)			Recursive bivariate probit	
	(1)	(2)	(3)	Equation 4.1	Equation 4.2
Constant	-6.035***	-6.846***	-6.836***	-4.527**	-0.610**
	(2.269)	(2.384)	(2.061)	(2.389)	(0.257)
S-Stop					0.736***
					(0.278)
Retrenchment					0.324***
					(0.132)
TED	0.423**	0.493**	0.272	0.418**	
	(0.204)	(0.220)	(0.191)	(0.200)	
VIX	0.021*	0.009	0.022*	0.020*	-0.023***
	(0.012)	(0.939)	(0.011)	(0.011)	(0.009)
GDP-home	0.192***	0.196***	0.099**	0.185***	
	(0.058)	(0.055)	(0.048)	(0.055)	
GDP-host	-0.113***	-0.108***	-0.044**	-0.103***	
	(0.024)	(0.024)	(0.022)	(0.025)	
Inflation	-0.007	-0.005	-0.003	-0.004	
	(0.020)	(0.020)	(0.016)	(0.017)	
FOREX	1.619***	2.000***	1.765***	1.164*	
	(0.623)	(0.655)	(0.558)	(0.666)	
CVSR	0.086**	0.057	0.078**	0.107***	
	(0.043)	(0.060)	(0.039)	(0.041)	
Bank return		-0.006*			
		(0.003)			
Fin-open	-0.125**	-0.142**	-0.025	-0.116*	
	(0.063)	(0.063)	(0.058)	(0.065)	
Co-lender	-0.069***	-0.072***	-0.072***	-0.067***	
	(0.018)	(0.019)	(0.023)	(0.018)	
Co-LA	-0.040**	-0.028	-0.025	-0.045**	
	(0.022)	(0.022)	(0.021)	(0.021)	
Co-CEE	-0.015	-0.060**	-0.003	-0.013	
	(0.029)	(0.028)	(0.026)	(0.027)	
Country dummies			YES		
Log-likelihood	-204.967	-210.823	-221.58	-456.53	
[p-value]	[0.00]	[0.00]	[0.00]	[0.00]	
Wald chi2	100.69	105.71	99.15	190.14	
Pseudo-R^2	0.273	0.244	0.204		

Notes: (1), (2) and (3) denote total external loan flows, external loan flows to banks, and external loan flows to the non-banking sector, respectively. Standard errors in parentheses. *, ** and *** represent significance at levels of 10%, 5% and 1% , respectively.

Table 4.7 – Marginal effects of variables

	Univariate probit (Equation 4.1)			Bivariate probit (Equation 4.2)	
	(1)	(2)	(3)	Indirect effect	Direct effect
S-Stop					0.288***
					(0.101)
Retrenchment					0.127**
					(0.051)
TED	0.168**	0.193**	0.107	0.071*	
	(0.081)	(0.086)	(0.075)	(0.038)	
VIX	0.008*	0.003	0.008*	-0.006	-0.009***
	(0.004)	(0.004)	(0.004)	(0.002)	(0.003)
GDP-home	0.076***	0.077***	0.039**	0.031***	
	(0.023)	(0.021)	(0.019)	(0.012)	
GDP-host	-0.045***	-0.042***	-0.017**	-0.017***	
	(0.009)	(0.009)	(0.008)	(0.006)	
Inflation	-0.003	-0.002	-0.001	-0.008	
	(0.008)	(0.007)	(0.006)	(0.003)	
FOREX	0.646***	0.784	0.693***	0.198	
	(0.009)	(0.257)	(0.219)	(0.136)	
CVSR	0.034**	0.022	0.030	0.018**	
	(0.017)	(0.023)	(0.015)	(0.007)	
Bank return		-0.002*			
		(0.001)			
Fin-open	-0.050**	-0.056	0.010	-0.019*	
	(0.025)	(0.024)	(0.022)	(0.012)	
Co-lender	-0.027***	-0.028***	-0.028**	-0.011***	
	(0.007)	(0.007)	(0.009)	(0.004)	
Co-LA	-0.016*	-0.011	-0.009	-0.007**	
	(0.008)	(0.008)	(0.008)	(0.003)	
Co-CEE	-0.006	-0.023**	-0.001	-0.002	
	(0.011)	(0.001)	(0.010)	(0.004)	

Notes: (1), (2) and (3) denote total external loan flows, external loan flows to banks, and external loan flows to the non-banking sector, respectively. Standard errors in parentheses. *, ** and *** represent significance at levels of 10%, 5% and 1%, respectively.

The full information maximum likelihood estimates of univariate and recursive bivariate probit models are summarised in Table 4.6, and Table 4.7 shows the marginal effects of variables. For the recursive bivariate probit, the marginal effects of variables on $E(y_2|y_1, x_1, x_2)$ include both direct and indirect effects. Three columns in the Univariate probit estimates (Table 4.6) represent the regression results for total loan flows (1), loan flows to the banking sector (2), and loan flows to the non-banking private sector (3). The last two columns in Table 4.6 show the estimated parameters for equations 4.1 and 4.2 in the recursive bivariate probit models. Most parameters have the expected signs and are statistically significant, which is consistent with the theories and confirms our hypotheses that the sudden reversals in international loans are associated with the liquidity shocks that affect the supply of loans, aggregate productivity shocks in host country that diminish the demand for loans and the contagion factors of the common lender and wake-up call effects. In order to measure how well the model fits the data, the McFadden pseudo-R^2 goodness-of-fit is calculated:

$$\boldsymbol{pseudo - R^2 = 1 - (\frac{LL_u}{LL_r})}$$

where LL_u is the value of the log-likelihood function at the estimated parameters in the full unrestricted model and LL_r is its value when all parameters except constants are set equal to zero[48]. Additionally, the χ^2 Wald test is used to test the hypothesis that the coefficients of several or all variables are zero. The Pseudo-R^2 reported in Table 4.6 explains around 20-27% of the variation in the probability of sudden stop in international lending flows to East Asia. The likelihood ratio test (with a p-value of 0.00) rejects the null hypothesis that all independent variables

[48] The log-likelihood function is given by: $LL = \sum_{i=1}^{N}\sum_{j=1}^{m} I_{ij} lnP_{ij}$
where N is the number of observations, I_{ij} is an indicator variable that is equal one if the i^{th} observation falls in the j^{th} event and zero otherwise. If the model contains no covariates, but only a constant term, then the restricted log-likelihood is: $LL_r = \sum_{j=1}^{m} n_j \ln(\frac{n_j}{n}) = \sum_{j=1}^{m} n_j\, lnp_j$

are simultaneously equal to zero. In all cases, country dummies are highly significant, indicating the importance of domestic effects.

4.4.2.1. The Systematic Sudden Stop in International Lending

Starting from supply shocks, the empirical results suggest that subject to funding pressure caused by global liquidity shortages, international banks tend to cut their lending to East Asian countries. This finding is consistent with those of MacGuire and Tarashev (2008) and Kamil and Rai (2010), who provide significant evidence that a deterioration in inter-bank liquidity adversely affects foreign banks' lending growth to Latin America. The marginal effects in Table 4.7 show that a 10% increase in TED spreads may increase the probability of sudden stop by a 1.68% point with a significant level of 5%. However, while liquidity shock has a powerful predictive function on loan flows to the banking sector, it appears to be insignificant for lending flows to the non-bank sector. This may be due to the fact that loans to non-bankers are usually in the form of local lending by foreign subsidiaries and branches, which is considered more stable than cross-border lending. As documented in Kamil and Rai (2010), the effect of global interbank market tensions on cross-border lending (which is largely denominated in foreign currencies and funded in wholesale markets) is larger, while the effect on lending from local affiliates (mostly denominated in local currencies and funded by domestic deposits) is much smaller. Herrero and Martinez Peria (2007) and Mihaljek (2008) also confirm that some countries with a higher presence of foreign owned banks even received additional loans during the global financial crisis, which contributed to the stability in overall foreign bank lending.

The positive significant coefficient of GDP-home versus the negative effect of GDP-host on the dependent variable strongly supports the flight to quality theory in Bernanke and Gertler (1989) and Bernanke et al. (1994). International banks tend to pull out from EMEs if there is a deterioration in economic growth in these countries and an improvement in economic performance in AEs (home countries) since this will entail higher profit opportunities at home. Moreover, the reversals may also come from the decline in loan demand from EMEs when they are faced with productivity shock that worsens their macroeconomic conditions. Specifically, a 10% decrease in GDP growth rate in East Asian countries increases the probability of sudden reversals in overall international bank loans flows to 0.45%, and to 0.42% and 0.17% for loans to bank and non-bank sectors, respectively.

Turning to contagion variables, there is convincing evidence to support the common lender hypothesis as the coefficient on Co-lender is negative and highly significant at 1% level in all specifications. The marginal effect in Table 4.7 reveals the consistence in magnitude of the effect for all cases and implies that East Asian country i will experience an increase of around 0.28% in the sudden stop possibility if gross international loans to the remaining countries in the sample decrease by 10%. This may imply that the common lender effect not only works with host country shocks, as discussed in numerous empirical papers (Kaminsky and Reinhart, 2000; Caramazza et al., 2000; Hernandex and Valdes, 2001; Van Rijckeghem and Weder, 2003; Peria et al., 2005) in the context of the 1990s financial crises in EMEs, but is also a concomitant of shocks emanating from source countries.

The wake-up call effect is not very clear, as the estimated marginal size of the coefficient on VIX is very low and only significant at a level of 10%. The effect of Co-LA is solely significant for total loans, and the Co-CEE coefficient is significant for loans to banks only. While global market uncertainty is found to significantly contribute to the decline in international lending flows to Latin America by Herrmann and Mihaljek (2010) and Pontines and Siregar (2012), it is not a dominant factor which can explain sudden stop probability in East Asia. In specification (1), the estimated parameter is significant for Co-LA, but not for Co-CEE, because CEE experienced less severe reduction in cross-border banking flows during the financial crises than Asia and Latin America, as mentioned by some studies (for example, Mihaljek, 2008; Heemann and Mihaljek, 2010). A healthier banking sector, more rigid exchange rates and greater financial openness with a large share of foreign-owned bank presence, have accounted for higher stability in cross-border bank flows in CEE (Mihaljek, 2008). In reality, even Latin America was less prone to credit pull-back during global financial crisis than emerging Asia because two-thirds of international loans to Latin America were disbursed by foreign affiliates and branches (around 35% in emerging Asia) and were mostly denominated in local currencies (Kamil and Rai, 2009).

Referring to other pull factors, the results indicate that international loan flows are more likely to stop going into countries with low financial openness (low exposure to cross-border banking activities) and higher financial risk. Specifically, in line with Peria et al. (2005) and Ponines and Siregar (2012), the estimated parameters suggest that the sensitivity of international lending to shocks in home or host economies tends to decrease as East Asian borrower countries increase their exposures to cross-border banking. In terms of financial risk, the high magnitude and significant positive coefficient of FOREX on sudden stop events captures mechanical valuation effects as well as the impact of currency crises occurring during the examined period. Local currency depreciation discourages international lending because it pushes up the cost of borrowing, weakens the expected rate of return (measured by the foreign currency) and reduces a borrower's ability to pay back an external loan. At the same time, increasing stock market volatility promotes financial instability and increases adverse selection and moral hazard problems (Mishkin, 1999), consequently making international banks more likely to cut and run out of these countries. Under this circumstance, we may assume that EMEs (Thailand, Indonesia, Philippines and Korea) are more susceptible to systematic sudden stop than the two financial centres of Hong Kong and Singapore. Although the literature suggests a significant effect of inflation on the volatility of international capital (Buch et al., 2010), the coefficient on this variable is not significant in any specification.

4.4.2.2. Sudden Stop and its Impacts on Host-Country Interbank Markets: Analysis with the Recursive Bivariate Probit Models

With respect to recursive bivariate probit estimates, the results from equation 4.1 show little variation compared to those of univariate probit models. However, as the coefficient on the S-Stop dummy in equation 4.2 is statistically significant and the null hypothesis of $\rho=0$ is rejected (the estimated value of ρ is 0.169 with a standard error of 0.104), it is reassured that the recursive models provide more reliable results than a single equation model. The positive coefficient of the S-Stop is consistent with our expectation and strongly supports the hypothesis about the feedback from the reversal in international loan flows to the tension in interbank markets in East Asia. The marginal effect estimations imply that after being controlled for supply, demand and contagion shock, as well as other pull and push factors, a 10% point increase in the probability of sudden stop will significantly boost the probability of interbank stress by 2.88%. As mentioned in section 4.4.1, our recursive bivariate probit estimates suffer from the exclusion restriction of jointly insignificant variables; therefore, the interbank stress equation includes two explanatory variables (except y_1 of the S-Stop variable), which are both statistical significant at the level of 5%.

As argued in Forbes and Warnock (2011), although global liquidity contracted during the global financial crisis, some countries received net capital inflows driven by the large repatriation of domestic investors as they liquidated their investment in foreign markets. This retrenchment will lead to an increase in bank loan portfolio "home bias", i.e. a reduction in the share of foreign assets in investors' portfolios. As a consequence, the volatility in net cross-border banking flows is mitigated, contributing to a calming down of interbank market tensions in host countries. Therefore, the retrenchment variable is included in the right-hand side of equation 4.2. This variable is measured by change in liabilities of BIS reporting bank vis-a-vis East Asian countries. The expected coefficient sign is positive as when domestic investors retrench their foreign investments, international banks' liability flows should be negative and interbank tension is less likely to occur. To be consistent with our hypothesis, the estimated results show that with a 10% point decline in international banks' liabilities, interbank market tension probability declines by 1.27% point. This finding increases evidence for the "flight-home effect" in cross-border banking, as studied in Milesi-Ferretti et al. (2010) and Giannetti and Laeven (2011).

However, the VIX index is surprisingly found to have negative influence on interbank stress. Although this result contradicts many empirical studies about the companion between financial risk and credit risk, this might be interpreted as the substitution between equity financing and debt financing in Asian financial markets. The finding also helps to strengthen the “flight-home effect” analysed above and is consistent with the theoretical model of Diamond and Rajan (1999, 2001), who provide more in-depth analysis of the relationship between financial risk and banks’ willingness to lend. The analysis carries an important implication for our results, in that a rise in financial risk would actually enhance profit-making opportunities, thus promoting domestic commercial banks’ willingness to provide loans via interbank markets. In general, despite the offsetting effects from the VIX and retrenchment channels, East Asia was not totally immune from liquidity shock spillovers and the consequence of the massive deleveraging process from international banks. However, the interbank market tension was relatively minor and manageable.

4.4.3. Robustness Tests

The robustness of the empirical results is tested from two dimensions: (i) estimates using different econometric methodologies (base regression vs. probability model); and (ii) estimates accounting for financial centre effects (EMEs vs. financial centres).

Base regression

Instead of applying the non-linear probability model to test the risk of sudden stop, equation 4.1 is estimated using base regression with fixed effects. In base regression, the dependent variable is not a dummy representing the outflows of external loans but is the change in external loan flows adjusted for exchange rate valuation effects in a given quarter.

Table 4.8 – Robustness check with base regression estimates.

Dependent variable	(1)	y_1 = *Exloan* (2)	(3)	y_2 = *LTED*
Constant	11.506**	12.533	11.488	-10.37***
	(4.644)	(5.229)	(4.046)	(2.488)
S-stop				0.537***
				(0.184)
Retrenchment				0.252*
				(0.166)
TED	-0.607*	-0.735**	-0.366	
	(0.348)	(0.353)	(0.310)	
VIX	-0.051**	-0.016	-0.046**	-0.028**
	(0.022)	(0.023)	(0.021)	(0.012)
GDP-home	-0.336***	-0.311***	-0.138*	
	(0.097)	(0.099)	(0.083)	
GDP-host	0.190***	0.172***	0.066*	
	(0.041)	(0.042)	(0.036)	
CPI	0.046*	0.043	0.008	
	(0.026)	(0.026)	(0.023)	
FOREX	-2.766**	-3.344***	-2.425**	
	(1.123)	(1.261)	(0.974)	
CVSR	-0.103*	-0.044	-0.105*	
	(0.062)	(0.065)	(0.056)	
Bank return		0.009		
		(0.006)		
Fin-open	0.250**	0.291**	0.013	
	(0.115)	(0.116)	(0.102)	
Co-lender	0.195***	0.183***	0.178***	
	(0.038)	(0.040)	(0.044)	
Co-LA	0.085**	0.048	0.047	
	(0.042)	(0.042)	(0.039)	
Co-CEE	-0.006	0.054	-0.019	
	(0.051)	(0.052)	(0.049)	
R^2	0.044	0.023	0.036	0.001
F-test	17.37	12.27	10.78	5.32
(p-value)	[0.00]	[0.00]	[0.00]	[0.00]

Notes: (1): total external loan flows, (2): loan flows to banking sector, (3): loan flows to non-bankers. ***, ** and * denote significance at 1%, 5% and 10% respectively. Standard errors are in parentheses.

Table 4.8 shows the estimated results, which are fairly consistent with those of the panel probit model estimates in Table 4.6 and similar to other empirical papers. Overall, the results suggest that liquidity shocks, host country productivity shocks and contagion via common lender effects act as the most important factors that make international active banks withdraw their lending from East Asia. Another significant contribution to the decline in cross-border banking flows comes from specific risk factors in the recipient country. The low R^2 in the fixed effect estimation explains the bias under base regression due to the nonlinear nature of international capital flows, and increases the explanatory power for this research's selection of probability models. The dependent variable is the change in external loan flows, which is expected to switch the signs to reflect inflows and outflows; it therefore has extremely high volatility. For example, the raw data of external loans flows in our sample range from a minimum of -US$ 67 billion to a maximum of US$ 50 billion per quarter. The average size of loan flows is US$ 0.17 billion and the standard deviation is also high.

EMEs vs. financial centres

As mentioned in Herrmann and Mihaljek (2010), locational data cannot control for third party effects, i.e. international bank lending to an East Asian country via a financial centre (Hong Kong and Singapore). Moreover, as regional financial centres, Hong Kong and Singapore play intermediary roles in circulating foreign money throughout emerging Asia by hosting a large number of foreign nationality banks. Therefore, the cross-border banking flows in these centres may experience quite different dynamics from those of EMEs. We therefore perform a robustness test by dropping Hong Kong and Singapore from the sample to ascertain whether the presence of these centres affects the results.

Table 4.9 – Robustness check with univariate and recursive bivariate probit estimates (excluding financial centre effects)

	Univariate probit (Equation 4.1)			Recursive bivariate probit	
	(1)	(2)	(3)	Equation 4.1	Equation 4.2
Constant	-6.106***	-6.065**	-7.957***	-3.856	0.481
	(2.234)	(2.524)	(2.397)	(2.632)	(0.320)
S-Stop					0.850**
					(0.403)
Retrenchment					0.309**
					(0.148)
TED	0.549**	0.562**	0.262	0.473*	
	(0.241)	(0.274)	(0.214)	(0.256)	
VIX	0.031**	0.040	0.011	0.026*	-0.020**
	(0.014)	(0.014)	(0.013)	(0.013)	(0.010)
GDP-home	0.231***	0.243***	0.086	0.197***	
	(0.070)	(0.067)	(0.061)	(0.075)	
GDP-host	-0.098***	-0.111***	-0.075***	-0.080**	
	(0.030)	(0.034)	(0.027)	(0.035)	
Inflation	0.015	0.017	-0.025	0.010	
	(0.027)	(0.029)	(0.018)	(0.021)	
FOREX	1.534**	1.749***	2.030***	0.873	
	(0.605)	(0.680)	(0.632)	(0.736)	
CVSR	0.081*	0.186**	0.079	0.127**	
	(0.048)	(0.075)	(0.051)	(0.050)	
Bank return		-0.007**			
		(0.003)			
Fin-open	-0.214	-0.503**	0.469**	-0.133	
	(0.232)	(0.245)	(0.237)	(0.227)	
Co-lender	-0.042**	-0.054**	-0.076***	-0.041**	
	(0.021)	(0.022)	(0.027)	(0.020)	
Co-LA	-0.059**	-0.045*	-0.002	-0.061**	
	(0.026)	(0.027)	(0.025)	(0.025)	
Co-CEE	-0.014	-0.066**	-0.022	-0.016	
	(0.033)	(0.033)	(0.033)	(0.030)	
Country dummies			YES		
Log-likelihood	-160.32	-156.17	-163.69	-345.41	
(p-value)	(0.00)	(0.00)	(0.00)	(0.00)	
Pseudo-R^2	0.258	0.264	0.238		
Wald chi2	65.07	81.17	80.24	151.18	

Notes: (1), (2) and (3) denote total external loan flows, external loan flows to banks, and external loan flows to the non-banking sector, respectively. Standard errors in parentheses. *, ** and *** represent significance at the levels of 10%, 5% and 1%, respectively.

Table 4.10 - Robustness check for marginal effects of variables (excluding financial centre effects)

	Univariate probit			Recursive bivariate probit	
	(1)	(2)	(3)	Indirect effect	Direct effect
S-Stop					0.316**
					(0.144)
Retrenchment					0.096*
					(0.050)
TED	0.218**	0.213**	0.262	0.188**	
	(0.095)	(0.104)	(0.214)	(0.102)	
VIX	0.012**	0.001	0.011	0.010**	-0.006***
	(0.005)	(0.005)	(0.013)	(0.005)	(0.003)
GDP-home	0.091***	0.092***	0.086	0.078***	
	(0.027)	(0.025)	(0.061)	(0.029)	
GDP-host	-0.039***	-0.042***	-0.075***	-0.032***	
	(0.011)	(0.012)	(0.027)	(0.014)	
Inflation	0.006	0.006	-0.025	0.004	
	(0.010)	(0.011)	(0.018)	(0.008)	
FOREX	0.610**	0.665***	2.030***	0.348	
	(0.241)	(0.259)	(0.632)	(0.293)	
CVSR	0.032*	0.071**	0.079	0.051**	
	(0.019)	(0.027)	(0.050)	(0.020)	
Bank return		-0.002**			
		(0.001)			
Fin-open	-0.085	-0.191	0.469	-0.053	
	(0.092)	(0.092)	(0.236)	(0.090)	
Co-lender	-0.016**	-0.020**	-0.076***	-0.016**	
	(0.008)	(0.008)	(0.027)	(0.008)	
Co-LA	-0.023**	-0.017*	-0.022	-0.024**	
	(0.010)	(0.010)	(0.030)	(0.009)	
Co-CEE	-0.005	-0.025**	-0.002	-0.006	
	(0.013)	(0.012)	(0.030)	(0.012)	

Notes: (1), (2) and (3) denote total external loan flows, external loan flows to banks, and external loan flows to the non-banking sector, respectively. Standard errors in parentheses. *, ** and *** represent significance at the levels of 10%, 5% and 1%, respectively.

As can be seen from Tables 4.9 and 4.10, estimates of the parameters are quite comparable to those of the original models reported in Tables 4.6 and 4.7. The only difference is that the variable of financial integration becomes statistically insignificant due to the similar level of exposure to cross-border banking between emerging Asia economies, but with a marked deviation from that of regional financial centres.

4.5. Conclusions and Policy Implications

The sudden reversals in cross-border banking flows was one of the main reasons for the severity of the East Asian financial crisis in 1997-1998. The global economic and financial turbulence in 2007-2011 brought back the picture of a repeated episode of the credit squeeze suffered by the region ten years ago given their increasing dependence on foreign-based financing to sustain the rapid growth of domestic economies. The large write-downs by some of the major international financial institutions after the collapse of Lehman Brothers in September 2008 and the synchronous deleveraging process of European banks at the height of the European sovereign debt crisis have raised much concern about the risk of systematic sudden stop in EMEs.

This chapter has examined the cross-border banking exposure and cross-border shock transmission in loan provision by international banks in East Asia. Based on BIS banking statistics, the evolution of cross-border banking activities and the potential vulnerability to contagion risk is analysed. The empirical tests of the probability of sudden stop in international lending flows and its impacts on the interbank markets in host countries follow. Differentiating from other empirical papers which focus on the gravity models and base regression to measure the waves in cross-border banking flows associated with various pull and push factors, this study employs the univariate and recursive bivariate probit models to quantify the marginal effects of several global and country-specific risk factors on the probability of a sudden stop and the link between the sudden stop and interbank market tensions during financial crisis episodes.

The empirical results suggest that sudden stops in international lending flows are significantly associated with (i) liquidity shocks in international credit market that affect the supply of bank loan, (ii) host country aggregate productivity shocks that diminish bank loan demand and (iii) the cross-border contagion effect via the common lender channel. This led to the transmission of money market tensions from AEs to the East Asian countries. However, interbank stress is mitigated by the "flight-home effect" caused by the active repatriation of funds invested abroad by domestic investors. We also find that emerging East Asia, with lower financial openness but higher financial risks is more prone to the sudden stop than the two regional financial centres of Hong Kong and Singapore. In terms of customer classification, the common lender effect and host-country productivity shock serve as key drivers of the sudden stop in cross-border lending flows to both non-bank private sectors and banking sectors. While the former is more stable and less susceptible to liquidity shock, the latter appears to suffer a much higher level of volatility. There is no robust evidence to support the wake-up call effect hypothesis. The sharp reversals in cross-border banking flows in East Asia during the past 16 years (1996-2011) seem to harmonise with Latin Amercia but differ from CEE.

Overall, the findings confirm the role of international banks in the transmission of economic and financial shocks from AEs to EMEs. Increasing cross-border banking alters the nature of the risk of financial instability by generally lowering the solvency risk, while increasing the potential for capital flow volatility and cross-border contagion (Mihaljek, 2008). In other words, there is potentially a trade-off between benefits and costs from a financial stability perspective. Therefore, it is more important for authorities and policy-makers to mitigate and withstand these kinds of risk rather than avoiding them by reducing exposure to cross-border banking. From our empirical analysis, since many domestic factors have predictive power on the risk of sudden stop, national authorities in East Asia should prioritise the strengthening of domestic economy resilience by improving institutions, deepening financial markets, implementing rapid progress in structural reforms[49], and enhancing macroeconomic and macroprudential bases. One of the most important borrower-specific risks that matters cross-border banking flows is foreign exchange rate risk. It is suggested from the literature that flexible exchange rate system should be encouraged as greater exchange rate flexibility can not only help resolve tension between various policy targets faced by countries in liberalising capital account and integrating with the global capital market, but also discourage short-term speculative capital inflows (Mihaljek, 2008).

As the common lender effect appears to be dominant factor for cross-border contagion, countries should consider diversifying funding sources and avoiding borrowing too much from any one creditor. Moreover, establishing foreign operations through subsidiaries, rather than relying on direct cross-border lending can help to reduce the volatility of foreign-based financial source. Another important policy implication worth mentioning is to do with currency and

[49] In Asia, structural reform and improvement has been gradual, compared to the rather more rapid process in CEE as a result of harmonisation with EU legislation during EU accession.

maturity mismatches. This can be done by fostering a shift from foreign exchange financing to local currency financing[50], encouraging foreign affiliates to depend on domestic deposits, and allowing banks to treat a proportion of sight and saving deposits to obtain an alternative source to fund medium and long-term loans. One proposal suggested by Mihaljek (2008) is to replace tight limits on maturity and currency mismatches with a capital charge for risks arising from such mismatches. Tight limits indeed contribute to more external vulnerability because they force commercial banks to hold substantial excess reserves and deposits abroad (to be highly liquid), and hence they rely more on foreign funding of credit. Application of a capital charge provides banks with a buffer against the risks of currency and maturity mismatches, and gives foreign banks more opportunities to access local funding.

Finally, the study's empirical results indicate the significant role of global and contagion factors, suggesting an important implication for cross-country banking supervision and cooperation to reduce the volatility of global capital flows.

[50] This process started earlier in LA and emerging Europe (Hohl, Mcguire and Remolona, 2006).

CHAPTER FIVE – THE SECOND-ROUND EFFECTS OF THE GLOBAL FINANCIAL CRISIS ON EAST ASIA: EVIDENCE FROM MACRO-FINANCIAL VARIABILITY AND BANK BEHAVIOUR

5.1. Introduction

Problems in banking sectors have been at the epicentre of the historical economic and financial crises in both EMEs and AEs 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. As discussed in chapter 2 of this thesis, during the period before the global financial crisis, banks in East Asian countries had good asset quality with low NPL ratios, a relatively profitable record comparable to that of AEs, a well-capitalised position with regulatory capital exceeding 10% of total risk-weighted assets, high liquidity and low reliance on the international wholesale funding market. Beyond balance sheet restructuring, the prudential framework for bank supervision has also been strengthened. It seems that the prospects of a reappearance of the banking crisis of 1997-1998 are unlikely.

Despite the healthy pre-crisis condition and limited direct exposure to the US subprime mortgage credit products, following the mounting pressures of the global financial markets, the short-term outlook of the Asian banking sector assessed by leading credit agencies was negative (Pomerleano, 2009). Table 5.1

summarises Moody's average bank financial strength ratings, which reflects 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 Hong Kong Monetary Authority 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 by the IMF in 2010[51].

Table 5.1 - 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 HKMA publication in 2008, the outlook is less promising and uncertain)
Korea	Oct.2008	C-	Negative, primary 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)

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 NPL. This would

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

therefore lead to higher provisions, lower profitability and considerable erosion in bank capital, which may have negative implications for further lending.

The purpose of this chapter is to examine empirically 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 2007-2011 on East Asian economies. The analysis is based on a panel of 174 commercial and investment banks and bank-owned companies from eight East Asian countries over a time period of 2003 to 2011 with an annual frequency. This chapter contributes to the existing literature by stressing the simultaneous adjustments in four dimensions of bank behaviour: asset quality (loan portfolio quality), profitability, capital buffer, and lending behaviour. The assumption is that any change in bank behaviour is caused by either endogenous bank-specific factors or exogenous factors of 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 adjustment, 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 stabilise the regional financial system in conditions of stress [52]. The effectiveness of these measures will be revised by using proxy variables for

[52] 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.

central bank policy interventions in the empirical tests. The findings should have several implications for bank managers, regulators and policy makers for forecasting and stress testing purposes to detect problems arising in the banking system.

Combining both the narrative from the financial crisis and the theoretical background to understand better the effect of the global financial crisis on the behavioural response of the financial sector, this chapter will attempt to answer the following research questions:

RQ3a - How did domestic banks react to changes in macro-financial conditions during the global financial crisis and how can their reactions to those risks be modelled?

RQ3b - Do bank behaviour adjustments magnify the impact of global shocks?

RQ3c - How do empirical estimates of bank reactions relate to the behavioural assumptions generally used in the theoretical literature?

The outline of this chapter is presented as follows. Section 5.2 reviews the theoretical framework and empirical evidence of macro-financial linkages and bank behaviour. Section 5.3 describes the empirical models, methodologies and data sample. The analysis of the empirical results will be discussed in section 5.4. Section 5.5 provides conclusions.

5.2. Literature Review of Macro-Financial Linkages and Bank Behaviour

5.2.1. Theoretical Framework

The theoretical literature explaining the response of banks to shocks is linked to the framework of macro-financial linkages, the business cycle theory and monetary transmission mechanism. An overview of Mishkin (1996) on the channels of monetary policy distinguishes between the interest rate channel (money channel), exchange rate channel, asset price channel and credit channel. This research's approach is based on the credit channel, stressing the role of borrower balance sheet and bank balance sheet effects. The credit channel is not only the most important mechanism to propagate and amplify real shocks in the form of the feedback loop, but is also highly relevant for the largely bank-dominated financial system in Asia. The balance sheet channels can arise as a result of credit market imperfections such as asymmetric information, problems in contract enforcement and agency cost. In addition, the bank balance sheet effect may be also a consequence of regulatory requirements on bank capital (BIS, 2011). In the study of Bernanke (1983) on the non-monetary effects of financial crises, the banking system channel and borrowers' credit worthiness are emphasised as the main factors which worsened the Great Depression. First, a financial shock causes a reduction in the quality of certain financial services, primarily credit intermediation. This leads to the disruption of bank credit and in turn inhibits consumer spending and capital investment, worsening the contraction. Second, the declining output and falling prices from the downturn will increase the real debt burdens and impair borrowers' cash flows and liquidities. This may generate widespread financial distress among borrowers, which likewise increases the risks to lenders. Therefore, there are likely to be interactions between borrower and bank balance sheets.

5.2.1.1. Borrower Balance Sheet Channel

The borrower balance sheet channel relates to borrowers' equity position (or net worth), which influences their access to credit. This is also known as the financial accelerator effect, which explains the behaviour of bank credit (loan extension to private agents) and its relationship with the cyclical fluctuations in the economy. The channel works through a so called external finance premium (EFP), associated with the work of Bernanke and Gertler (1994), Bernanke et al. (1999) and Kiyotaki and Moore (1997). Due to credit market imperfections, external financing is more expensive than internal financing, and the EFP is the wedge reflecting the difference in the cost of externally and internally raised funds. Bernanke and Gertler (1994) argue for an inverse relationship between the borrowers' net worth and EFP in an economy in which firms are financed by Townsend's (1979) costly state verification (CSV) framework. In the CSV model, the verification of entrepreneur performance is costly, therefore banks have to incur an auditing cost, which is interpretable as the cost of bankruptcy (including auditing, accounting, legal costs, as well as loss associated with asset liquidation and interruption of business). The inverse relationship arises because the borrowers' net worth is likely to be pro-cyclical; during business upturn, it is improved and the greater the net worth of borrowers, the more likely they are to use self-financing as a means to fund investment and/or have more collateral to put up against the funds they need to borrow. As a result, lenders assume less risk when lending to high net worth agents, and EFP is lower. An adverse productivity shock that lowers borrowers' current cash flows (weakening firm profits and household income) leads to a decline in their net worth 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 (1997) develop a dynamic equilibrium model to demonstrate that borrowers' net worth 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[53]. When asset values are hit by a temporary shock, a direct effect occurs because the changes in collateral values cause changes in obtained credit, which in turn affect firm investment. 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 models elaborate the interactions between credit limits and asset prices through the spiral mechanism, explainable as within-period and inter-temporal multipliers (BIS, 2011).

Bernanke et al. (1999) incorporate the financial accelerator theory of Bernanke and Gertler (1994) and Kiyotaki and Moore (1997) in a quantitative business cycle framework to explain the amplification of shocks to macroeconomy. Basing on firm's demand for capital and the optimal contractual arrangement between entrepreneur and financial intermediary, the critical link between capital expenditures by the firm and financial condition is expressed as follows:

$(\mathbf{5.1})\ \boldsymbol{QK = \varphi\left(\frac{R^k}{R}\right)N,\ with\ \varphi(1) = 1, \varphi'(\cdot) > 0}$, equivalent to

$$(\mathbf{5.2})\ \boldsymbol{E\{R^k\} = s\left(\frac{N}{QK}\right)R,\ \ s'(\cdot) < 0}$$

[53] The need for collateral is due to the fact that lenders cannot force borrowers to repay their debts unless the debts are secured.

where:

R^k is aggregate rate of return on capital;

R is real risk-free interest rate;

QK are total funds invested by firms with K being the level of a firm's capital and Q the price per unit of capital;

N is a firm's net worth

If a firm is not fully self-financed, in equilibrium the return to capital will be equated to the marginal cost of external finance. Equation 5.2 shows the key relationship in financial accelerator model, in that EFP or discount return to capital (calculated from the ratio of cost of external finance R^k to the risk free rate R), depends inversely on the share of a firm's net worth in the total funds. The model is designed to enhance more empirical relevance (heterogeneous firms and asset price effects) and permit the standard model to explain a broader class of important cyclical phenomena, such as changes in credit extension and spreads between safe and risky interest rates. In conclusion, Bernanke et al.'s (1999) theoretical model explains a simulated dynamic response of the credit market in relation to the evolution of firm's net worth in stress conditions, which amplifies various shocks to the economy in a quantitatively significant way.

5.2.1.2. Bank Balance Sheet Channel

The bank balance sheet channel refers to the effect of an adverse shock on various components of both sides of banks' balance sheets and thus the supply of bank loans. This can be divided into two separate components: the traditional bank lending channel and bank capital channel.

Traditional bank lending channel

The traditional bank lending channel focuses on the reserve-deposit constraints on the supply of bank loans. In particular, any shock on the economies or any policy action to increase interest rates and reserve requirement rates will lead to a fall in deposits. Due to the imperfect information between banks and their providers of funds, banks cannot costlessly compensate for the reduction in deposits; therefore, they opt to readjust their portfolio by reducing their assets. Given that securities and bank loans are imperfect substitutes as sources of funds[54] because loans are riskier and less liquid, a reduction in deposits as a result of monetary policy tightening will lead to a reduction in bank loan supply. This inward shift in the supply of bank loans will have an impact on the real activities of firms given the absence of a close substitute for bank loans. The importance of the traditional bank lending channel depends on the extent to which banks rely on deposit financing and adjust their loan supply schedules following changes in bank reserves (Alcoforado Farinha and Robalo Marques, 2001). The standard model explaining the channel was developed by Bernanke and Blinder (1989) by extending the well-known IS-LM model (investment saving-liquidity preference money supply). While LS-LM model comprises three markets of bonds, money and goods; Bernanke and Blinder consider bank lending as additional market and assume that both borrowers and lenders choose between loans and bonds according to the interest rates of these two credit instruments. The balance sheet equation of banks is then:

$$\mathbf{(5.3)}\boldsymbol{B^b + L^s + E = (1-\varphi)D}$$

[54] See Kashyap and Stein (1994) and Peeak and Rosengren (1995) for further discussion of the conditions for the bank lending channel to operate.

where B^b denotes bonds held by banks, L^s is the supply of bank loans, E is excess reserves, φ is the required reserve rate, and D are deposits of non-banks. In equilibrium, the credit market can be characterised as:

$$(\mathbf{5.4})\ \boldsymbol{\pi}\left(-\boldsymbol{R}, +\boldsymbol{R}^{\boldsymbol{l}}\right)(\mathbf{1}-\boldsymbol{\varphi})\boldsymbol{D} = \boldsymbol{L}(-\boldsymbol{R}^{\boldsymbol{l}}, +\boldsymbol{R}, +\boldsymbol{Y})$$

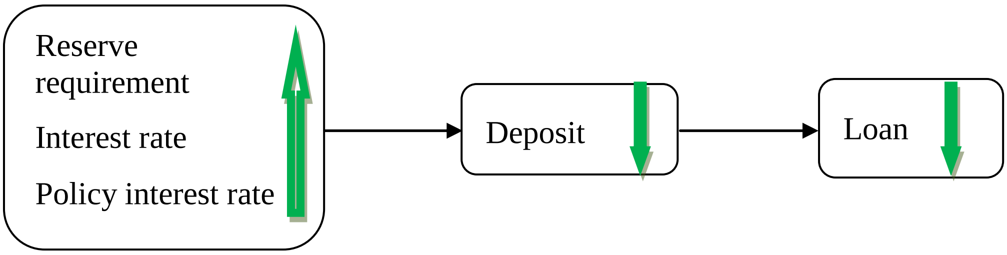
The left-hand side of equation (5.4) represents the supply of loans which depends negatively on the interest rate of bonds *R,* and positively on the interest rate of loans R^l, and the amount of deposits not needed to fulfil the reserve requirement; while $\pi(-R, +R^l)$ is considered as a function comparable to the money multiplier.

The right-hand side of equation shows the demand for loans which is negatively affected by interest rate on loans and positively on interest rates on bonds and the scaling variable income Y. Furthermore, the interest rate on loans is depends positively on the interest rate on bonds and income, but is a negative function of money supply M^s such that:

$$(\mathbf{5.5})\ \boldsymbol{R}^{\boldsymbol{l}} = \boldsymbol{R}^{\boldsymbol{l}}(+\boldsymbol{R}, +\boldsymbol{Y}, -\boldsymbol{M}^{\boldsymbol{s}})$$

As M^s is considered as exogenous policy variable, the restrictive monetary policy has an impact on both interest rate on loans and output, in that interest rate will increases and income decreases.

The theories have been applied and extended by a number of studies (for example, Kashyap et al., 1992; Bardsen and Klovland, 2000) to emphasise the effect of the shock on bank behaviour through different monetary mechanisms such as interest rates, policy rates and reserve requirements; and the amplification of the real effect on economies.



Bank capital channel

The traditional bank lending model has largely ignored the role of bank capital and endogenous credit risk shocks by assuming that all loans are paid back. However, more and more theoretical studies have explored the cyclical behaviour of bank capital and its influence on lending behaviour. 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 that is present in borrowers' investment decisions. Therefore, a shrinkage in bank capital due to a fall in loan pay-offs following a shock that weakens firms' net worth will reduce the volume of loan supply. Another theoretical explanation of the bank capital channel relates to regulatory capital requirements. Blumm and Hellwig (1995), Lowe (2002), Borio et al (2001) and Goodhart et al (2004) study the macro implications of the Basel capital requirements. Increases in credit risk during recession cause a deterioration in 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. Markovic (2006) models three separate components in the bank capital channel: the default risk channel, adjustment cost channel and capital loss channel. All these channels cause a variation in the expected return and thus a variation in the cost of bank capital. The model is extended from Bernanke et al's. (1999) corporate balance sheet channel to explain the interactions between the demand and supply sides of the credit market and has the following form:

$$(5.6)\ \frac{R^k}{R} = s\left(\frac{N}{QK}\right)\xi$$

$$(5.7)\ \xi = 1 + \frac{R^Z - R}{R} \times \frac{P^Z Z}{L}$$

where R^Z is the cost of bank capital, P^z denotes the price of bank share and Z the volume of bank shares, L is the volumes of loans extended to firms.

The additional variable, ξ that affects the EFP encompasses the shock to the cost and value of bank capital. ξ depends positively on the ratio of a bank's capital to loan $\frac{P^Z Z}{L}$, and the wedge between the cost of bank capital and the cost of deposits, $R^Z - R$. The change in equity risk premium in the banking sector $R^Z - R$, which is then transferred to borrowers via increasing EFP arises due to the default risk, adjustment cost or capital loss channels, such that:

$$(5.8)\ E_t\left(\widehat{R^Z}_{t+1}\right) + E_t\left(\widehat{P^Z}_{t+1} - \widehat{P^Z}_t\right) = \hat{R}_t + \gamma_1\left(\hat{Z}_{t+1} - \hat{Z}_t\right) - \frac{\gamma_1}{R_0} E_t\left(\hat{Z}_{t+2} - \hat{Z}_{t+1}\right) + \frac{\gamma_{2_0}}{1-\gamma_{2_0}} \hat{\gamma}_{2t}$$ [55]

where:

$E_t\left(\widehat{R^Z}_{t+1}\right)$ is expected gross dividend rate;

---

[55] See Markovic (2006) for further explanation of the equation 5.9, which is derived based on household optimisation problem. In this equation, ^ denotes deviations from the steady-state values and subscript 0 denotes the steady-state value.

$E(P^Z_{t+1} - P^Z_t)$ denotes expected capital gain;

Thus, $E_t\left(\widehat{R^Z}_{t+1}\right) + E_t\left(\widehat{P^Z}_{t+1} - \widehat{P^Z}_t\right)$ implies the expected required return on bank capital.

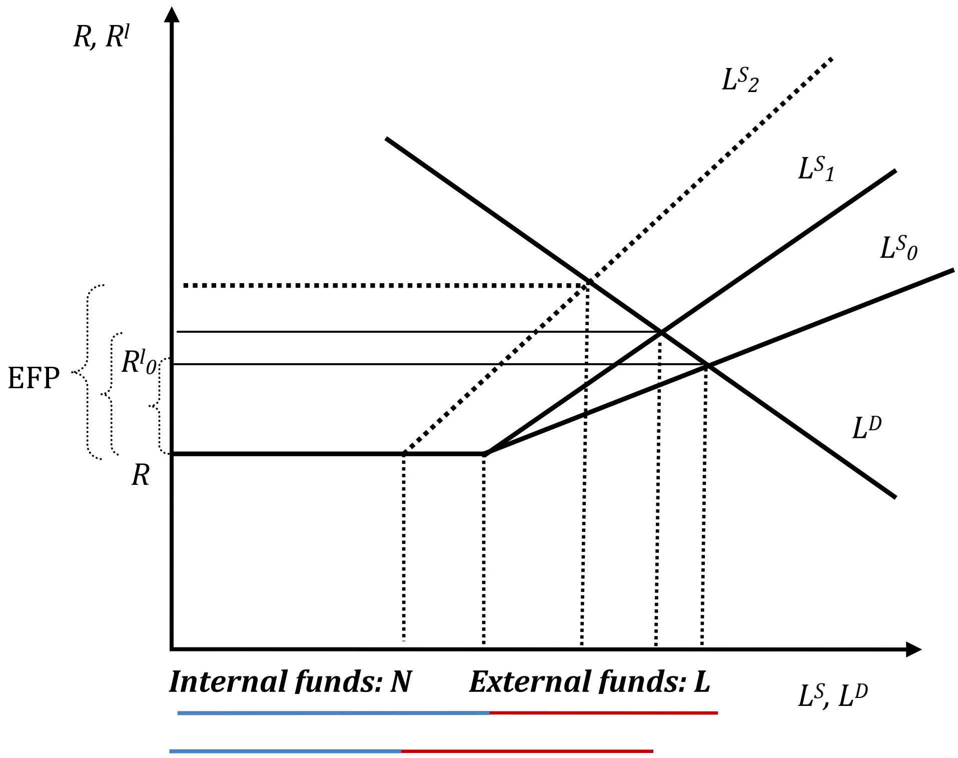
The right-hand side of equation 5.8 have the three important factors:

- R_t is the risk free rate or the return on the alternative asset;
- The term $\gamma_1\left(\hat{Z}_{t+1} - \hat{Z}_t\right) - \frac{\gamma_1}{R_0} E_t\left(\hat{Z}_{t+2} - \hat{Z}_{t+1}\right)$ represents the adjustment cost, which depends on loading factor $\gamma_1$and the expected change in volume of bank shares;
- γ_2 is the probability of the bank defaulting on its capital.

In summary, equation 5.8 describes specific channels through which bank capital facilitates the transmission of shocks to real economy. The capital loss channel arises from the expectation of a capital gain or loss from the holding bank shares $\left(\frac{P^Z_{t+1}}{P^Z_t} < 0\right)$. In a contraction, a bank which is in need of acquiring fresh capital would send a bad signal about its financial situation to the market. Potential investors may anticipate a future fall in the price of bank shares and therefore require a higher dividend. In such a case, a bank is able to acquire more capital if it sells new shares at a discount. The adjustment cost channel arises when there is a change in the current or expected level of bank capital and the potential new shareholders have to check the health of a bank before investing in its shares and thus suffer an adjustment cost. Finally, the default risk channel causes an increase in the cost of bank capital because during the period of financial crises, the probability of default on bank capital γ_2 is higher than in normal times; hence, shareholders may require higher dividend rates to prevent them from selling bank shares.

By incorporating the bank capital channel in the borrowers' balance sheet channel of Bernanke et al. (1999), Markovic (2006) explains the interactions between the supply side and demand side of the credit market, which is illustrated in Figure 5.1.

Figure 5-1 – The behavioural response of the credit market



Source: Markovic (2006)

As can be seen from the graph, firms finance their investments using internal funds *N* with its opportunity cost *R* (or the risk free-rate) and external funds *L* with the loan interest rate R^l. The EFP, the difference between R^l and *R*, depends positively on the shares of external funds in total funds (i.e. negatively to firm's net worth as collateralised part of the debt). The slope of loan supply line L_0^S depends not only on bank's perception of risk to economy and the auditing cost (as explained in borrower balance sheet channel with equations 5.1 and 5.2 but also on the cost of bank capital and its share in total liabilities in equation 5.8). For example, the requirements or desires of bank to raise capital will produce the shift of the loan supply from L_0^S to L_1^S. Because the cost of bank capital is higher than the cost of deposit, bank opts to increase the loan interest rate to cover the higher average cost of bank liabilities or to maintain the profit margin. This increase in cost of funds that firm finances its investments will lead to a temporary decline in firm's profit and thus its net worth. Therefore, unexpected increase in bank capital ratio produces shock to the loan supply side and a temporary effect on the demand side of the credit market. The demand reaction leads to further increase in loan interest rate and EFP and consequently affects the level of investments and real output. This actually corresponds with the loan supply shifts to L_2^S.

The theoretical review delivers an interesting implication that there is likely a continual interaction between the bank capital channel (or bank balance sheet channel) and borrower balance sheet channel. Therefore, it is important to empirically model bank behaviour in response to macro-financial variability in a dynamic structure allowing for the endogenous effects of each component in bank balance sheets and considering heterogeneity issue.

5.2.2. Empirical Evidence for Banks 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.

5.2.2.1. Economic Condition and Pro-cyclical Bank Behaviour

Extensive research has linked bank credit risk, profitability, capital buffer and credit supply to the overall condition of the economy. In terms of credit risk, a large amount of work conducting macro stress testing identifies significant relationships between real economic variables and the credit risk factors of corporations or banks. Credit risk is usually captured by NPL, LLP (loan loss provision), PDs (probability of defaults) and LGDs (loss given defaults). Kalirai and Scheicher (2000) perform preliminary stress testing on the Australian banking system and explain that a rise in short-term interest rates, a fall in business confidence and industrial production, and a decline in the stock market have significant effects on bank's LLP. The study of Jacobson et al. (2005) uses the VAR approach to study the interactions between the evolution of the Swedish economy and firms' balance sheets and finds that macro variables are important for explaining the time-varying default frequency. Using the same methodology, Alves (2005) and Sommar and Shahnazarian (2009) identify cointegrating relationships between macro variables (interest rates, GDP and inflation) and Moody's KMV EDFs. Castren et al. (2008) analyse the impact of a wide range of global macro-financial shock scenarios on corporate sector credit quality in the euro area with a Global VAR model. Their empirical results suggest that median EDFs react mostly to the shocks to GDP, exchange rates, oil prices and equity prices. Within the non-linear threshold VAR framework, Drehmann et al. (2006) explore the non-linear transmission of macroeconomic shocks to aggregate corporate PDs in the UK. By presenting a model combining macro stress scenarios and credit risk at portfolio level, the study of Padilla and Segoviano (2006) shows that credit risk could materialise quickly if boom-burst in real estate prices and credit occurs. Dullmann and Erdelmeier (2008) do a stress test on credit portfolios of German banks, assuming an economic downturn in the automobile industry. The results confirm that the expected loss conditional on the stress event increases substantially when accounting for the inter-sector correlations. Another strand of literature using panel data (Laeven and Majnoni, 2003; Fofack, 2005; Vallcorba and Delgado, 2007; Louzis et al., 2011) also suggest the importance of GDP growth alongside other macroeconomic factors in determining the variation in NPL and LLP.

In the empirical findings, the effect of macro-financial variables on bank profitability is mixed. On one hand, the work of Bourke (1989), Molyneux and Thornton (1992), Demirguc-Kunt and Huizinga (1999) and Athanasoglou et al. (2008) show a statistically significant positive relationship between macro variables (GDP growth, inflation rate and central bank 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 affect the bank's profits (Pangestu, 2009; Vong and Chan, 2009; Davydenko, 2010). Another conflict in the empirical evidence relates to the effect of market concentration on bank profitability. Some studies such as Bourke (1989) and Molyneux and Thornton (1992) show a statistically significant positive relationship between bank concentration ratios and bank profitability, supporting the traditional structure-conduct-performance hypothesis. However, Berger (1995), Mamatzakis and Remoundos (2003) and Staikouras and Wood (2011) do not find evidence to support this hypothesis, instead arguing for the presence of oligopolistic profits.

On behavioural 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 the choice of capital buffers or 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' capital buffers increase during downturns and decrease during upturns. However, the main concern of cyclical influences is the banks' inability to raise capital during economic contractions. Therefore, banks may reduce lending rather than raise additional capital to meet regulatory requirements. This behaviour tends to increase the duration and magnitude of the economic cycles, making it potentially more difficult for policy-makers to maintain economic stability (Francis and Osborne, 2009).

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 behaviour in response to the signals of these expectations, both in terms of stability and level of economic performance (Somoye and Ilo, 2009). Baum et al. (2002) investigate bank lending behaviour during macroeconomic uncertainty using US data and find a significant negative relationship between the loan to assets ratio and the variability of industrial production and consumer price index (CPI). In a study of Ukraine banks, Talavera et al. (2012) 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 (Ivashina and Scharfstrin, 2010; Aisen and Franken, 2010; Guo and Stepanyan, 2011). Moreover, these studies also identify other external factors which affect bank lending, such as international capital flows, external financing position, and currency mismatches.

5.2.2.2. 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 of bank behaviour. The empirical papers have provided considerable evidence to support the following hypotheses relating to bank-specific characteristics:

a – 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 regulatory protection (for example, be bailed out by governments) due to the systematic effects. In general, bank size is shown to yield a positive effect on asset quality (Louzis et al., 2010) and profitability (Demirguc-Kunt and Maksimovic, 1998; Goddard et al., 2004). Some other papers (Alfon et al., 2005; Stolz and Wedow, 2005; Jokippi and Milne, 2008) find a negative effect of bank size on capital management, which means that larger banks hold less capital buffer.

b – Moral hazard hypothesis

The moral hazard hypothesis shows 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 ratio in the future. On the contrary, a higher level of capital reduces risk-taking, which in turn reduces the credit risk (Keeton and Morris, 1987; Furlong and 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), Hellman et al. (2000) and Stolz et al. (2004) argue that there is a positive relationship between portfolio risk and regulatory capital. Banks raise capital to keep up their capital 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.

c – Inefficiency hypothesis

The inefficiency hypothesis refers to the effect of bank cost management on asset quality and profitability. Berger and DeYoung (1997) and Louzis et al. (2010) provide convincing proof of a significant positive relationship between the ratio of operating expenses to income (as a measure of cost management) and NPL ratio, which confirms that bad management goes hand in hand with poor skills in screening and monitoring borrowers. William (2004) and Louzis et al. (2011) who study the link between loan quality and cost efficiency in European banks also find evidence to support this hypothesis. In terms of profitability, there is consistent evidence from the literature (Pasiouras and Kosmidou, 2007; Athanasoglou, 2008) 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.

d – Credit risk effect hypothesis

Credit risk is the main source of risk in bank operation and may simultaneously affect many aspects of bank performance and hence their decisions. The effect of credit risk on bank profitability is equivocal from the empirical analysis. For example, Athanasoglou et al. (2008) mention that this relationship is negative due to the fact that poor quality of loans reduces interest revenue and reduces bank profitability. 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. Paroush and Schreiber (2008) examine the relationship between credit risk, profitability and capital in US commercial and saving/mortgage banks, taking into account the simultaneous effect of the three variables. They argue that banks usually price loans and simultaneously set aside capital against unexpected losses. Their findings imply that the relationship between profitability and credit risk is more positive in commercial banks (with larger size loans and lower cost of monitoring borrowers), while the relationship between capital and credit risk is more positive in saving/mortgage banks (with smaller loans and higher monitoring costs).

Credit risk may also either directly affect lending behaviour or indirectly impact loan supply by its influence on profitability and capital. Berger and Udell (2004) show that banks tend to tighten credit standards in response to rising loan loss reserves or deterioration in credit quality. Dumicic and Ridzak (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. Through its influence on capitalisation, a rising NPL ratio would diminish credit supply to the non-bank sector. Nevertheless, Peek and Rosengren (2003) find the contradict behaviour from Japanese banks who have incentives to roll over loans for severely impaired firms to limit the growth of bad loans, despite the fact that this loan extension behaviour may create additional losses for the bank.

e - Earning effect hypothesis

As one of the key components representing financial soundness in the CAMEL system, earnings play an important role in all financial decisions of the banking sector. First, 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 buffers (Myers, 1984; Barton et al., 1989; Rime, 2001; Schaeck and Cihak, 2007; Jokipii and Milne, 2009). However, the negative effect of ROA on bank capital buffers is also significant according to the study of 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.

5.2.3. Critique of Existing Literature and Suggestion for Empirical Strategy

The existing literature focuses on investigating each aspect of bank behaviour (i.e. asset quality, profitability, capital buffer or lending behaviour) separately. The study on the simultaneous adjustment of these all four dimensions of bank performance appears to be very limited. Furthermore, although the empirical evidence mostly shows the relationships between bank-specific characteristics in pairs, our literature survey suggests that specific performance and behavioural factors are endogenously determined.

Secondly, empirical research measures bank behaviour which is mostly determined by internal variables of bank management decisions and external macroeconomic environment. They seem to ignore the common global shocks, which may impact domestic bank performance via the first-round effects on macro-financial condition. Regarding to the studies of global shock transmission across countries, the main focus is the asset price and capital flow channels with less attention has been paid to microeconomic condition and institutional factors.

Lastly, in accordance with the study on one specific dimension of bank performance, current research tend to apply single-equation framework and the most common econometric technique is VAR model or fixed effects model in panel data. However, the fixed effects model may encounter the dynamic panel bias and fail to capture the reverse causality of bank behaviour. The problem of endogenous nature of variables has been addressed in some empirical works using instrumental variables estimation (e.g. 2SLS), but 2SLS is efficient under homoscedasticity (Roodman, 2009).

These literature gaps motivate the development of our empirical strategy. Specifically, this chapter examines the simultaneous adjustment in asset quality, profitability, capital buffer and lending behaviour in reaction to the changes in macro-financial environment and shocks in the global financial markets. It, therefore takes into account the effects of international contagion as well as monetary transmission mechanism. Moreover, the adjustment in one dimension of behaviour is endogenously determined by other bank-specific characteristics. In terms of econometrics, the partial adjustment model and system GMM estimation is applied to deal with dynamic panel data, fixed effects, endogeneity, omitted variables and persistent series. The following research hypotheses are developed from the theoretical framework of macro-financial linkages and empirical evidence of bank behaviour:

Hypothesis 1: *The deterioration of bank asset quality and profitability (because of the fall in borrowers' loan-payoff probability) is linked to macro-financial shocks.*

Hypothesis 2: The shrinking in bank capitalisation is linked either directly to macro-financial shocks or the deterioration in asset quality and profitability.

Hypothesis 3: The reduction in bank loan supply is jointly determined by borrower balance sheet channel and bank capital channel, while the former is captured by the deterioration of loan portfolio quality and profitability because of the fall in borrowers' loan-payoff probability.

Hypothesis 4: The adjustment in banks' asset quality, profitability, capital and lending behaviour has been jointly determined by the macro-financial shocks and central banks' policy interventions

5.3. Empirical Models and Data Sample

5.3.1. Empirical Models and Methodologies

Partial Adjustment Model

The empirical analysis is based on partial adjustment model to explore bank behaviour in interactions with balance sheet adjustment under macro-financial variability and shocks from the global financial markets. The simple specifications of the model are given by:

$$(5.9)\ \boldsymbol{Y_t - Y_{t-1} = \beta(Y_t^* - Y_{t-1})}$$

$$(5.10)\ \boldsymbol{Y_t^* = \sum_{k=1}^{K} \alpha_k X_{kt} + \mu_t}$$

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 K internal and external factors, denoted by X_{kt};

β reflects the rate at which such convergence occurs. 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 error term.

Combining (5.9) and (5.10) give the following model:

$$(\mathbf{5.11}) \boldsymbol{Y_t = (1-\beta)Y_{t-1} + \beta Y_t^* = (1-\beta)Y_{t-1} + \sum_{k=1}^{K} \beta\alpha_k X_{kt} + \mu_t}$$

Equation 5.11 implies that the bank behaviour is a function of dynamic partial adjustment process and the desired target level, which may depend on the state of the economy and bank's financial situation. We proxy four dimensions of bank behaviour 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 total asset ratio (ROA) to represent bank profitability, (iii) capital buffer (CAP), which is the excess capital ratio above the minimum required level in BASEL III (10%)[56], and (iv) lending behaviour is measured by the percentage difference in total gross loan to non-bank customers (LOAN). Following the theoretical and empirical literature, 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 partial adjustment model for each dimension of bank performance and behaviour, the four equations are set up as follows:

$$(\mathbf{5.12})\ \boldsymbol{NPL_{it} = \gamma_1 NPL_{it-1} + \delta_1 ME_{it} + \theta_1 FM_{it} + \varphi_1 GF_t + \pi_1 Z_{it} + \varepsilon_{1,it}}$$

$$(\mathbf{5.13})\ \boldsymbol{ROA_{it} = \gamma_2 ROA_{it-1} + \delta_2 ME_{it} + \theta_2 FM_{it} + \varphi_2 GF_t + \pi_2 Z_{it} + \varepsilon_{2,it}}$$

$$(\mathbf{5.14})\ \boldsymbol{CAP_{it} = \gamma_3 CAP_{it-1} + \delta_3 ME_{it} + \theta_3 FM_{it} + \varphi_3 GF_t + \pi_3 Z_{it} + \varepsilon_{3,it}}$$

$$(\mathbf{5.15})\ \boldsymbol{LOAN_{it} = \gamma_4 LOAN_{it-1} + \delta_4 ME_{it} + \theta_4 FM_{it} + \varphi_4 GF_t + \pi_4 Z_{it} + \varepsilon_{4,it}}$$

where:

[56] In this study, capital buffer is preferable to the capital-to-asset ratio as generally used in the existing literature because capital buffer represents the cushion that controls for the level of bank risk and the probability of bank default. Furthermore, capital buffer is a direct measure of banks' capacity to extend credit as it takes into account prudential regulation constraints.

$i = \{1,2, \dots, N\}$ 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 partial adjustment model as $\gamma = 1 - \beta \Rightarrow \beta = 1 - \gamma$. All explanatory variables enter the estimation of equations 5.12-5.15 with the current lags basing on the assumption that banks revise their targets during estimation period.

Difference and System GMM estimation and Model Specifications

We run the specified equations 5.12 – 5.15 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 for the following reasons. The first reason arises from the structure of the data panel, with a limited number of years (t = 9) and a substantial number of cross-sectional observations (n = 174) (Arellano and Bond, 1991). Second, 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. Moreover, it is robust to the omitted variables problem, which often arises in the empirical work on determinants of bank performance. Third, this methodology helps avoid Nickell's (1981) bias, when the presence of the lagged dependent variable with fixed effects gives rise to autocorrelation. 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.

In order to understand more about how GMM estimators accommodate such econometric concerns, let us reiterate the data generating process of a dynamic model.

$$(\mathbf{5.16})\ \boldsymbol{y_{it} = \alpha y_{it-1} + \beta x'_{it} + \varepsilon_{it}}$$

$$\varepsilon_{it} = \omega_i + \vartheta_{it}$$

$E(\omega_i) = E(\vartheta_{it}) = E(\omega_i\vartheta_{it}) = 0$ for $i = 1, \ldots, N$ and $t = 2, \ldots, T$

$$E(\vartheta_{it}\vartheta_{is}) = 0, \qquad i = 1, \ldots, N \ and \ t \neq s.$$

As the disturbance term in equation 5.16 has fixed effect ω_i, difference-GMM uses first-differencing transformation to eliminate the individual effect, such that:

$$(\mathbf{5.17})\ \Delta\boldsymbol{y_{it}} = \boldsymbol{\alpha}\Delta\boldsymbol{y_{it-1}} + \boldsymbol{\beta}\Delta\boldsymbol{x'_{it}} + \Delta\boldsymbol{\vartheta_{it}}$$

Although fixed effects are removed in equation 5.17, the lagged dependent variable and any predetermined variables in x that are not strictly exogenous become potentially endogenous because they may be correlated with ϑ_{it} in $\Delta\vartheta_{it}$. GMM estimators use "internal instruments" to control for endogeneity. Specifically, they instrument the regressors in the first-differenced equation using levels of the second lags or more. Together with the previous assumption that error terms ϑ_{it} are serially uncorrelated, the assumption required on the initial conditions is that they are uncorrelated with the subsequent disturbances ϑ_{it} for t=2, 3, …, T.

These assumptions give moment restrictions:

$$E\left(y_{i,t-2}\Delta\vartheta_{it}\right) = 0 \ for \ t = 3, \ldots, T$$

In general, the moment restrictions can be expressed as:

$E(Z_i' \Delta\vartheta_i) = 0 \; for \; i = 1, 2, \dots, N$

where Z_i and $\Delta\vartheta_i$ can be defined by the following matrices

$$Z_{si} = \begin{bmatrix} y_{i1} & 0 & 0 & \cdots & 0 & \cdots & 0 \\ 0 & y_{i1} & y_{i2} & \cdots & 0 & \cdots & 0 \\ . & . & . & \cdots & . & \cdots & . \\ 0 & 0 & 0 & \cdots & y_{i1} & \cdots & y_{i,T-2} \end{bmatrix}; \; \Delta\vartheta_i = \begin{bmatrix} \Delta\vartheta_{i3} \\ \Delta\vartheta_{i4} \\ \cdots \\ \Delta\vartheta_{i4} \end{bmatrix}$$

The GMM estimator for α in differenced-model ($\hat{\alpha}_d$) is given by (Arellano and Bond, 1991):

$$\hat{\alpha}_d = \frac{\Delta y_{-1}' Z_d W_N^{-1} Z_d' \Delta y}{\Delta y_{-1}' Z_d W_N^{-1} Z_d' \Delta y_{-1}}$$

where $\Delta y = (\Delta y_1', \Delta y_2' \dots \Delta y_N')'$; $\Delta y_i = (\Delta y_{i3}, \Delta y_{i4}, \dots, \Delta y_{iT})'$; Δy_{-1} is the lagged version of Δy; $Z_d = (Z_{d1}', Z_{d2}', \dots, Z_{dN}')'$; and is W_N a weight matrix determining the efficiency properties of the GMM estimator.

However, according to Blundell and Bond (1998), the first-differences estimation has a large bias and low precision with short sample period and relatively persistent data. They show that when explanatory variables are persistent over times, lagged levels of dependent variables turn out to be weak instruments because they become less correlated with current first-differences. This is clearly a concern in the studies of bank behaviour, since some of the variables, such as bank assets, display high levels of persistency, even after controlling for time trends. We therefore follow Arellano and Bover (1995) and Blundell and Bond (1998) in using 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).

System GMM allows for additional moment conditions from the assumption on the initial condition such that: $E(w_i \Delta y_{i2}) = 0$. This holds when the process in mean is stationary, i.e. $y_{i1} = \frac{w_i}{1-\alpha} + \epsilon_i$ with $E(\epsilon_i) = E(\epsilon_i \omega_i) = 0$. The full set linear moment conditions under assumptions in system GMM is given by:

$$E\left(y_{i,t-2} \Delta \varepsilon_{it}\right) = 0 \quad t = 3, \ldots, T;$$

$$E\left(\varepsilon_{it} \Delta y_{i,t-1}\right) = 0 \quad t = 3, \ldots, T$$

or: $E(Z'_{si} p_i) = 0$, where:

$$Z_i = \begin{bmatrix} Z_{di} & 0 & \cdots & 0 \\ 0 & \Delta y_{i2} & & 0 \\ \cdot & \cdot & \ddots & \cdot \\ 0 & 0 & \cdots & \Delta y_{iT} \end{bmatrix}; \; p_i = \begin{bmatrix} \Delta \varepsilon_i \\ \varepsilon_i \end{bmatrix}$$

The GMM estimator based on these moment conditions is

$$\hat{\alpha}_s = \frac{q'_{-1} Z_s W_N^{-1} Z'_s q}{q'_{-1} Z_s W_N^{-1} Z'_s q_{-1}}; \text{ with } q_i = (\Delta y'_i, y'_i)'.$$

Using XTABOND2 module for the STATA package (Roodman, 2009), we regress equations 5.12-5.15 with system GMM and the following model specifications:

- Two-step estimation is chosen because is it asymptotically more efficient than the one-step estimator in the presence of heteroskedasticity and serial correlation (Arellano and Bond, 1991; Blundell and Bond 1998)
- However, the two-step estimator imposes a severe downward bias in standard errors. Follow Windmeijer (2005), finite sample correction to two-step covariance matrix is employed in the estimations (Windmeijer-corrected cluster–robust errors).

- The validity of instrument sets is checked with the Hansen (1982) J-test. It is performed under the null of joint validity of all instruments. The J statistics normalises the empirical moments against their own estimated covariance matrix and is distributed $\chi 2$ with degrees of freedom equal to the degree of overidentification.
- To test for autocorrelation, the Arellano–Bond test is applied to check the absence of second-order serial correlation in the first differenced residuals.
- Time dummies are included in all models to make the assumption of no correlation across individuals in the idiosyncratic in the autocorrelation test more likely to hold.

5.3.2. Descriptions of Variables and Data Sources

The empirical analysis is based on an annual panel dataset spanning the period from 2003 to 2011 and covering 174 commercial and investment banks and bank-owned companies in eight East Asian countries (Thailand, Indonesia, Philippines, Malaysia, Korea, Singapore, Hong Kong and Japan)[57]. Banks are selected based on country location categories in the Bankscope database and start with all banks that have observations available within the time period from 2003 (or 2004) to 2011 (or 2010). Banks without deposits or information on other bank-specific variables are then dropped from the sample. Not all banks enter the sample in every year, so the selection process results in an unbalanced panel. The cross-country distribution of banks is also uneven. For example, Japan accounts for 25% of total observations, while Singapore takes only a 2.3% share. Emerging East Asian

[57] In total, we have 16 banks in KR, 23 in ID, 29 in ML, 17 in TL, 24 in PH, 41 in JP, 20 in HK and 4 in SG.

economies contribute around 63% of bank counts; nearly double the number of banks in developed markets (Japan, Hong Kong and Singapore). This caveat needs to be borne in mind when interpreting empirical results.

The set of variables relating to macroeconomic variability, financial market perception, global financial stress factors and bank-specific characteristics is decided basing on the literature survey and the narrative of the crisis.

Macroeconomic variables: the macroeconomic variables examined in this study consist of the real GDP annual growth rate (GDP), inflation calculated as the average change in the CPI (INFL), change in 3-month interbank rate (IR3M) as a proxy for the nominal interest rate, and the annual growth rate of export of goods and services (EXP). The global financial crisis hit the East Asian real economy badly via export and investment channels. Exports were significantly down in the fourth quarter of 2008, reflecting the evaporation of import demand in the US and Europe, the two biggest export destinations of many East Asian economies. The shrinking of exports led to factory closures and rising job losses, negative consumer sentiments which discouraged household spending, and negative business sentiments which discouraged investment. GDP contracted considerably in 2008 and 2009, in line with the global economic downturn. Additionally, under the pressure of increasing global commodity prices[58], managing inflation remained a key policy concern for many central banks in the region in order to maintain macroeconomic stability.

From a theoretical point of view, we develop the hypothesis that banks respond significantly to changes in the macro-economic condition. Specifically, adverse

[58] In July 2008, the oil price peaked at $150 a barrel and food prices surged on higher global demand, standing around 50% higher than a year earlier.

economic conditions caused by a decline in GDP and exports (as a consequence of the contagion effect from external shock) negatively affect borrowers' cash flows and reduce their loan payoff probabilities. As a result, banks may suffer losses because of the increasing problems in outstanding loans, interpretable as rising NPL and declining profits. The downward adjustments in loan portfolio quality and profitability will weaken bank capital. Associated with borrower balance sheets and bank capital effects, banks' credit supply is expected to fall. 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), hence discouraging banks' willingness to lend. The effect of inflation and interest rates is challenging. In theory, increases in interest rates and unanticipated declines in inflation cause firms' net worth to decrease, which leads to rising problems in the banking sector (Stiglitz and Weiss, 1981; Bernanke and Gertler, 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. But if variation in inflation and interest rates promotes uncertainties and financial volatilities, it may lead to asymmetric information with adverse selection and moral hazard (Mishkin, 1999), and will weaken a bank's balance sheets. In short, the signs of the macroeconomic coefficients are expected as follows:

Table 5.2 – Expected signs of the macroeconomic coefficients on bank behaviour

	GDP	EXP	INFL	IR3M
NPL	-	-	+/-	+/-
ROA	+	+	+/-	+/-
CAP	+	+	+/-	+/-
LOAN	+	+	+/-	+/-

Financial market variables*:* Four variables to represent the market perception of the financial health of a country are employed: composite stock price indices, which will be used for conversion into stock market returns (SR); conditional volatilities of stock returns are extracted from GARCH(1,1) procedure on weekly returns; returns on nominal exchange rates (FER); and sovereign CDS spreads (CDS). Many empirical studies strongly support the hypothesis that asset prices become highly correlated during a crisis. A negative shock in one country leads to a deterioration of balance sheets through inter-connected portfolios and causes the deleveraging process to take place in other countries as a contagion effect. As explained in previous chapters, 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 price could dampen consumer spending through a negative wealth effect. Moreover, stock price devaluation promotes financial instability (Mishkin, 1999) and increases adverse selection and moral hazard problems because it leads to a large decline in the market value of firms' net worth (Bernanke and Gertler, 1989; Calomiris and Hubbard, 1990). Since borrowers have more moral hazard incentives to make risky investments and lenders are now less protected against the consequences of adverse selection, stock market declines and stock return volatility lead to a deterioration in banks' asset quality, profitability and capitalisation and to declines in lending.

Together with the contagion effect in the stock market and the dramatic collapse in international risk appetites following the collapse of Lehman Brothers, the unprecedented increases in sovereign CDS spreads promoted financial volatility in East Asian countries. Changes in CDS may affect the default risk of banks because financial institutions often hold a significant share of sovereign debt in total assets (Lahmann, 2012). For example, banks in Philippines widely exposed to the country sovereign spreads, which was often levered through innovative credit products such as Credit Linked Notes (Ree, 2011). The incentives for banks to hold sovereign debt is that this is considered as a 'low-risk' investment, providing a stable source of income, and that it receives favourable regulatory treatment. Therefore, a negative effect of CDS variable on banks' financial soundness is expected (i.e. the increase in CDS spreads leads to negative effects on banks' asset quality, profitability, capital and lending).

Another factor contributing to financial instability is unanticipated exchange rate depreciation. Asian currencies[59] (except the Japanese yen and Chinese yuan) depreciated sharply against the US dollar as a result of capital outflows and the sell-off of local currencies. Sudden exchange rate depreciations make domestic borrowers unable to roll over foreign currency liabilities, thereby exacerbating downward pressures on exchange rates. At the same time as the drying up of offshore credit, exports were collapsing, forcing firms who needed to refinance dollar-denominated debts and derivative exposures to sell local currency assets and/or to seek US dollar borrowing from local markets. This situation raised the financing costs faced by borrowers in East Asia, and consequently increased the perceived default risk of the banking sectors. Moreover, exchange rate depreciation can also produce direct effects on bank balance sheets because it causes a mismatch in the value of foreign denominated assets and liabilities (Mishkin, 1999). Specifically, currency devaluation leads to substantial rise in the

[59] Indonesian rupiah, Korean won, Philippine peso, Indian rupee, Australian and New Zealand dollars.

domestic value of foreign denominated liabilities, while the value of foreign denominated assets typically does not rise because the likelihood of loan pay-off is quite low in the face of worsening business conditions.

Global financial stress variables: In order to investigate the effect from the global financial crisis, we are particularly interested in employing two variables, VIX and TED that measure the state of the global financial markets. A higher value of VIX corresponds to more volatile market expectations, which will have a negative effect on bank performance. The higher TED spreads reflect the increase in risk of default on interbank loans and global liquidity strain. International banks tend to react to global liquidity shortages by withdrawing their exposure from other countries, causing a sudden stop in international lending flows. EMEs which are strongly reliant on wholesale funding tend to suffer more. This affects the supply side of domestic bank lending.

Micro data of individual banks: From the literature survey, a distinctive feature of particular banks is expected to exert a decisive influence on the bank balance sheets, with simultaneous effects. The following bank level variables in is involved in the estimations: TA (logarithm of a bank's total assets) to control for the asset size effect, NIEA (the ratio between non-interest expenses to total assets) to control for the efficiency effect, CAP (capital buffer) to control for the moral hazard effect, NPL (the ratio of NPL to gross loans) to control for the credit risk effect, ROA (return on total assets) to control for the earning effect, LOAN (growth rate of gross loan) to control for risk-taking behaviour, and LTD to capture bank liquidity and the relative dependence on wholesale funding. These factors are assumed to serve as endogenous variables for others and expected to have either positive or negative coefficient signs. These micro variables are also useful to control for cross-sectional heterogeneity.

Policy variables: In order to control for central bank interventions to sustain contagion effect, we extend the model by adding three policy variables: (i) the change in policy rates (ΔPR), (ii) adjustment of reserve requirement ratios (ΔRR), and (iii) government injection of bank capital (RECAP). RECAP is a dummy variable taking the value of 1 in the subsequent years to the application of a government capital injection into a specific bank and zero otherwise. These policy variables will capture the effect of the traditional bank lending channel.

The macro data comes from IMF – IFS and IMF-WEO, financial market and global financial stress data are collected in Datastream and bank-level data are extracted from BankScope. The description of list of variables entered the empirical models is provided in Table 5.3. Table 5.4 is the summary of descriptive statistics of variables, which reports the min, max, mean, standard deviation and the number of observations. As can be seen from Table 5.4, there exist large performance differences of banks in the sample. On average, the NPL ratio between 2003 and 2011 is 5.3%, which is quite low compared with the peak in the 1997 Asian crisis. The minimum NPL ratio is 0 belonging to a bank in Hong Kong, and the maximum is 61.85%, for a bank in Malaysia. Banks' regulatory capital also varies considerably. The best capitalised bank in the sample has a total regulatory capital ratio of 91.6% (equivalent to a capital buffer of 81.6%), whereas this ratio for the least capitalised institution is -39.8%. The negative bank capital ratios may be due to the net accumulated losses (retained losses offset earnings) reported in the shareholder equity section in the balance sheets. However, on average banks in the sample have high capital ratios, well above the Basel III requirement. In terms of profitability, the mean of bank ROA is reported at 0.94%, which is quite small because some banks experienced losses with negative ROA and the highest ratio is 12%. There is also a quite large heterogeneity between banks in terms of their size, credit growth and cost efficiency.

The statistics on macro and financial market variables also show evidence of a large dispersion both across countries and over time. Annual real GDP growth is 3.85% on average, with the highest figure 14.76% in Singapore; the lowest ratio is -5.53% in Japan. In general, most of the countries in the sample experience negative GDP growth rates as a consequence of the global economic slowdown during the 2007-2009 crises. Like GDP growth rate, export growth rate also suffers a dramatic fall, to a lowest point of -24.20% from the peak of 27.5%; however, the mean value of 6.52% reflects the important role of exports in the economic growth of Asian countries. Inflation and interbank rates also show variability due to the global crisis and cross-country heterogeneity. The biggest difference in financial market variables belongs to CDS spreads, which have a minimum of 3.8 basis points (in Japan in 2006) and a maximum of 511.7 (in Philippines in 2004), reflecting the different perception of sovereign credit rating between countries in the region. This variable also has the highest standard errors of 105.2, indicating a high volatility level. The minimum value of stock return and return on exchange rates occurred during the global crisis in 2008 and 2009, although some countries had a very high returns, with a maximum of 45.56% before the crisis. The variation in VIX and TED variables indicates the collapse of the risk appetite of international investors and the global liquidity shortage, causing contagion effects to Asia. Table 5.5 shows the correlation coefficients between variables entered into the estimations. Since most of the correlations between independent variables are relatively low, there may be no problem in involving them all in the regressions. For variables of high correlations (above 0.6) at conventional confident level, they will be regressed separately in different specifications to avoid the problem of collinearity.

Table 5.3 – Summary of explanatory variables

Categories	**Variables description**	
	Mnemonic	**Definition**
Macro-economic variables (IMF-IFS, IMF- WEO)	GDP	Real GDP annual growth rate
	INFL	Inflation, average consumer price (percent change)
	IR3M	Change in 3-month interbank rate
	EXP	Export of goods and services (real growth rate)
Financial market variables (Datastream)	SR	Stock market return calculated from composite stock price indices (PI) with the following formula: $SR = 100 * \ln(PI_t/PI_{t-1})$
	CVSR	Conditional variances of stock returns extracted from GARCH(1,1) procedure on weekly returns
	FER	Return on nominal foreign exchange rate (local currency per US dollar)
	CDS	Sovereign credit defaults swaps spreads expressed by basis point (in logarithm)
Global variables (Datastream, BIS)	VIX	Change in VIX Chicago Board Options Exchange S&P 100 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 billion USD)
	LTD	Ratio between loan to deposit
	CR	Regulatory capital ratios
	CAP	Capital buffer: excess capital ratio above the Basel III minimum requirement (10%)
	NPL	Non-performing loan to gross loan
	NIEA	Non-interest expenses to total assets
	LOAN	Percentage change in gross loan provided to non-bank sectors
	ROA	Net income after tax to average assets
Central bank intervention variables		
ΔPR		Changes in central bank policy rates
ΔRR		Adjustment in reserve requirement ratios
Recap		Bank capital support by government injections

Table 5.4 – Descriptive statistics of variables

Variable	Min	Max	Mean	Std. Dev.	Obs
Bank-specific variables					
NPL	0.000	61.850	5.306	6.594	1466
ROA	-16.640	12.000	0.943	1.191	1497
CR	-29.840	91.600	16.127	7.996	1461
CAP	-39.840	81.600	6.127	7.996	1461
LOAN	-94.460	515.960	11.664	24.551	1483
TA (level, in bil USD)	0.050	2594.496	96.593	273.136	1500
TA (in logarithm)	3.907	14.769	9.610	2.027	1500
LTD	0.001	6.852	1.162	214.192	1500
NIEA	0.160	59.720	2.421	3.892	1497
Macroeconomic variables					
GDP	-5.530	14.760	3.859	3.139	1566
EXP	-24.200	27.400	6.530	9.497	1566
INFL	-2.570	13.104	2.928	3.009	1566
IR3M	-4.910	4.120	-0.179	1.332	1566
Financial market variables					
SR	-44.579	45.563	8.443	22.533	1566
CVSR	1.590	27.910	10.486	5.717	1566
FER	-14.573	20.381	-2.341	6.397	1566
CDS (in level)	3.800	511.700	97.128	105.199	1175
CDS (in logarithm)	1.335	6.238	3.921	1.269	1175
Global financial stress					
VIX	-17.240	10.210	-0.563	7.668	1566
TED	0.204	1.743	0.562	0.460	1566
Policy variables					
ΔPR	-5.250	5.320	-0.160	1.381	1566
ΔRR	-2.500	0.000	-0.109	0.454	1566
RECAP	0.000	1.000			1566

Table 5.5-Correlation matrix of variables

	NPL	ROA	CAP	LOAN	NIEA	LTD	TA	GDP	EXP	IR3M	INFL	SR	CVSR	FER	CDS	VIX	TED
NPL	1																
ROA	-0.148*	1															
CAP	0.002	0.301*	1														
LOAN	-0.142*	0.161*	0.001	1													
NIEA	0.021	0.086*	0.048	0.087*	1												
LTD	-0.030	0.007	-0.022	0.006	0.003	1											
TA	-0.238*	-0.188*	-0.466*	-0.174*	-0.151*	-0.009	1										
GDP	0.048	0.222*	0.210*	0.153*	0.103*	0.002	-0.343*	1									
EXP	-0.026	0.018	0.013	0.059*	0.018	0.038	-0.029	0.648*	1								
IR3M	0.033	-0.071*	-0.056*	-0.052*	-0.046	0.005	0.109*	0.120*	0.084*	1							
INFL	0.065*	0.227*	0.232*	0.306*	0.180*	0.004	-0.527*	0.367*	0.118*	0.041	1						
SR	-0.040	0.217*	0.082*	0.163*	0.078*	-0.012	-0.213*	0.597*	0.530*	0.100*	0.345*	1					
CVSR	-0.170*	-0.101*	-0.084*	0.004	0.024	0.019	0.102*	-0.508*	-0.369*	-0.214*	0.108*	-0.337*	1				
FER	-0.037	0.088*	0.082*	0.022	0.055*	-0.006	-0.158*	0.062*	-0.033	-0.118*	0.109*	-0.078*	0.135*	1			
CDS	0.202*	0.192*	0.266*	0.176*	0.198*	0.005	-0.510*	0.157*	-0.062*	-0.170*	0.628*	-0.071*	0.149*	0.161*	1		
VIX	-0.016	-0.098*	-0.007	-0.037	-0.004	-0.024	0.007	-0.196*	-0.217*	-0.1626*	-0.024	-0.431*	0.421*	0.237*	0.348*	1	
TED	-0.075*	-0.099*	-0.052*	0.040	-0.006	-0.030	0.023	-0.264*	-0.324*	-0.067*	0.248*	-0.225*	0.623*	0.017	0.055	0.501*	1

Note: * denotes the statistical significant at the level of 5% (2-tailed test).

5.4. Empirical Results and Discussion

The estimation results are reported in Tables 5.6, 5.7, 5.8 and 5.9, each representing different dimensions of bank performance. Various specifications of equations 5.12-5.15 are examined. We first estimate bank behaviour, which is subject to the variability of domestic macroeconomic and financial conditions (specification 1 and 2). The global financial stress indicators are then included to capture the vulnerability of East Asian banks to external shocks from AEs (specification 3). Finally, proxy variables of central bank policy interventions during the crisis period are added in the regressions to see whether these measures gauge any difference in bank reactions to shocks. In all the estimations, the macro-financial variables are treated as strictly exogenous, while bank-specific variables are considered as 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, as indicated by the F-test statistics, which rejects the null hypothesis of jointly insignificant parameters. The Hansen test for over-identifying restrictions confirms that the structural specifications are well modelled. High Hansen test p-values show the evidence that the null hypothesis of valid instruments cannot be rejected. Two diagnostics tests, AR(1) and AR(2) were used to check for first and second order autocorrelation in the residuals of the differenced equations. As Δv_{it} and $\Delta v_{i,t-1}$ are mathematically related to each other via the term $v_{i,t-1}$, negative first-order serial correlation is expected in differences. Thus, the test will look for second-order correlation in differences, i.e. to detect correlation between the $v_{i,t-1}$ in Δv_{it} and the $v_{i,t-2}$ in $\Delta_{vi,t-2}$. 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% (5% for ROA), 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 slow for asset quality (β is around 0.16) and capital buffer (β is around 0.25), but relatively faster for lending behaviour (β is around 0.38). Bank profitability shows a lower level of persistence while it appears to be highly volatile. We also find that a substantial part of movements in bank performance as well as their target values reflects the changes in banks' risks and earnings associated with the state of the economy and market perception. In all models, most of the macro-economic and financial variables have statistically significant effects on bank behaviour. However, the bank capital buffer is not very sensitive to external factors, but instead depends more on their specific characteristics. Generally, the empirical results seem to be fairly robust, although the significance and size of a few coefficients may vary in different specifications.

5.4.1. Adjustment in Asset Quality

The results in Table 5.6 show that most external factors influence the target level of asset quality. NPL is statistically and negatively affected by economic growth, export growth and inflation, while it is positively impacted by nominal interest rates. The significantly negative coefficients on GDP and EXP variables sharpen the cyclical nature of banks' behaviour, implying that in downturns, higher than expected NPL ratios are associated with declines in borrowers' cash flows and net worth, which lower their debt servicing capacity. In particular, a decrease of 1% in the GDP growth rate leads to an increase of around 0.03% in the NPL ratio. Inflation shows negative effects but it not consistently significant in all specifications. Negative coefficient on INFL variable may suggest that high inflation reduce the real value of outstanding loan given fixed lending rates, which make debt servicing easier for borrowers. The positive effect of IR3M appears to be consistent with the theoretical consensus that rising interest rates increase debt burdens for borrowers and reduce debt pay-off probability, consequently deteriorating bank loan portfolio quality (Bernanke et al., 1994; Mishkin, 1999).

The deterioration in financial market perceptions represented by increased CDS spreads and local currency depreciation also signals an increase in banks' NPLs. Local currency depreciation lowers the debt-servicing capacity of export-oriented firms who borrow in foreign currencies. A small value of FER coefficient implies that borrowers may hedge their position from exchange rate risk, therefore the potential effect is not so large. Increases in sovereign credit risk signal economic uncertainties and financial instability, which have negative implications for banks' risks and expected losses. Stock market return has a positive effect on dependent variable at the significant level of 10% but the marginal size of the coefficient is very small. The positive coefficient on SR variable suggests that a period of asset booms usually coincides with reckless risk taking, and a consequent increase in impaired loans.

Table 5.6 – System GMM Estimation of Asset Quality

Dependent variable: NPL	(1)	(2)	(3)	(4)
L.Y: Lag of	0.833***	0.837***	0.838***	0.842***
dependent variable	(0.037)	(0.040)	(0.036)	(0.038)
Adjustment parameters	0.167	0.163	0.162	0.158
Macro variables				
GDP	-0.029**		-0.030**	-0.027**
	(0.012)		(0.012)	(0.011)
INFL	-0.030**	-0.041***	-0.030**	-0.016
	(0.013)	(0.013)	(0.013)	(0.014)
IR3M	0.032**	0.018	0.035**	
	(0.014)	(0.015)	(0.015)	
EXP		-0.022***		
		(0.004)		
Financial market variables				
SR	0.003*		0.003*	0.003
	(0.001)		(0.001)	(0.002)
CVSR		0.010*		
		(0.005)		
FER	0.009***	0.015***	0.009***	0.009***
	(0.003)	(0.002)	(0.002)	(0.002)
CDS	0.091***	0.106***	0.086***	0.103***
	(0.031)	(0.034)	(0.031)	(0.036)
Global factors				
VIX			-0.081***	-0.058**
			(0.030)	(0.035)
TED			0.159***	0.165***
			(0.055)	(0.055)
Bank-specific characteristics				
TA	-0.024	-0.004	-0.025	-0.026
	(0.027)	(0.022)	(0.028)	(0.028)
LOAN	-0.005***	-0.004***	-0.005***	-0.005***
	(0.0007)	(0.0007)	(0.007)	(0.0007)
ROA	-0.087**	-0.088***	0.084**	-0.082**
	(0.034)	(0.031)	(0.003)	(0.036)
CAP	-0.001	-0.002	-0.001	-0.004
	(0.005)	(0.004)	(0.004)	(0.005)
LTD	0.001	-0.008	0.001	-0.006
	(0.011)	(0.010)	(0.011)	(0.009)
Policy interventions				
ΔPR				0.017

				(0.023)
ΔRR				0.097**
				(0.030)
RECAP				0.099*
				(0.054)
No. of Obs.	967	967	967	967
Banks (cross sections)	174	174	174	174
Instrument counts	168	168	170	172
F-test	137.92***	131.17***	138.73***	126.77***
Hansen test $\chi 2$	164.04	157.89	163.84	162.47
	[0.205]	[0.313]	[0.242]	[0.266]
AR(1)	-4.71***	-4.68***	-4.60***	-4.81***
AR(2)	-0.15	-0.23	-0.05	0.12

Notes:

(1) ***, ** and * represent statistical significant at levels of 1%, 5% and 10%, respectively

(2) Standard errors in parentheses

(3) p-values for the Hansen test are reported in brackets

Turning to global factors, the TED variable demonstrated a significant and positive influence on domestic banks' asset quality, which indicates the transfer of credit risk. However, it is interesting to find that coefficient on VIX is negative and significant. This result can be interpreted as an option of Asian banks to await a decision to declare NPL and dilution through new lending when facing with the uncertainty in the global financial conditions.

Among the bank-specific characteristic factors, there is a significant connection between NPL and banks' loan growth and profitability. The negative coefficient of ROA on NPL supports the cost efficiency hypothesis. Better managed banks tend to have better quality of assets, on the contrary, deterioration in asset quality is more likely to increase in banks with lower profitability, meaning lower cost management skills. The change in gross loans also affects NPL at 1% significance level; however, the coefficient has a very small value. 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 no evidence to support the size effect and moral hazard hypotheses, verified by insignificant coefficients on TA and CAP variables. A possible explanation for this is that East Asian banks are all well-capitalised; therefore the moral hazard incentive is minimised.

5.4.2. Adjustment in Profitability

Bank profitability shows a low level of persistence and a fast speed of adjustment, implying that its convergence toward equilibrium level is relatively rapid. One of the reasons can be the increasing intensity of competition in banking industry as a result of financial integration in East Asia. Banks profits and its optimal target level appear to be very sensitive to the state of the economy and financial market perception. Growth and export factors are the main macroeconomic drivers of bank profitability adjustment, but the coefficient signs seem intuitive. The business cycle significantly affects bank profits, even after controlling for other determinants. The positive effects of GDP on bank profitability are consistent with much of the previous empirical literature, confirming that bank profits improved in good economic conditions because there is higher demand for credit, as well as non-credit services and less credit risk. One of the most surprising results comes from the effect of the EXP variable on ROA. It is expected that this relationship should be positive, since high export growth implies good economic conditions[60] and high loan supply. However, the negative coefficient on EXP variable may reflect the attitude of banks toward risk. Subject to the increase in export growth which

[60] Asian countries are exported-oriented economies and export plays an important role in economic growth.

consequently leads to more loan demand and supply, banks may assume a higher level of credit risk and hence increase loan loss provision. Such a high level of provisions in fact depresses bank income. There is also significant impact of inflation on profitability. The interpretation for its negative effect is that high and variable inflation rates may cause difficulties in negotiating loans and bring about an increase in bank costs (Hoggarth et al., 1998; Demirguc-Kunt and Huizinga, 1999). The effect of change in interest rates on banks' earnings turns to be insignificant, which is inconsistent with other studies. The reason may be due to the offset between the increase in bank costs (via increasing deposit rates) and bank revenue (via rising lending rates).

Financial market performance has conflicting effects on ROA. The positive and significant influence of stock market returns on bank earnings is in line with expectations. The asset booms increase corporations' borrowing capacities and bank credit as the main profit contributor also increases. The rise in stock returns also promises greater profit opportunities for borrowers, contributes to a reduction in credit risk and improves bank profitability. However, the coefficient on FER variable is positive and significant which seems to contradict to the research 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 variable controlling for global liquidity shock, TED, has a significant and negative impact on ROA, demonstrating that funding shortages together with the corruption of international investors' risk appetite, may lead to 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.

Table 5.7 – System GMM Estimation of Bank Profitability

Dependent variable: ROA	(1)	(2)	(3)	(4)
L.Y: Lag of	0.142**	0.144**	0.143**	0.140***
dependent variable	(0.056)	(0.059)	(0.058)	(0.065)
Adjustment parameters	0.858	0.856	0.857	0.860
Macro variables				
GDP	0.073**			
	(0.028)			
INFL	-0.033**	-0.029**	-0.027**	-0.036**
	(0.016)	(0.013)	(0.013)	(0.015)
IR3M	-0.012	0.050	0.052*	
	(0.025)	(0.031)	(0.030)	
EXP		-0.025***	-0.024***	-0.030***
		(0.007)	(0.027)	(0.010)
Financial market variables				
SR		0.004**	0.005**	0.005**
		(0.002)	(0.002)	(0.002)
CVSR	-0.007			
	(0.009)			
FER	0.007	0.013***	0.012***	0.012**
	(0.004)	(0.004)	(0.004)	(0.005)
CDS	0.038	-0.008	-0.008	0.050
	(0.062)	(0.057)	(0.057)	(0.065)
Global factors				
VIX			-0.012	-0.021
			(0.015)	(0.014)
TED			-1.637***	-2.115***
			(0.529)	(0.775)
Bank-specific characteristics				
TA	-0.126*	-0.140*	-0.131*	-0.186**
	(0.071)	(0.073)	(0.070)	(0.080)
LOAN	-0.002	-0.002	-0.002	-0.002
	(0.002)	(0.002)	(0.002)	(0.002)
NPL	-0.302**	-0.336***	-0.332***	-0.369***
	(0.102)	(0.110)	(0.110)	(0.101)
CAP	-0.001	-0.001	0.001	-0.007
	(0.026)	(0.024)	(0.025)	(0.020)
LTD	-0.004**	-0.004**	-0.004**	-0.005**
	(0.002)	(0.002)	(0.002)	(0.002)

NIEA	0.031	0.026	0.026	0.031
	(0.030)	(0.025)	(0.025)	(0.029)
Policy interventions				
ΔPR				0.006
				(0.021)
ΔRR				-0.068
				(0.064)
RECAP				0.227
				(0.270)
No. of Obs.	1113	1113	1113	1113
Banks (cross sections)	174	174	174	174
Instrument counts	175	175	177	206
F-test	12.64***	9.15***	9.07***	11.26***
Hansen test χ2	170.75	169.02	169.72	169.12
	[0.183]	[0.209]	[0.203]	[0.777]
AR(1)	-2.76***	-2.7***	-2.7***	-2.64***
AR(2)	-0.78	-0.57	-0.56	-0.70

Notes:

(1) ***, ** and * represent statistical significant at levels of 1%, 5% and 10%, respectively
(2) Standard errors in parentheses
(3) p-values for the Hansen test are reported in brackets

Turning to bank-specific characteristics, we find evidence to support the credit risk effect. As expected, rising NPL is negatively and significantly related to bank profitability, which means a poor quality of loans reduces interest revenue and increases provisioning cost, which lowers bank profitability. This suggests the important implication that in order to maximise profits, East Asian banks should improve the screening and monitoring of the risk of loan default. The negative and significant of coefficients on TA and LTD indicates that variability in bank earnings performance arises from different operating strategies. Specifically, bank profitability is more likely to improve in banks with smaller size and traditional business model. This lends the support to the economies of scope, which trade-offs the benefits of diversifications. For example, in order to maximise operating efficiency, banks tend to focus on the market share and product range that they have comparative advantages rather than expanding and diversifying their operation. Moreover, banks that are less dependent on wholesale funding will tend to have higher profits. In all specifications, the effect of other bank-level factors is not statistically important.

5.4.3. Adjustment in Capital Buffer

The estimated parameters reported in Table 5.8 suggest a dynamic structure for bank capital buffer in which today's buffer adjusts to the previous period level. However, the speed of adjustment toward the desired capital buffer is fairly slow (around 25% per annum), possibly due to market frictions and adjustment costs. The high cost of capital adjustment is also one of the important factors that explain why East Asian banks prefer to hold such high regulatory capital ratios. Surprisingly, there is no evidence to support the hypothesis that changes in macroeconomic and financial conditions has a significant impact on bank capital buffer, which is contradictory to that of other studies. The empirical literature on the pro-cyclical bank behaviour has found that banks regularly change their capital holdings to accommodate fluctuations in risk arising from variations in the economic environment (Ayuso et al., 2004; Lindquist, 2004; Nier and Baumman, 2006; Brown and Davis, 2009; Jokipii and Milne, 2008; Stolz and Wedow, 2009; Fonseca and Gonzalez, 2009). However, the insignificance of the coefficients on most of the exogenous macro-financial variables appears to be consistent with Vennet et al's. (2004) arguments that highly capitalised banks are better able to alleviate adverse changes in the business cycle, and consequently are less sensitive to shifts in business cycle conditions. Moreover, this result may suggest that, given the fluctuation in the economic environment and financial markets, the change in banks' capital base and the change in risk-weighted assets are at the same rate. This is because bank assessment of how much capital should be increased to provide a buffer against elevated risk is parallel to that implied by the associated change in risk-weighted assets (Wong et al., 2005).

Among all external factors, only nominal interest rates, export and VIX index affect the target capital at a conventional significant level. The positive coefficient on IR3M variable indicates that increasing interest rates will lead to a reduction in bank lending and the consequent risk-weighted assets. This has simultaneous effect to lower bank regulatory capital ratio. The impacts of export and VIX on capital buffer reflect the fact that banks seek to adjust their buffers basing on perception about risks. Specifically, a rising export growth rate is going to be associated with rising loan demand. Subject to the increase in loans, banks may perceive that their asset portfolio has become more risky. Furthermore, an increasing VIX index signals financial uncertainties and risks are more likely to materialise. Therefore, banks tend to increase their capital buffers as an insurance against risk.

However, it is interesting to find that while bank capital is not very sensitive to macro-financial conditions; it is highly dependent on banks' own characteristics. Coefficients on LOAN, ROA and NPL are all significant at the level of either 1% or 5%. The findings support the results from Alfon et al. (2004), in that banks decide the level of capital according to internal risk assessment. First, the negative coefficients of LOAN indicate that the increase in risky assets will have a contemporaneous effect on weakening bank capital ratios. ROA also shows a statistically significant and positive effect, implying that profitable banks prefer to retain their earnings to improve their capitalisation. Lastly, the negative and significant coefficient of NPL indicates that default risk or credit risk weakens the bank capital position. Combining the continuous effects from NPL on ROA, ROA on CAP and NPL on CAP, we can conclude that credit losses remain key drivers of capital shocks.

Table 5.8 – System GMM Estimation of Capital Buffer

Dependent variable: CAP	(1)	(2)	(3)	(4)
L.Y: Lag of	0.757***	0.751***	0.748***	0.749***
dependent variable	(0.061)	(0.062)	(0.060)	(0.061)
Adjustment parameters	0.243	0.249	0.252	0.251
Macro variables				
GDP	-0.006			
	(0.128)			
INFL	-0.029	0.041	0.042	0.091
	(0.077)	(0.077)	(0.077)	(0.094)
IR3M	0.256*	0.332***	0.298**	
	(0.136)	(0.148)	(0.145)	
EXP		0.060*	0.058*	0.090***
		(0.034)	(0.033)	(0.034)
Financial market variables				
SR	-0.025*			
	(0.014)			
CVSR		-0.005	-0.003	-0.030
		(0.035)	(0.005)	(0.048)
FER	0.014	-0.028	-0.026	-0.030
	(0.016)	(0.020)	(0.019)	(0.018)
CDS	-0.087	-0.136	-0.095	-0.076
	(0.195)	(0.216)	(0.220)	(0.222)
Global factors				
VIX			0.068**	1.026***
			(0.320)	(0.353)
TED			-0.337	-0.068
			(0.414)	(0.536)
Bank-specific characteristics				
TA	-0.302	-0.198	-0.190	-0.194
	(0.283)	(0.201)	(0.198)	(0.216)
LOAN	-0.042***	-0.041***	-0.041***	-0.041***
	(0.009)	(0.009)	(0.009)	(0.009)

ROA	0.906***	0.806***	0.744***	0.780***
	(0.189)	(0.192)	(0.192)	(0.194)
NPL	-0.104**	-0.116***	-0.112**	-0.114**
	(0.047)	(0.044)	(0.004)	(0.044)
LTD	-0.015	-0.004	-0.011	-0.015
	(0.053)	(0.059)	(0.062)	(0.062)
Policy interventions				
ΔPR				0.244
				(0.155)
ΔRR				0.425
				(0.588)
RECAP				-0.993
				(0.634)
No. of Obs.	961	961	961	961
Banks (cross sections)	174	174	174	174
Instrument counts	168	168	170	172
F-test	65.24***	80.17***	79.78***	72.98***
Hansen test $\chi 2$	167.26	162.28	161.78	159.64
	[0.159]	[0.233]	[0.278]	[0.319]
AR(1)	-5.02***	-5.08***	-5.14***	-4.98***
AR(2)	-0.15	-0.12	-0.21	-0.24

Notes:

(4) ***, ** and * represent statistical significant at levels of 1%, 5% and 10%, respectively

(5) Standard errors in parentheses

(6) p-values for the Hansen test are reported in brackets

5.4.4. Adjustment in Lending Behaviour

The empirical results in Table 5.9 show that the lagged dependent variable has a positive sign and statistically significant in all specifications, giving the adjustment parameter of around 0.37. This implies that banks tend to adjust their loan portfolios toward the desired level of around 37% per annum. Although the speed of adjustment in credit growth is relatively slow, it is somehow faster than those of asset quality and capital buffer. The possible explanations for the slower speed of asset quality adjustment is due to the delayed effects of recognizing NPLs, while the delay in the closure of capital gap may indicate that the cost of adjusting capital is higher than the cost associated with loan portfolio adjustment. Overall, the rate at which banks adjusts their lending behaviour depends significantly on GDP growth, inflation, changes in nominal interest rates, foreign exchange rates, global financial stress and changes in their specific performance characteristics. First, a positive coefficient of GDP affirms the procyclical nature of lending behaviour in banks' response to crisis. 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 risk of loan default but also lowers loan demand, especially in large exporting corporate clients, as a result of global demand dry-ups. Therefore, banks may react to these combined effects of the downturn by rationing credit. Subject to the effect of inflation, it suggests that higher inflation significantly increases the quantity of loans extended to the private sector. This result appears to contradict the theoretical literature which investigates the connection between inflation, financial intermediaries and economic growth (Barro, 1995; Huybens and Smith, 1998). The key insight of these theories suggests that inflation might adversely affect economic growth through credit rationing in the banking sector. In particular, higher inflation decreases the real rate of return on assets, contributing to lower credit quality because borrowers entering the credit markets in that condition are more likely to default on their loans. Moreover, in the presence of information asymmetries, higher inflation exacerbates credit market frictions, with negative repercussions for financial sector performance. Banks may react to these effects by reducing the overall amount of credit available to business. However, further theoretical and empirical predictions stress the nonlinear relationship between inflation and finance (Azariadis and Smith, 1996; Boyd and Smith, 1997; Boyd et al., 2000)[61]. Several inflation thresholds have been considered in the literature, suggesting that once inflation exceeds a certain critical level, credit rationing occurs. For example, Boyd et al. (2001) find evidence of a threshold of 15%, which means that economies with annual inflation rates above 15% may experience a large drop in financial sector development. In other words, beneath a certain threshold, higher inflation might actually lead to increased credit growth. This argument can be a good explanation to support the significant positive coefficient on INFL variable in our estimation, as during the analysed period inflation in East Asian countries was well-behaved and under control[62]. The negative significant effect of IR3M on LOAN is consistent with the credit rationing theory (Stiglitz and Weiss, 1981), demonstrating that a higher interest rates lead to greater adverse selection and increases the likelihood that banks are lending to a bad credit risk. Moreover, in Bernanke and Gertler's (1994) survey of the credit view of monetary transmission, a rise in interest rates causes a debt burden for households and firms and decreases firms' cash flows. Theoretically, even a small rise in risk free rate may lead to a huge decline in lending and the possible collapse of the loan market (Mishkin, 1997).

Turning to financial variables, currency devaluation is associated with raising the perceived level of uncertainty about firms' future cash flows and profitability. This discourages bank from extending credit. At the same time, global financial

[61] For example, Azariadis and Smith (1996) and Boyd et al. (1997) argue that when inflation is very low, credit market frictions may be "non-binding", so that inflation does not distort the flow of information or interfere with resource allocation for growth. When inflation exceeds a certain threshold level, credit market friction becomes binding, which intensifies credit rationing.

[62] Most countries had relatively low and stable inflation during the period (moderate single-digit inflation). Central banks always pay attention to manage inflation pressures. For example, when inflation peaked at 12% in Indonesia in September 2008, the policy rate was raised by 175 basis points to help maintain the real rate of return.

uncertainties are signalled by increasing VIX and TED indices. Changes in investors' expectations can be self-fulfilling and have negative aggregate effect of bank lending. Moreover, TED spreads is also a measure of global funding shock. Although East Asian countries were considered to be less reliant on wholesale funding (except Korea) because domestic deposits were large enough to meet private credit needs, the estimation results suggest that liquidity shortage in international credit market has deterred commercial banks' private credit growth. For example, 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.

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 statistically 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 implication on banks' capital position and limit their access to financing as mentioned in bank capital channel. This in turn contributes to lower banks' credit growth. Generally speaking, there would be a strong, albeit adverse feedback effect from losses in banks' balance sheets on economic activities. Second, credit tends to grow faster in highly profitable banks, as verified by the significantly positive coefficient on ROA. This may be because more profitable banks are less constraints and less risk averse, they are therefore more likely to expand their loan portfolios. There is also evidence to confirm that 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 CAP variable on LOAN indicates that well-capitalised banks are more risk-averse because they want to limit the probability of not meeting capital requirements (Dewatripont and Tirole, 1994). Moreover, the implicit subsidy derived from deposit insurance is a decreasing function of capital (Flannery, 1989; Gennotte and Pyle, 1991), so well-capitalised banks tend to reduce their lending supply in poor economic conditions to avoid risk. Lastly, the sensitivity of credit growth to the bank liquidity buffer (LTD) turns out to be insignificant, suggesting that decelerating loan growth is diluted by a drop in deposit growth.

Table 5.9 – System GMM Estimation of Credit Growth

Dependent variable: LOAN	(1)	(2)	(3)	(4)
L.Y: Lag of	0.625***	0.613***	0.625***	0.617***
dependent variable	(0.212)	(0.218)	(0.212)	(0.213)
Adjustment parameters	0.375	0.377	0.375	0.373
Macro variables				
GDP	0.020***		0.021***	0.020***
	(0.007)		(0.007)	(0.007)
INFL	0.021**	0.006*	0.021**	0.021**
	(0.009)	(0.003)	(0.009)	(0.009)
IR3M	-0.010**	-0.011**	-0.010**	
	(0.005)	(0.004)	(0.004)	
EXP		-0.001		
		(0.185)		
Financial market variables				
SR	-0.001		-0.001	-0.003

	(0.009)		(0.009)	(0.009)
CVSR		0.009**		
		(0.003)		
FER	-0.008**	-0.006**	-0.008**	-0.007**
	(0.003)	(0.003)	(0.003)	(0.003)
CDS	0.006	0.029	0.007	0.006
	(0.019)	(0.030)	(0.019)	(0.020)
Global factors				
VIX			-0.681*	-0.633*
			(0.387)	(0.301)
TED			-6.944*	-6.448*
			(3.937)	(2.974)
Bank-specific characteristics				
TA	0.375*	0.347*	0.376*	0.378*
	(0.198)	(0.210)	(0.200)	(0.196)
NPL	-0.010**	-0.011***	-0.010**	-0.011**
	(0.004)	(0.004)	(0.004)	(0.004)
ROA	2.704***	2.765**	2.300**	2.403*
	(0.871)	(1.165)	(1.007)	(1.570)
CAP	-0.018***	-0.017***	-0.018***	-0.018***
	(0.005)	(0.005)	(0.005)	(0.005)
LTD	-0.003	-0.003	-0.003	-0.004
	(0.006)	(0.006)	(0.007)	(0.007)
Policy interventions				
ΔPR				-0.011**
				(0.005)
ΔRR				0.038
				(0.025)
RECAP				0.097
				(0.074)
No. of Obs.	1116	1116	1116	1116
Banks (cross sections)	174	174	174	174
Instrument counts	183	183	185	187
F-test	1744***	1818***	1904***	1683***
Hansen test $\chi 2$	169.84	170.05	169.09	168.21
	[0.361]	[0.357]	[0.419]	[0.437]
AR(1)	-1.98**	-1.97**	-1.96**	-2.07**
AR(2)	-0.50	-0.24	-0.50	-0.48

Notes:

(1) ***, ** and * represent statistical significant at levels of 1%, 5% and 10%, respectively
(2) Standard errors in parentheses
(3) p-values for the Hansen test are reported in brackets

5.4.5. Behavioural Response to Policy Interventions

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 reduction and government injections of bank capital. Specifically, the accumulated changes (in basis point) 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). A reserve requirement adjustment was applied in Indonesia (-4.1%), Malaysia (-3%) and Philippines (-2%) (Filardo et al., 2010). Government injections of bank capital were announced in Japan, Hong Kong, Thailand and Korea for state-owned banks to boost bank lending in late 2008 and 2009. We test the impact of these policy responses on bank behaviour by including policy intervention variables in all regressions. The estimation results in specification 4 of Table 5.9 provide evidence to support the bank lending channel theory. The significant and negative coefficient of ΔPR implies that easing monetary policy helps to boost bank lending to overcome continuous recession. This also evidences the pass-through of policy rate cuts to borrowing cost (See Appendix 5.1), which contributed to minimising the financial accelerator effects as the East Asian economies recovered quickly in 2010. The insignificance of the ΔRR and RECAP variables may be due to statistical problems, i.e. limited observations relative to the full sample[63]. Although monetary policy variables do not yield any direct significant effects on other dimensions of

[63] The cross-country study by Laeven and Valencia (2011) shows that the recapitalisations of banks conducted in 50 different countries had a significant positive effect on the growth performance of credit dependent firms.

bank performance, such as asset quality, bank profitability or capital buffer, they may have indirect effects in terms of mitigating macro-financial variability. Moreover, although these measures do not generate significant effects individually, they may have a joint significantly positive effect with other measures such as guarantees, asset purchases and liquidity supports on preserving the intermediation function of the financial sector, as verified by the quick economic recovery and financial stability of the region.

5.5. Conclusions

This chapter has investigated the interlinkages between macro-financial variability and bank behaviour, which justifies the second round effects of the 2007-2011 global financial crisis on East Asia. Applying the partial adjustment models and dynamic panel data techniques with System GMM estimation, the empirical analysis provides some evidence to confirm the hypothesis of balance sheet adjustments in interactions with shocks in the financial system and the economy. However, banks will react differently depending on their financial strength and attitude toward risks. The main finding is that volatility in the global financial markets and changes in domestic macro-financial conditions negatively affects bank asset quality, profitability and lending behaviour. Although there is no robust evidence to support the direct effect of macro-financial variation on bank capital adjustment, there is an indirect effect that occurs from its impact on bank financial soundness, which tends to change capital buffers. For example, deterioration in asset quality may reduce profitability and directly or indirectly weaken capital for banks that raise capital via retained earnings. In other words, the main source of capital shock is credit losses, which potentially arises under macro-financial unfavourable conditions resulted from international financial contagion. This may suggest an important implication for bank managers and authorities in terms of managing default and credit risk, and strictly adhering to regulatory capital requirements as a cushion to absorb negative shocks. Additionally, the empirical results also show evidence about the effectiveness of conventional monetary easing measures. Specifically, aggressive interest rate cuts help to boost domestic credit and to mitigate the impact of the global crisis on East Asian economies. This experience may draw an interesting lesson for central banks in manipulating monetary policy that explicit inflation targeting is not always easier than non-inflation targeting in terms of boosting confidence, stimulating economic activity and controlling inflation.

Our results are robust but they are still subject to some limitations. First, the data are not timely, so may not fully capture the procyclical nature of bank behaviour. Second, the low frequency of the data (annually) may also cause some bias, as we expect the effect and adjustment to occur quarterly. Third, the data sample does not involve all financial institutions, and not all financial institutions report comprehensive data. Last, the differences in national regulatory and accounting and tax regimes may reduce the effectiveness of cross-country comparison.

In general, the adverse effects of global economic and financial market turmoil on the East Asian banking system are not insignificant, but limited and manageable. The effects also occurred in a short period of time. East Asia has showed a very quick recovery since 2010; in fact, the region has actually experienced a V-shaped business cycle. This stylised fact has two implications. First, the financial accelerator effect is negligible with external shock, although it is proved to be amplified by an internal shock. Second, the quick recovery is due to timely policy interventions to boost the economies. This may suggest that although good fundamentals do not guarantee a full decoupling from crisis contagion, they have provided scope for strong and effective policy responses.

CHAPTER SIX – CONCLUSION

6.1. Main findings and contribution of the thesis

History is strewn with financial crisis episodes and their frequency has been double that of the Bretton Woods Period (1945-1971) and the Gold Standard Era (1880-1993) (Bordo et al., 2001). Nevertheless, the global financial crisis was unpredicted by the international financial community in terms of its suddenness, financial scale, and especially its cross-border contagion (See Appendix 6.1). Unlike the series of financial turbulent episodes in the 1990s, when EMEs were at the epicentre of the crises, the global financial crisis started from the problems in AEs in North America and Europe. However, the unprecedented spike in financial stress in AEs heightened this stress across EMEs to the levels above those witnessed during the 1997-1998 East Asian financial crisis. Improved and resilient macro-financial fundamentals, especially higher current account and fiscal balances, did little to insulate those EMEs from crisis contagion. The turbulence in the global financial markets in the past five years has implied that those who believe in the decoupling myths surrounding EMEs have underestimated the potential costs of cross-border financial linkages, while over-estimating the cushion from economic fundamentals. It seems that in the new global economy, sound fundamentals may not be enough to prevent financial crises. The extent of pass-through of financial stress varies across countries, depending not only on the depth of their financial linkages with AEs, but also on country-specific risks and their historical experiences.

This thesis has attempted to provide an econometric assessment of cross-border financial linkages and international financial contagion. The fundamental question is to identify the financial mechanisms that propagate and amplify shocks from AEs to EMEs in East Asia. Three channels have been investigated: (i) asset price volatility linkages, (ii) sudden stop in cross-border funding, and (iii) the second-round effects on banking sectors prompted by macro-financial linkages.

The first transmission mechanism was investigated in chapter three. The literature survey reveals that methodologies in testing contagion via asset prices are subjective to some econometric problems, making empirical evidence rather inconclusive. This study applied the MS-VAR framework to model asset prices' volatility linkages and their dynamic behaviour during financial stress, and the multivariate unconditional correlation tests to assess whether the volatility shock transmission is simply "interdependence" or a consequence of "shift-contagion". The contribution of this chapter is the testing technique, which has taken into account the endogeneity of the variables, non-linear linkages, heteroscedasticity, simultaneous equations and allowed for endogenous identification between normal and crisis periods instead of an a priori breakdown of the sample data.

The empirical results show the structural change in variances is common to all countries and coincides with major events of the global financial crisis of 2007-2011. This kind of asset price interaction has been strongly linked to the globalisation of financial markets in East Asia, which allows international investors to increase their exposure in those markets to search for high yielding investments, as well as allowing domestic investors to extend their investments in more complicated financial products in AEs. The linkage is as strong in normal periods as crisis periods, except for the case of Thailand, whose stock return volatility linkages with those of the US significantly strengthened during the time of financial stress. This has the important implication that global investors are especially sensitive to countries which have suffered a severe financial crisis in the past.

One of the interesting results is the intensified intra-regional linkages in the event of an external shock and there may be a transfer in directional interactions. The fact that financial markets in East Asian countries are closely linked to each other is not a new discovery. A number of studies have shown that the interaction of East Asian financial markets caused financial contagion during the regional financial crisis of 1997-1998. However, the level of integration within regional markets has also been significantly enhanced by the external financial shock, causing crisis contagion to be considered as severe as internal shock. For example, the stock return volatility in the US and EU did not have direct contemporaneous effects on all East Asian countries at the same time, but it may have exported its volatility first to Hong Kong via direct financial linkages, and then Hong Kong volatility shock may have caused shift-contagion in Singapore and Indonesia. The linkages in foreign exchange and sovereign debt markets also experienced a significant improvement. Exchange market integration can be explained by the increasing inter- and intra-regional trade which leads East Asian members to monitor and follow the behaviour of currencies in neighbouring countries in order to maintain their competitive advantages. On the other hand, the intra-regional equity and sovereign markets reflects the fact that markets have the same assessment of country credit risk in the region, making those countries more vulnerable to the wake-up call effect. In general, these findings confirm that contagion tends to be regional rather than global.

In addition to affecting asset prices, foreign exchange rates and changes in sovereign default, the financial crisis also affected investors' willingness to extend credit to EMEs. Therefore, an exclusive focus on asset price channel may not be sufficient. Chapter four tested the probability of the sudden stop in cross-border funding and the links between the sudden stop to the interbank market tensions in host countries. While empirical literature has strongly focused on the gravity models and base regression to measure the waves in cross-border funding flows associated with various pull and push factors; this chapter appears to be the first to use the univariate and recursive bivariate probit models to quantify the marginal effects of several global and country-specific risk factors on the sudden stop probability and its simultaneous effects on East Asian interbank markets. This econometric approach fits the nature of the panel data and the research objectives.

We find that cross-border banking and high reliance on external funding expose East Asian countries to the risk of a sudden stop in international lending flows caused by the common lender and wake up-call effects. In the context of the 2007-2011 global financial crisis, the sudden stop was also associated with a liquidity shock in international credit markets, which affected the supply of bank loans and host country aggregate productivity shock, which reduced the demand for bank loans. This caused the transmission of money market tensions from AEs to the seven East Asian countries. However, interbank stress was mitigated by the "flight-home effect" caused by the active repatriation of funds invested abroad by domestic investors and the serial liquidity support introduced by central banks in those countries. A sudden stop is more likely to occur in countries with lower financial openness but higher financial risks, such as local currency depreciation and stock market volatility. The results also show that international lending flows to the banking sector are more sensitive to shocks and hence suffer a higher level of volatility than the flows to the non-bank private sectors. This is because lending to banking sector is commonly in the form of direct cross-border lending, denominated in foreign currencies, and relies on wholesale funding. On the other hand, the latter is usually in the form of local lending by foreign subsidiaries and branches, mostly denominated in local currencies and partly funded by local deposits. This suggests important policy implications for East Asian authorities in stabilising cross-border banking flows in particular, and in managing international capital flows in general.

The last potential crisis transmission channel to be tested in this thesis was the second-round effects on banking sectors prompted by macro-financial linkages. This enhances the contribution of this thesis because it fills the gap in the financial literature. Most of the studies which investigate the transmission of global shock between economies focus on real effects via trade links or financial effects via the co-movement of asset prices and international capital flows. They ignore the potential of the second round effects, defined as adverse feedback loops from changes in macro-financial conditions on the performance of banking sectors via the rise in NPL and deterioration of bank profitability and capital with negative implications for bank lending. In the studies of bank behaviour, a notable gap arises from the separate examination of adjustment in one specific dimension of performance, with limited attention paid to simultaneous adjustment in overall performance. Moreover, the application of partial adjustment model and system GMM estimations to examine the adjustment in bank asset quality, profitability, capital adequacy and loan supply overcomes the drawbacks from other econometric approaches in dealing with dynamic panel bias, persistent series, endogeneity, autocorrelation and heteroskedasticity.

The empirical results provide some evidence to confirm the hypothesis of bank balance sheet adjustments in interactions with shocks in the financial system and the economy. This therefore, justifies the second-round effects of the global financial crisis on East Asian economies. Specifically, we find that global financial stress and variation in domestic macro-financial conditions negatively affect bank asset quality, profitability and either directly impact or feedback on bank lending. Bank capital appears to stay resilient as relatively high regulatory capital ratios provide banks with a cushion to absorb negative shocks. However, if adjustment in asset quality and bank profitability is large enough, it will activate an adjustment in bank capital, causing capital shocks. There is also some evidence to support the effectiveness of monetary easing policy. By aggressively cutting policy rates, central banks were successful in boosting bank lending and mitigating the contagion effect. In particular, this experience may suggest a very important lesson in manipulating monetary policy, that explicit inflation targeting is not always easier than non-inflation targeting in stimulating economic activity and controlling inflation. Although the second-round effects are inevitable in the context of macro-financial interaction, these effects were relatively limited and manageable in East Asian countries. The quick recovery in those economies implies that financial accelerators may be not very strong for external shock compared to internal shock. But the most important reason is that central banks in the region have had active and time-line policy interventions to control this effect.

6.2. Policy implications

6.2.1. Trade-offs of financial liberalisation

The thesis has provided some empirical evidence of potential costs associated with cross-border financial linkages, especially the increased vulnerability and susceptibility of a country to external shocks despite its sound fundamentals. This brings about an important implication for the trade-offs associated with financial liberalisation.

Financial liberalisation strategies and proper diversification: the findings in chapter 3 and 4 imply that volatility transmission, shift-contagion effect and the sudden stop in international funding occurred not only in developed markets of Hong Kong and Singapore but also in emerging Asia. Nevertheless, the stories from the Asian financial centres suggest that while financial openness exposed them to large withdrawals of foreign capital in stress conditions, the repatriation of domestic investors more than offset capital outflows and mitigated the pressures in the financial markets. On the contrary, EMEs with less interconnectedness and lower flexibility are more likely to be subject to higher one-way risk of deleveraging. Therefore, reducing a country's exposure to international trade and finance does not necessarily help to avoid risks and enhance stability. Instead, it is crucial to balance this trade-off with an appropriate strategy of liberalisation and diversification supported by well-functioning financial markets and sound fundamentals. According to the IMF (2012), countries may achieve the largest benefits of liberalisation when they attain a certain level of financial and institutional development. Moreover, a larger number of cross-border links (i.e. increased interconnectedness) provides better risk diversification and make the network more robust (Allen and Gale, 2005). The concentration of exposures to a few sources could create severe deleveraging, especially when a shock hits this single source country. Diversification in cross-border capital transactions should be considered from both inward and outward dimensions, as each direction can deliver diversification benefits.[64]

Developed and well-functioning financial markets: as financial markets was an important propagator of shocks across borders, a well-functioning markets associated with sound financial regulation, risk management, prudential buffers and transparency could help to strengthen markets' resilience and capacity to absorb shocks. Developed and well-functioning capital markets should create a diverse menu of savings and investment options and allow for fully financial interaction between households, corporations, banks and governments. The economic theory suggests that the corporate bond market is an important ingredient for a well-functioning capital market because it offers a more efficient form of market-disciplines for channelling funds from savers to investors (Burger et al., 2008). Moreover, local currency bond market development will help to reduce reliance on foreign currency borrowing, and reduce the potential risks of currency mismatches. Given the limited size of bond markets (especially corporate bond ones) in East Asia, fostering their development should be a high priority. Empirical literature (Burger and Warnock, 2007; Burger et al., 2010) suggests that the growth in EME local bond markets was stronger for those with investor-friendly macroeconomic policies and institutional arrangements (See Appendix 6.2). Specifically, high inflation volatility can impede private bond insurance because volatile inflation raises the uncertainties of real returns on long-term fixed

[64] See Schoenmaker and Wagner (2011).

rate bonds and makes them unattractive to investors. This suggests the importance of an anti-inflationary monetary policy. Additionally, the expansion of local bond market development is more likely to be associated with greater market liquidity and efficiency, stronger regulatory quality and creditor rights, better market infrastructure, fewer capital controls, lower taxation and larger local institutional investor base (Burger et al., 2010). A potential avenue for improving market liquidity and broadening the investor base would be to accommodate value-relevant information about the creditworthiness of issuers, market conventions governing trading, settlement, distribution, pricing and issuance, and to enforce better legal rights among market players. A heterogeneous investor base with various views and risks can also add diversity, increase trading activities and hence market liquidity. In order to attract foreign participation in local bond markets, currency risk is a big concern[65]. From the foreign investors' perspective, investing in EME local currency bonds seems like a currency game with some yields. The potential for attracting global investors would depend on countries' abilities to differentiate bond investment from currency exposure.

Another essential strategy is the development and functioning of OTC markets, especially credit derivatives markets. OTC markets can offer a wide range of products tailored to individual customer needs, therefore generating benefits in terms of flexibility and innovation. However, the counterparty risk is greater in OTC markets than organised ones because their decentralised nature causes difficulties in collecting market-wide information about trading activities, trading and exposures. In order to improve market transparency and mitigate

[65] Global investors prefer to invest in foreign currency denominated bonds rather than local currency bonds. However, issuing bonds in a foreign currency to attract foreign investors may lead to excessive reliance on foreign currency debts, increased currency mismatches and high susceptibility to currency crisis, as experienced in 1997-1998.

counterparty and operational risks, the Financial Stability Forum (2008) urged market participants to apply a central counterparty for clearing OTC credit derivatives.

The role of fundamentals in the trade-offs: although good fundamentals have not guaranteed a full decoupling from the contagion of financial crises, they have helped to buffer those economies against vulnerabilities and have provided scope for strong policy responses. For example, the two financial centres of Hong Kong and Singapore suffered a severe reversal in cross-border banking flows. However, persistent current account surpluses, high sovereign ratings and expanded deposit insurance supported the repatriation of capital, thus providing a substitute for external lending. The story of Korea is a good example of successful use of foreign reserves to stabilise financial markets when global risk aversion rises. More than other countries in the region, Korea was strongly affected by capital outflows. By the end of 2008, equity outflows reached over US$ 70 billion, accounting for 7.7% of GDP. Cross-border contagion from global foreign currency liquidity pressures was extremely serious, as the country depended greatly on wholesale funding. Korea had to recourse to its substantial foreign reserves to smooth foreign exchange market volatility and more importantly to provide currency liquidity to domestic banks and exporters. Swap facilities with Federal Reserve, Japan and China were introduced to provide US dollars against local currency. All of this explained the sharp bounce back of East Asian economies compared to other countries and regions.

6.2.2. Managing country-specific risks

Foreign exchange rate risks: the key source of country-specific risk is foreign exchange rate risk, which tends to increase a country's vulnerabilities to crisis contagion. The study of Friedman (1953) suggests that exchange rate flexibility can help country to respond easily and quickly to negative external demand shocks. Empirical evidence also confirms the benefit of floating exchange rate as a key buffer to alleviate the effects of falling external demand (Berkmen et al., 2009). More flexible rates can help resolve tension between various policy targets (i.e. inflation and exchange rate targets) faced by countries in liberalising capital accounts and integrating with global capital markets, by letting the appreciation absorb the impact of the inflows. Moreover, greater exchange rate flexibility may discourage short-term speculative inflows because it exposes market players to two-way exchange rate risks (Mihaljek, 2008). The floating exchange rate regime eliminates the need for inefficient additional foreign reserve build-up. However, countries should bear in mind the potential costs associated with excessive exchange rate volatility, such as inflationary pressure, the adverse effect on economic structure and economic growth. In general, in managing foreign exchange rates and mitigating external vulnerabilities, it is more important to smooth out excessive volatility and avoid currency misalignment, rather than to keep exchange rates artificially weak for trade competitiveness enhancement purposes.

Foreign exchange reserves: the global financial crisis has stressed the importance and value of an ample foreign reserve for the orderly functioning foreign exchange markets in East Asian countries. However, excessive additional build-up is inefficient as it tends to, *ceteris paribus,* increase the monetary base and ease monetary conditions, which cause the side effect of exchange appreciation and weakening of a country's trade competitiveness. The question of the appropriate level of reserves is a challenging issue for consideration. In fact, in some Asia-Pacific countries with internationalised currencies and well developed financial markets, such as Australia and New Zealand, the absence of large reserves is not an obstacle. The use of financial derivatives to manage short-run foreign currency exposures has proved to be a useful strategy. Therefore, enhanced swap lines may be an ideal solution to reduce the incentive for increasing foreign reserves. In fact, East Asian countries' endeavours to employ this strategy have been reflected in the setting up of the Chiang Mai Initiative (CMI) and subsequent upgrading to the Chiang Mai Initiative Multilateralisation (CMIM) for regional liquidity support. CMIM allows member countries (ASEAN+3)[66] to draw from 50% (for larger countries) to 500% (for smaller countries) of their contribution to a $120 billion multilateral reserves pooling arrangement.

6.2.3. Monetary policy manipulation during the crisis

First, the successful policy responses of East Asian countries to mitigate the contagion effect suggest that monetary policy during a crisis may require a fundamentally different tactical approach. In normal times, central banks should react to changing economic conditions gradually, in small steps and in a forward-looking fashion. For example, under inflationary pressures, keeping policy rates rising is the optimal target. However, in stress conditions the tail risks can develop very quickly and the macro-economic outlook is threatened, so large and

[66] Association of Southeast Asian Nations: Singapore, Thailand, Malaysia, Indonesia, Philippines, Vietnam, Laos, Cambodia, Myanmar and Brunei, plus three others: China, Japan and Korea.

aggressive policy rate cuts are necessary to boost confidence and stimulate economic activity. Explicit inflation targeting is not always easier than non-inflation targeting in monetary policy manipulation. The key challenge for central banks is how to maintain a primary focus on inflation while concerns about the vulnerability of economic growth, financial instability and the potential volatility of capital flows are also rising. Should central banks compartmentalise their policy priorities or smoothly trade off output and inflation stabilisation? What should be appropriate monetary policy frameworks? The answers to those questions are not straightforward, instead depending on the nature of the economic environment and how well-functioning the financial system is. Strategies need to be tailored to each country, taking into account several factors such as the extent to which a country is exposed to commodity price shocks, financial openness and exposure to capital flow volatilities, the country's capacity to absorb such shocks, and the role of exchange rates in the inflation process. However, these factors are time-variant, implying that the monetary framework cannot be static.

Moreover, there is a risk that monetary policy measures to cope with crises may produce some distortionary effects that bring about inefficiencies and possible imbalance in the long run. For example, too much liquidity support and blanket guarantees may lead to excessive risk taking and a potential moral hazard problem. Extended liquidity supply by central banks and low interest rates may also discourage lending and borrowing activities in interbank money markets and put banks' business models under pressure. The effectiveness of monetary policy strategies may need revisiting, particularly in terms of countercyclical effects. When economic activities start to rebound and financial headwinds abate, central banks need to exit from their very accommodating policy stances and crisis measures should be phased out. However, it is important to calibrate the speed and timing of exit strategies and communicate these to the public.

Second, the countercyclical fiscal response has been impressive and effective, suggesting the desirability and high importance of monetary-fiscal coordination in East Asia. The macroeconomic objectives to achieve non-inflationary stable growth have usually been taken by two major groups of policy instruments[67]: monetary instruments employed by central banks and fiscal instruments employed by ministries of finance. However, they usually conflict with each other. Before 2008, East Asian countries were characterised by high growth rates and moderate inflation. However, the world commodity price shocks during the first half of 2008 and the global financial crisis in late 2008 to 2009 have posed serious challenges for policy makers. While both crises call for expansionary fiscal policy, they require different monetary responses for different crisis episodes. Tightening monetary stance is essential for the price shock to reduce domestic inflationary pressure. However, on the spread of global economic and financial market turmoil, which caused severe economic contraction associated with rising unemployment and price falling, easing monetary policy in support of the fiscal response was highly preferable. The implementation of monetary and fiscal policy coordination should depend on the following factors (Hasaon and Isgut, 2009):

- The stage of development of the domestic financial market and institutions: models of monetary-fiscal coordination (Laurens and de la Piedra, 1998) vary across four stages of development: (i) the early stage of development, (ii) government starts to auction short-term marketable securities, (ii) domestic

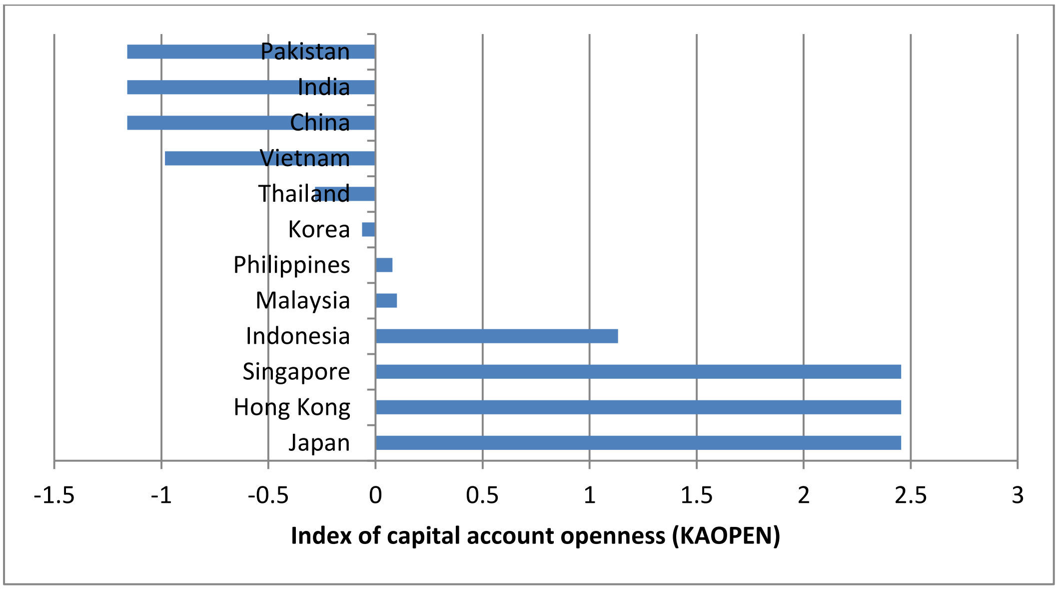
[67] According to Hasan and Isgut (2009), the theory of economic policy initiated by Jan Tinbergen and Henri Theil suggests that the achievement of more than one policy target (i.e. growth rate and inflation rate) requires more than one policy instruments.

financial markets start to develop and (iv) fully developed financial markets. Accordingly, the East Asia case belongs to the third stage, where the role of interest rate increases and monitoring of the financial market become critical. Therefore, coordination aims at reducing rising interest rates, which could threaten economic growth. Central banks also need to switch from broad money programming to reserve money programming and to market-based instruments.

- The level of capital account openness: monetary-fiscal policy coordination becomes more complex in an economy which is more open to international capital flows. In this case, the current account balance should be an additional policy target and exchange rate control should become an additional policy instrument. However, it is challenging to simultaneously control the level of exchange rate and monetary policy instruments[68]. According to the Mundell-Fleming model, policy instruments depend on exchange rate regimes. Under a pure floating exchange rate regime, a country retains the use of an independent monetary policy but gives up the use of exchange rate as an additional instrument to target the balance of payments. If a country pegs its currency, government forsakes both monetary policy instruments and control of the inflation target. As shown in Figure 6.1, there is cross-country variation in the level of capital account openness. While developed Asia (JP, HK and SG) is fully open to financial capital flows, emerging East Asia is less financially open. Therefore, those countries retain the use of monetary policy instruments even when they target the value of exchange rates.

[68] See Obstfeld et al. (2005) for the monetary policy trilema or "impossible trinity".

Figure 6.1 - Capital account openness in Asia



Source: Chinn and Ito (2010)

- Fiscal space[69] and debt management: the use of fiscal instruments to achieve macroeconomic goals depends on budgetary balances and public debts. Large budget deficits will restrict the fiscal space to finance additional expenditure. Even if additional expenditure is financed, countries may face the upward pressure of the domestic cost of credit, which creates obstacles not only for future expansion of government expenditure but also for the implementation of policy instruments to boost the economy (Appendix 6.3 provides more information on budget balances in East Asia before the global financial crisis). Moreover, a large share of public debt (denominated in foreign currencies) and a large concentration of maturities (at a particular point in time) may also have an adverse impact on the cost of servicing public debt. Therefore,

[69] Fiscal space is defined as the availability of budgetary room that allows a government to provide resources for a desired purpose without prejudicing the sustainability of a government's financial position (Heller, 2005).

management of public debt should be coordinated with monetary and fiscal policies.

6.2.4. Regional financial cooperation

Since the East Asian financial crisis in 1997-1998, regional cooperation for better macroeconomic and financial management has been a central concern for national authorities. ASEAN+3 and EMEAP (Executives' Meeting of East Asia Pacific Central Banks) have played an important role in regional cooperation. Their endeavours focus on three dimensions of financial cooperation: (i) strengthening crisis management regimes, (ii) developing regional bond markets and (iii) fostering regional exchange rate cooperation and monetary integration.

Strengthening crisis management regimes: two measures have been established to strengthen crisis management regimes: the setting up of regional emergency liquidity support with swap arrangements under CMI and CMIM, and the reinforcement of surveillance and monitoring frameworks. CMIM was developed from bilateral swap arrangements to multilateral arrangements associated with expansion in volumes and enhancement in collective decision-making processes. There is a need for continuous upgrading to an advanced CMIM framework as a foundation for the creation of an Asian monetary fund in the near future. Countries in the region have also made efforts to build surveillance and monitoring systems to strengthen their policy cooperation. The ASEAN Surveillance Process is an example; it draws up monitoring reports of members' economic development and policy recommendations concerning further regional development. Accordingly, the Monetary and Financial Stability Committee was launched in 2007 to perform risk and crisis management and resolution network. The network is composed of a high-level team and technical level crisis management team to provide advice in dealing with crisis and the execution of business community plans.

Developing regional bond markets: concerning backward financial markets, the EMEAP created the ABF and fostered the insurance of bonds through the ABMI. The member countries have endeavoured to build common structures, such as credit guarantees, credit rating and a settlement system to facilitate regional bond market development. Further discussions to foster development have been in progress. For example, the Working Group on New Securitised Debt Instruments is devoted to finding ways to provide tax incentives for regional currency-denominated bond insurance and to coordinate a response to withholding taxation. The Technical Assistant Coordination Team for the Focal Group has studied ways to globalise members' bond markets and improve the human resource quality in these markets. There are also Working Groups in various fields such as Credit Guarantee and Investment Mechanisms, Foreign Exchange Transactions and Settlement Issues, Rating Systems and Information Dissemination on Asian Bond Markets.

Regional exchange rate cooperation and monetary integration: the experience of the 1997-1998 financial crisis sparked the need for regional exchange rate cooperation to prevent competitive devaluations of currencies. Many studies have been conducted by ADB and major research institutes on the development of an Asian Currency Unit (ACU) since 2005. ACU would be a good indicator to monitor the movements of regional currencies as a whole against currencies outside the region and against the currencies of individual regional countries. Meanwhile, ASEAN+3 has been studying the development of a single regional monetary unit since 2006, based on the model of the European Union's adoption of the EMU. However, unifying member countries' currencies is challenging as it requires tight harmonisation in monetary, trade and political policies. Therefore, the region should enhance information sharing, promote more open discussion of national and regional policy interventions, facilitate the development of an Asian investment infrastructure, harmonise prudential indicators, and increase coordination on early warning system analysis.

6.2.5. International supervisory cooperation

The historical financial crises have revealed numerous weaknesses in international legal frameworks and supervisory systems, especially in supervising cross-border banking flows. Mihaljek (2008) addresses the fundamental problem from the mismatch between home and host countries' financial stability concerns, as well as banking supervision and risk management. For example, host countries may be concerned about domestic asset price boom-bust, rapid credit growth and external balance pressure, while they may find it difficult to address these concerns given their uncertainties about the foreign banks' financial soundness. On the contrary, foreign-owned branches and subsidiaries have incentives to boost bank lending, while underestimating the credit risk associated with credit boom. Although these foreign-owned institutions are usually well equipped with risk measurement and management skills, these skills may be irrelevant for application in EMEs, where there are inadequate accounting, auditing, financial reporting and disclosure structures and insufficient credit risk data. The Basel Committee on Bank Supervision has set out the Basel Concordat to provide principles and standards for effective prudential supervision of cross-border banking since 1975. In 2001, the Basel Committee elaborated Memoranda of Understanding (MoUs) to facilitate bilateral relationships in cooperation with banking supervisors for effective Basel accord implementation. However, both the Concordat and MoUs have proved to be of little practical help in the cross-border coordination of intervention to respond to bank distress because of the barriers to information sharing arising from political, legal or tax-related issues. Cooperation between supervisors is strongly in need of reinforcement. Home - host authorities need to establish information and burden sharing regimes across jurisdictions. EMEs, by reporting and analysing the Financial Stability Assessment Programme of the IMF and the World Bank, could upgrade their knowledge and skills of supervision and acquire information on the use of complex financial products by foreign and domestic banks.

6.3. Limitations and further research

Our endeavours to provide a thorough econometric analysis of different transmission mechanisms which propagate shock across borders are subject to some limitations. First, this thesis tends to investigate “common” patterns across EMEs in their responses to shocks, rather than cross-sectional heterogeneity. For example, we do not control for the influence of fundamentals in testing the existence of contagion in chapter three. The reason is that data for fundamental variables are available only at relatively low frequency, while the literature suggests that contagion is a short-lived feature which is better captured in high-frequency observations (Dungey et al., 2005). The same problem is observed in chapter 5 where annual data is used to analyse bank behaviour in response to macro-financial variation, but we actually expect that bank adjustment may occur quarterly. Moreover, the differences in national regulations and supervisions and accounting and tax regimes make the data deviate from being totally consistent across countries. The data samples also do not involve all financial institutions and the uneven distribution of the number of cross sections within the sample place limits on a strict cross-country heterogeneity analysis.

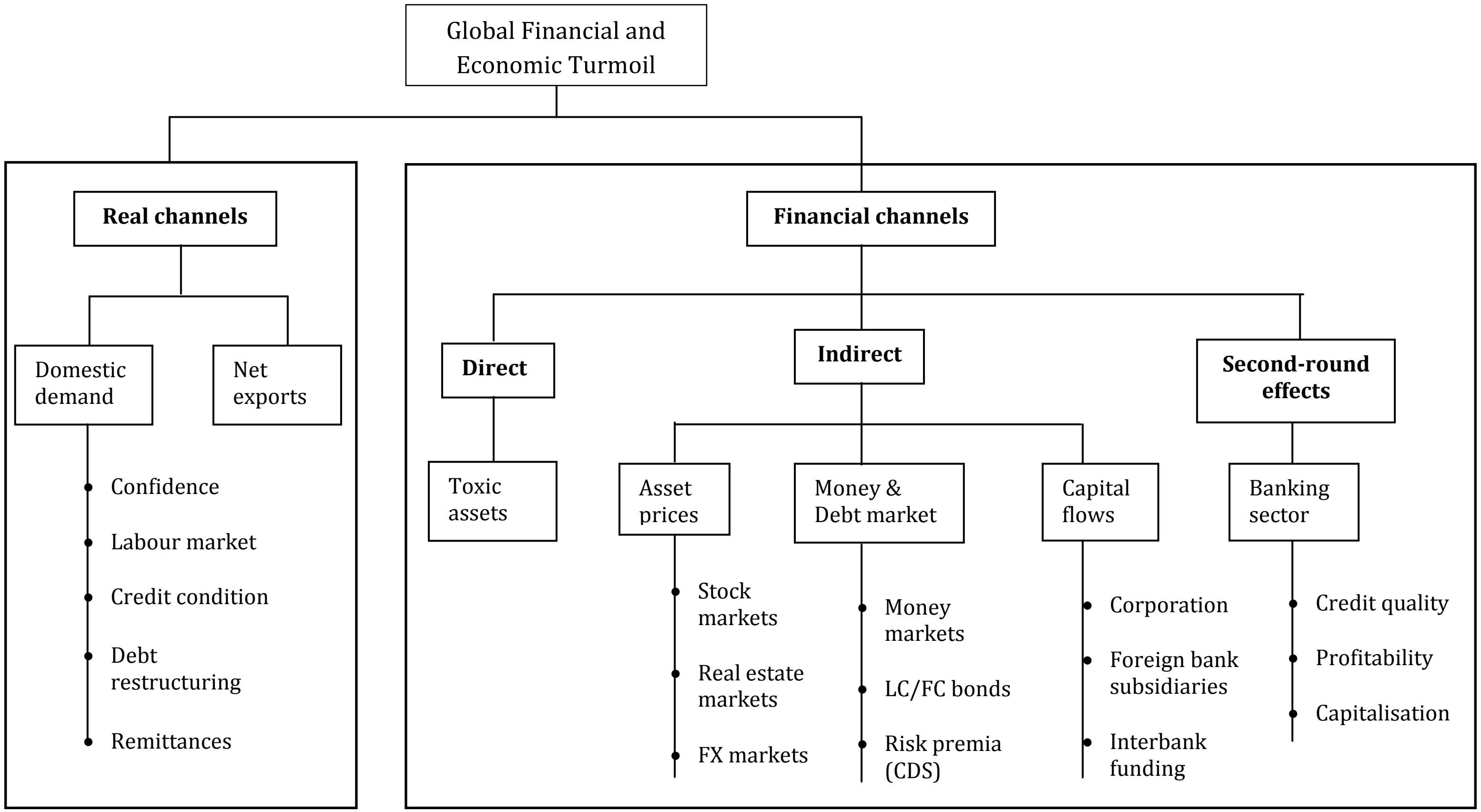
Second, this thesis attempts to argue for and provide some evidence of investor-based contagion. However, it did not conduct a detailed investigation of different groups of investors and financial intermediaries. Neither did it empirically test the particular behaviour that may cause volatility spillovers. Some of the questions remaining unanswered are: (i) what is the role of hedge funds, mutual funds and foreign exchange traders? (ii) how do they behave during a period of financial turmoil? And (iii) is investors' behaviour rational or irrational? In general, our analysis is based on the general assumption that investors' behaviour is rational. However, investors' behaviour is not always entirely discerning. Especially in stress conditions, investors sometimes behave irrationally, as they falsely assume the interdependence of fundamentals or overestimate the extent of interdependence. This may adversely affect asset prices and volatility linkages; and propagation become excessive, causing substantial disruption to global financial markets. There is a need for further research to differentiate between rational and irrational behaviour in creating the asset price transmission channel of shock propagation across countries.

Third, the empirical results show that the cross-border contagion effects on East Asian economies were significant during the 2007-2011 global financial crisis. However, the magnitude of the effects has not been totally quantified, as there may be some distortionary effects arising from aggressive policy interventions; for example, restriction on the short sales of equities, buybacks of government bonds, regional liquidity support and fiscal stimulus packages. Due to multicollinearity problems, we could not include all policy measures to control for their effects.

Lastly, we find some evidence for the potential costs associated with cross-border financial links, especially capital flow volatility and international financial contagion during financial market turmoil. However, we could not identify to what extent the costs may outweigh the benefits and the desirable cross-border financial exposures. This raises the question about the optimal form of financial integration and linkages within East Asian economies and between East Asian economies and the rest of the world. A further question that concerns the financial community is what the new global financial architecture will be after decades of financial crises and contagion. We suggest further research on this issue.

APPENDICES

Appendix 1.1 – Transmission channels of the global financial crisis to EMEs



Source: Gallego et al. (2010)

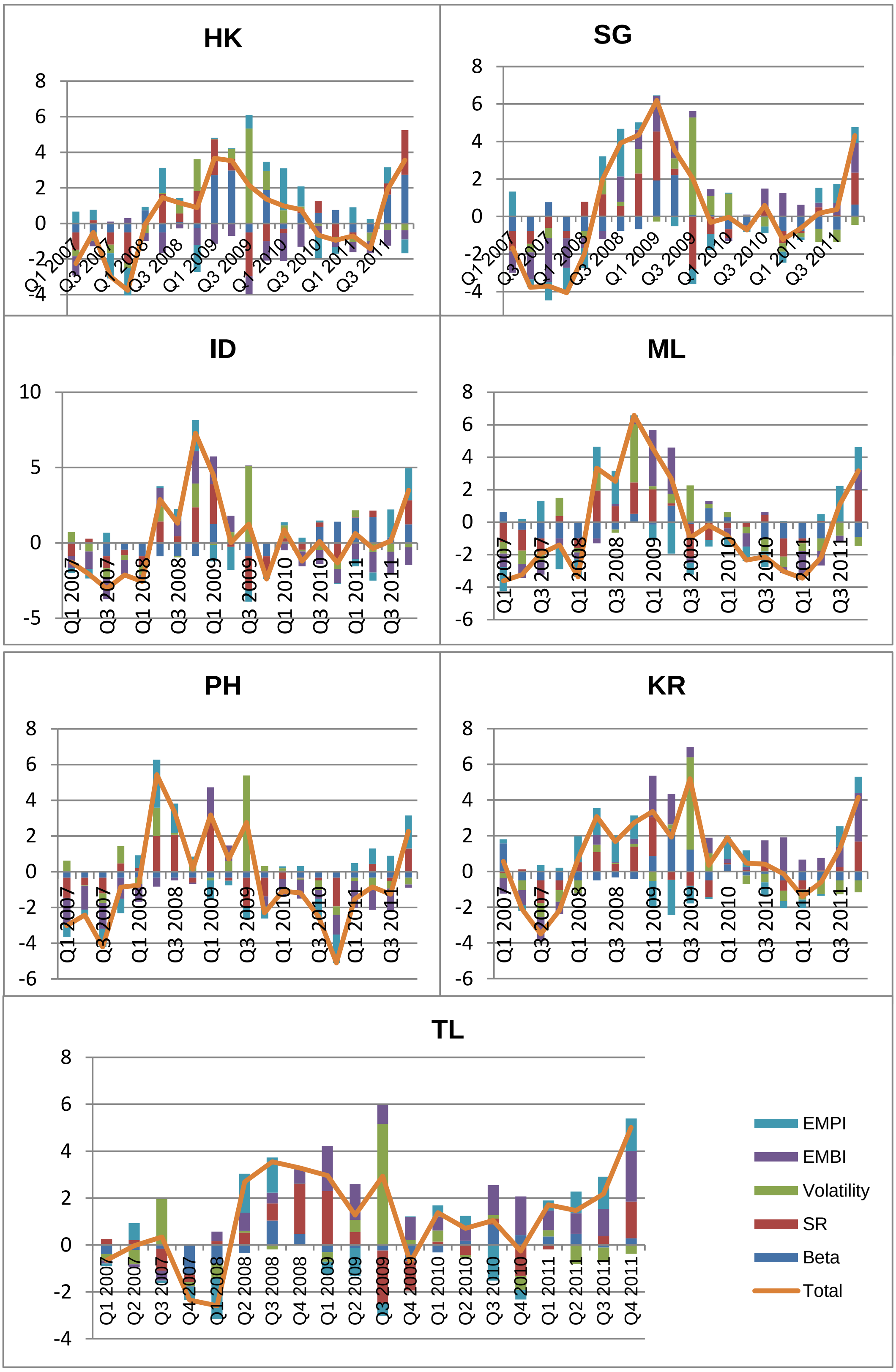
Appendix 2.1 – Some comparisons between East Asian crisis and global crisis

	Changes in GDP growth		Stock price declines		Exchange rate changes	
	Asian crisis	Global crisis	Asian crisis	Global crisis	Asian crisis	Global crisis
TL	-13.3	-13.1	-68	-56	-53	-12
ID	-23.5	-2.2	-62	-55	-83	-24
KR	-14.1	-9.9	-60	-49	-47	-37
ML	-19.6	-13.6	-72	-40	-43	-14
PH	-8.4	-7.9	-58	-51	-40	-17
SG	-13.6	-19.6	-56	-58	-19	-11
HK	-15.3	-15.1	-56	-59	-1	1
JP	-4.6	-11	-35	-58	-21	36
China	0	12	-12	-71	-3.5	-6.5
India	-1.3	-3.5	-35	-56	-20	-23
Australia	-2	-3.8	-11	-51	-23	-32
NewZealand	-4.4	-6.2	-34	-41	-32	-36

Source: Filardo et al.(2010)

Notes: Crisis period is defined over June 1997 - June 2000 for East Asian crisis and over June 2007 – March 2009 for global crisis. Change in GDP growth is calculated by the largest differences in year-on-year GDP growth rates. Stock price decline is the peak-to-trough change in the benchmark stock market index. Exchange rate change implies the maximum depreciation (-) or appreciation (+) against the US dollar.

Appendix 2.2 – Financial stress indices 2007-2011



Source: Calculated by authors basing on data from Datastream and IMF-IFS

Notes: Emerging market financial stress index (EM-FSI) was constructed following the method introduced by Balakrishnan et al. (2009). The EM-FSI comprises of five variables: banking sector beta (β), stock market returns (SR), time-varying stock market return volatility (Volatility), Sovereign debt spreads (EMBI), and an exchange market pressure index (EMPI), such that:

$$EM - FSI = \beta + SR + Volatility + EMBI + EMPI$$

(i) The banking-sector beta is the standard CAPM beta and is defined as $\beta_{i,t} = \frac{COV(R_{i,t}^{M}, R_{i,t}^{B})}{\sigma_{i,M}^{2}}$, where $R_{i,t}^{M}$ and $R_{i,t}^{B}$ represent quarterly market return and bank return. Beta is computed based on weekly data. The series takes positive value exceeding a threshold of one, and zero otherwise as beta greater than 1 indicates banking stocks move more than proportionately with the overall stock market, suggesting the banking sector is relatively risky.

(ii) Stock market return is computed as $SR = \ln\left(\frac{P_t}{P_{t-1}}\right)$ where P_t is quarterly composite stock price index. This variable is inverted, implying that a decline in stock return corresponds to increased securities market related stress.

(iii) Stock market volatility is a time-varying measure of market volatility obtained from GARCH(1,1) specification, using weekly real returns and modelled as an autoregressive process with 5 lags.

(iv) Sovereign debt spreads obtained from JPMorgan EMBI-Global spreads over the benchmark 10-year US Treasuries bond yield.

(v) The EMPI captures exchange rate depreciations and declines in international reserves and is defined for country i as follow:

$$EMPI_{i,t} = \frac{\Delta e_{i,t} - \mu_{i,\Delta e})}{\sigma_{i,\Delta e}} - \frac{\Delta RES_{i,t} - \mu_{i,\Delta RES}}{\sigma_{i,\Delta RES}}$$

where Δe and ΔRES denote the percent changes in the exchange rate and total reserves, respectively. μ and σ denote the mean and the standard deviation of the relevant series.

Observations are standardized based on the long-term average and the standard deviation of the series. The aggregation of five sub-indices into EM-FSI is based on a variance-equal weighting.

Appendix 3.1 – Covariances of stock returns for stable and crisis regimes (derived from MS-VAR estimation)

Regime 1 (Stable period)									
	TL	**ID**	**PH**	**ML**	**KR**	**SG**	**HK**	**US**	**EU**
TL	8.7280								
ID	5.0109	9.9497							
PL	4.0000	5.3606	9.8891						
ML	2.4688	3.3413	3.3083	3.4093					
KR	4.3043	4.5912	4.6473	2.9736	7.9196				
SG	3.2742	4.3492	4.1202	2.8992	4.1321	4.5725			
HK	3.1799	3.6814	3.9483	2.7522	4.3396	3.8839	5.4914		
US	1.6893	1.9291	2.3883	1.4435	2.6618	2.0485	2.2213	2.5778	
EU	3.2633	3.7780	3.9576	2.5483	4.3356	3.7500	3.7585	3.0641	6.3725
Regime 2 (Crisis period)									
	TL	**ID**	**PH**	**ML**	**KR**	**SG**	**HK**	**US**	**EU**
TL	30.5500								
ID	32.1877	53.6778							
PL	19.3950	26.3839	20.4626						
ML	14.9512	19.6651	12.3379	12.7179					
KR	36.7613	46.9336	24.4875	19.4699	67.2323				
SG	24.3640	32.5499	17.6608	15.0230	35.4388	31.0428			
HK	24.5829	34.6124	17.4767	14.5075	35.8713	28.7219	33.8674		
US	12.5080	15.6411	8.5012	8.3811	16.0054	17.0932	15.5946	19.3555	
EU	20.2399	26.1432	15.4576	14.7532	31.4827	27.1863	24.4208	21.7302	36.1277

Appendix 3.2 – Covariances of bank stock returns for stable and crisis regimes (derived from MS-VAR estimation)

Regime 1 (Stable period)									
	TL	**ID**	**PH**	**ML**	**KR**	**SG**	**HK**	**US**	**EU**
TL	13.9591								
ID	6.2248	20.4193							
PL	3.2751	5.1447	7.6390						
ML	2.2422	2.9803	2.1010	3.9618					
KR	5.5527	6.9542	4.2936	3.3840	15.2290				
SG	2.6081	3.6910	2.4784	2.4276	3.8434	4.0779			
HK	2.1922	2.6858	1.8361	1.7404	3.2248	2.3067	3.3828		
US	0.8356	1.6544	1.6515	1.1005	1.4821	1.4555	1.6180	4.6211	
EU	2.8512	3.7775	2.5953	2.2993	4.3638	3.0842	2.7383	3.3937	8.0742
Regime 2 (Crisis period)									
	TL	**ID**	**PH**	**ML**	**KR**	**SG**	**HK**	**US**	**EU**
TL	30.8767								
ID	23.1868	37.9906							
PL	17.8841	20.5265	22.5010						
ML	14.1347	15.5306	11.9759	12.7473					
KR	30.6159	35.4244	25.3420	18.5466	79.7848				
SG	22.0549	24.2476	18.9905	14.4536	34.8661	27.8447			
HK	22.5100	24.0913	18.3935	14.4708	35.6134	25.4079	32.5702		
US	18.8636	20.0078	17.1388	14.6683	34.5952	24.5065	25.9131	64.8651	
EU	27.0631	31.7839	24.3354	19.4926	46.1292	32.3037	32.0404	43.3439	64.0802

Appendix 3.3 – Covariances of FOREX for stable and crisis regimes (derived from MS-VAR estimation)

Regime 1 (Stable period)						
	TL	**ID**	**PH**	**ML**	**KR**	**SG**
TL	0.3388					
ID	0.1269	0.5668				
PH	0.0914	0.2173	0.5465			
ML	0.1128	0.2828	0.2025	0.4103		
KR	0.1510	0.3011	0.2999	0.3015	0.8543	
SG	0.1515	0.1805	0.1201	0.2196	0.2098	0.3299
Regime 2 (Crisis period)						
	TL	**ID**	**PH**	**ML**	**KR**	**SG**
TL	0.5928					
ID	0.8235	6.5301				
PH	0.3265	1.1108	1.1287			
ML	0.4533	1.2905	0.5162	0.9911		
KR	0.7601	2.4289	2.1646	1.5586	12.0589	
SG	0.4863	1.4676	0.4725	0.9859	2.0319	1.8840

Appendix 3.4 – Covariances of CDS for stable and crisis regimes (derived from MS-VAR estimation)

Regime 1 (Stable period)								
	TL	**ID**	**PH**	**ML**	**KR**	**HK**	**US**	**GR**
TL	0.0084							
ID	0.0054	0.0054						
PH	0.0054	0.0048	0.0049					
ML	0.0080	0.0057	0.0056	0.0092				
KR	0.0080	0.0056	0.0056	0.0086				
HK	0.0039	0.0032	0.0031	0.0043	0.0047	0.0095		
US	0.0036	0.0028	0.0030	0.0043	0.0045	0.0027	0.0091	
GR	0.0047	0.0034	0.0034	0.0047	0.0050	0.0029	0.0052	0.0119
Regime 2 (Crisis period)								
	TL	**ID**	**PH**	**ML**	**KR**	**HK**	**US**	**GR**
TL	0.0704							
ID	0.0332	0.0466						
PH	0.0363	0.0406	0.0409					
ML	0.0624	0.0460	0.0484	0.0715				
KR	0.0274	0.0401	0.0367	0.0458	0.0460			
HK	0.0068	0.0144	0.0113	0.0116	0.0125	0.1608		
US	0.0072	-0.0049	-0.0029	-0.0018	-0.0129	-0.0179	0.7463	
GR	0.0313	0.0237	0.0221	0.0319	0.0166	0.0190	0.0021	0.0427

Appendix 3.5 – Unconditional correlation tests (Dungey et al., 2004) for stock returns

	TL	ID	PH	ML	KR	SG	HK
Constant	-0.056	0.081*	0.033	0.036	0.065	0.025	-0.030
	(0.048)	(0.047)	(0.044)	(0.044)	(0.055)	(0.035)	(0.042)
α_1	0.226**	0.011	-0.183*	-0.116	-0.302**	0.004	-0.032
	(0.109)	(0.107)	(0.100)	(0.099)	(0.125)	(0.081)	(0.096)
β_{TL}		0.224***	0.065	-0.008	0.161**	0.035	0.032
		(0.054)	(0.053)	(0.051)	(0.064)	(0.041)	(0.049)
β_{ID}	0.275***		0.199***	0.124**	0.065	0.150***	-0.037
	(0.062)		(0.057)	(0.057)	(0.072)	(0.045)	(0.055)
β_{PH}	0.076	0.189***		0.143***	0.064	0.056	0.061
	(0.062)	(0.059)		(0.055)	(0.070)	(0.044)	(0.053)
β_{ML}	-0.012	0.149**	0.180***		0.051	0.232***	0.113*
	(0.070)	(0.067)	(0.063)		(0.079)	(0.048)	(0.060)
β_{KR}	0.225***	0.074	0.077	0.048		0.093*	0.212***
	(0.067)	(0.065)	(0.062)	(0.061)		(0.048)	(0.057)
β_{SG}	0.094	0.326***	0.128	0.418***	0.178*		0.467***
	(0.092)	(0.089)	(0.085)	(0.080)	(0.105)		(0.075)
β_{HK}	0.056	-0.052	0.091	0.133**	0.262***	0.304***	
	(0.076)	(0.073)	(0.069)	(0.067)	(0.083)	(0.050)	
β_{US}	-0.082	-0.097	0.101	0.013	0.161**	0.001	0.061
	(0.070)	(0.067)	(0.062)	(0.062)	(0.078)	(0.050)	(0.060)
β_{EU}	0.106	0.028	-0.005	0.011	0.052	0.198***	0.042
	(0.078)	(0.075)	(0.071)	(0.070)	(0.088)	(0.055)	(0.067)
θ_{TL}		-0.055	0.081	0.259**	0.424***	0.013	0.029
		(0.109)	(0.103)	(0.100)	(0.124)	(0.082)	(0.099)
θ_{ID}	-0.140		0.080	0.044	0.194	-0.078	0.315***
	(0.107)		(0.094)	(0.096)	(0.122)	(0.078)	(0.091)
θ_{PH}	0.125	0.295**		0.262**	-0.121	0.023	-0.228**
	(0.130)	(0.120)		(0.113)	(0.149)	(0.095)	(0.113)
θ_{ML}	0.229**	0.034	0.073		-0.186	-0.132	-0.159
	(0.114)	(0.110)	(0.101)		(0.131)	(0.081)	(0.099)
θ_{KR}	-0.027	0.036	-0.091	-0.101		-0.010	-0.112
	(0.086)	(0.085)	(0.081)	(0.080)		(0.064)	(0.075)
θ_{SG}	-0.042	-0.229*	-0.067	-0.296**	0.084		0.153
	(0.139)	(0.132)	(0.126)	(0.121)	(0.156)		(0.105)
θ_{HK}	-0.006	0.335***	-0.189*	-0.176*	-0.026	0.167**	
	(0.117)	(0.110)	(0.106)	(0.104)	(0.130)	(0.074)	
θ_{US}	0.199**	0.114	-0.190**	-0.083	-0.476***	0.095	0.008
	(0.095)	(0.092)	(0.086)	(0.085)	(0.099)	(0.068)	(0.082)
θ_{EU}	-0.244**	-0.210	0.111	0.189*	0.304**	0.029	-0.098

	(0.115)	(0.111)	(0.105)	(0.103)	(0.126)	(0.081)	(0.100)
R2	0.571	0.690	0.580	0.674	0.701	0.848	0.774
F-Statistic	31.295	52.471	32.494	48.583	55.122	131.673	80.498
p-value	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
DW Stat	2.13	2.14	2.16	1.83	2.31	2.28	1.98

Notes: *, ** and *** denote significance at 1%, 5%, and 10% levels, respectively.

Appendix 3.6 – Unconditional correlation tests (Dungey et al., 2004) for bank stock returns

	TL	ID	PH	ML	KR	SG	HK
Constant	-0.014	0.036	0.089	0.076	-0.016	0.104**	-0.031
	(0.059)	(0.056)	(0.059)	(0.056)	(0.071)	(0.052)	(0.070)
α_1	0.030	0.039	-0.112	-0.078	0.014	-0.186**	0.073
	(0.098)	(0.093)	(0.100)	(0.095)	(0.120)	(0.088)	(0.118)
β_{TL}		0.156***	0.063	0.035	0.150**	0.056	0.032
		(0.058)	(0.063)	(0.060)	(0.074)	(0.056)	(0.074)
β_{ID}	0.164***		0.231***	0.029	0.123	0.055	0.027
	(0.063)		(0.062)	(0.061)	(0.076)	(0.057)	(0.076)
β_{PH}	0.071	0.248***		0.101	0.129*	0.082	0.023
	(0.066)	(0.061)		(0.063)	(0.079)	(0.059)	(0.079)
β_{ML}	0.047	0.037	0.120*		0.111	0.296***	0.091
	(0.072)	(0.068)	(0.072)		(0.087)	(0.061)	(0.085)
β_{KR}	0.183***	0.142**	0.140**	0.100		0.068	0.138*
	(0.067)	(0.064)	(0.069)	(0.066)		(0.062)	(0.081)
β_{SG}	0.102	0.095	0.132	0.399***	0.101		0.342***
	(0.083)	(0.079)	(0.084)	(0.075)	(0.101)		(0.095)
β_{HK}	0.045	0.037	0.028	0.095	0.160*	0.267***	
	(0.074)	(0.070)	(0.075)	(0.071)	(0.089)	(0.063)	
β_{US}	-0.038	-0.001	0.116*	0.027	-0.117	-0.017	0.145*
	(0.068)	(0.064)	(0.068)	(0.065)	(0.082)	(0.061)	(0.080)
β_{EU}	0.055	0.033	-0.033	0.042	0.141	0.201***	0.149*
	(0.077)	(0.073)	(0.078)	(0.074)	(0.093)	(0.068)	(0.091)
θ_{TL}		-0.044	0.045	0.165*	-0.040	0.084	0.239*
		(0.098)	(0.105)	(0.099)	(0.126)	(0.093)	(0.123)
θ_{ID}	-0.027		0.011	0.235**	0.124	0.088	0.126
	(0.111)		(0.111)	(0.106)	(0.135)	(0.101)	(0.134)
θ_{PH}	0.014	-0.093		0.118	-0.111	0.151*	-0.037
	(0.099)	(0.092)		(0.094)	(0.120)	(0.088)	(0.118)
θ_{ML}	0.111	0.133	0.101		-0.217*	-0.128	0.015
	(0.103)	(0.097)	(0.103)		(0.125)	(0.090)	(0.123)
θ_{KR}	-0.141*	-0.066	-0.131	-0.151*		0.081	0.029
	(0.085)	(0.080)	(0.086)	(0.082)		(0.076)	(0.101)
θ_{SG}	0.006	-0.004	0.097	-0.235**	0.206		0.254**
	(0.111)	(0.105)	(0.111)	(0.103)	(0.134)		(0.124)
θ_{HK}	0.054	0.008	-0.035	-0.046	0.003	0.015	
	(0.089)	(0.085)	(0.091)	(0.086)	(0.107)	(0.076)	
θ_{US}	0.026	-0.062	-0.146**	-0.013	0.131	0.051	-0.069
	(0.073)	(0.069)	(0.074)	(0.071)	(0.089)	(0.066)	(0.087)
θ_{EU}	-0.042	0.024	0.095	0.002	-0.028	-0.088	-0.133
	(0.091)	(0.086)	(0.923)	(0.087)	(0.109)	(0.081)	(0.108)
R2	0.432	0.468	0.527	0.562	0.535	0.778	0.706
F-Statistic	17.889	20.698	26.19	32.482	27.019	82.655	56.552
p-value	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]

DW Stat	2.17	2.39	2.27	1.88	2.34	2.22	1.97

Notes: *, ** and *** denote significance at 1%, 5%, and 10% levels, respectively

Appendix 3.7 – Unconditional correlation tests (Dungey et al., 2004) for FOREX

	TL	ID	PH	ML	KR	SG
Constant	-0.436	-0.357	-0.375	0.033	-0.550	0.368
	(0.406)	(0.612)	(0.380)	(0.327)	(0.703)	(0.450)
α_1	-0.120	-0.503**	0.432***	0.236*	-0.482*	0.113
	(0.163)	(0.247)	(0.151)	(0.131)	(0.283)	(0.182)
β_{TL}		0.055	0.053	0.023	0.155	0.229***
		(0.093)	(0.057)	(0.049)	(0.104)	(0.065)
β_{ID}	0.065		0.168***	0.242***	0.091	0.120**
	(0.063)		(0.059)	(0.048)	(0.109)	(0.070)
β_{PH}	0.063	0.202**		0.134**	0.272**	-0.029
	(0.066)	(0.099)		(0.052)	(0.111)	(0.073)
β_{ML}	0.040	0.385	0.197		0.375***	0.405***
	(0.079)	(0.115)	(0.074)		(0.131)	(0.082)
β_{KR}	0.176***	0.067	0.262***	0.262***		-0.036
	(0.064)	(0.099)	(0.059)	(0.050)		(0.072)
β_{SG}	0.300***	0.154	-0.034***	0.309***	-0.038	
	(0.067)	(0.105)	(0.065)	(0.052)	(0.121)	
θ_{TL}		0.435**	0.069	0.224**	-0.247	-0.049
		(0.186)	(0.116)	(0.097)	(0.214)	(0.136)
θ_{ID}	0.011		-0.103	-0.160***	-0.103	-0.123
	(0.076)		(0.071)	(0.059)	(0.132)	(0.084)
θ_{PH}	0.058	0.185		0.115	1.268***	-0.290**
	(0.126)	(0.189)		(0.098)	(0.197)	(0.138)
θ_{ML}	0.257*	0.255	0.093		-0.137	0.596***
	(0.139)	(0.209)	(0.130)		(0.243)	(0.136)
θ_{KR}	-0.184**	-0.067	-0.102	-0.242***		0.092
	(0.073)	(0.112)	(0.065)	(0.057)		(0.082)
θ_{SG}	-0.235**	-0.171	-0.081	0.002	0.239	
	(0.094)	(0.145)	(0.089)	(0.068)	(0.166)	
VIX(-1)	0.139	0.086	0.136	-0.011	0.136	-0.169
	(0.144)	(0.217)	(0.135)	(0.116)	(0.249)	(0.159)
TED(-1)	-0.011	0.369**	-0.288***	-0.086	0.389**	0.051
	(0.105)	(0.158)	(0.097)	(0.084)	(0.181)	(0.116)
R2	0.292	0.363	0.412	0.600	0.415	0.446
F-Statistic	11.167	15.387	18.950	40.633	19.150	21.820
p-value	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
DW Stat	1.89	1.98	2.18	2.17	2.64	2.62

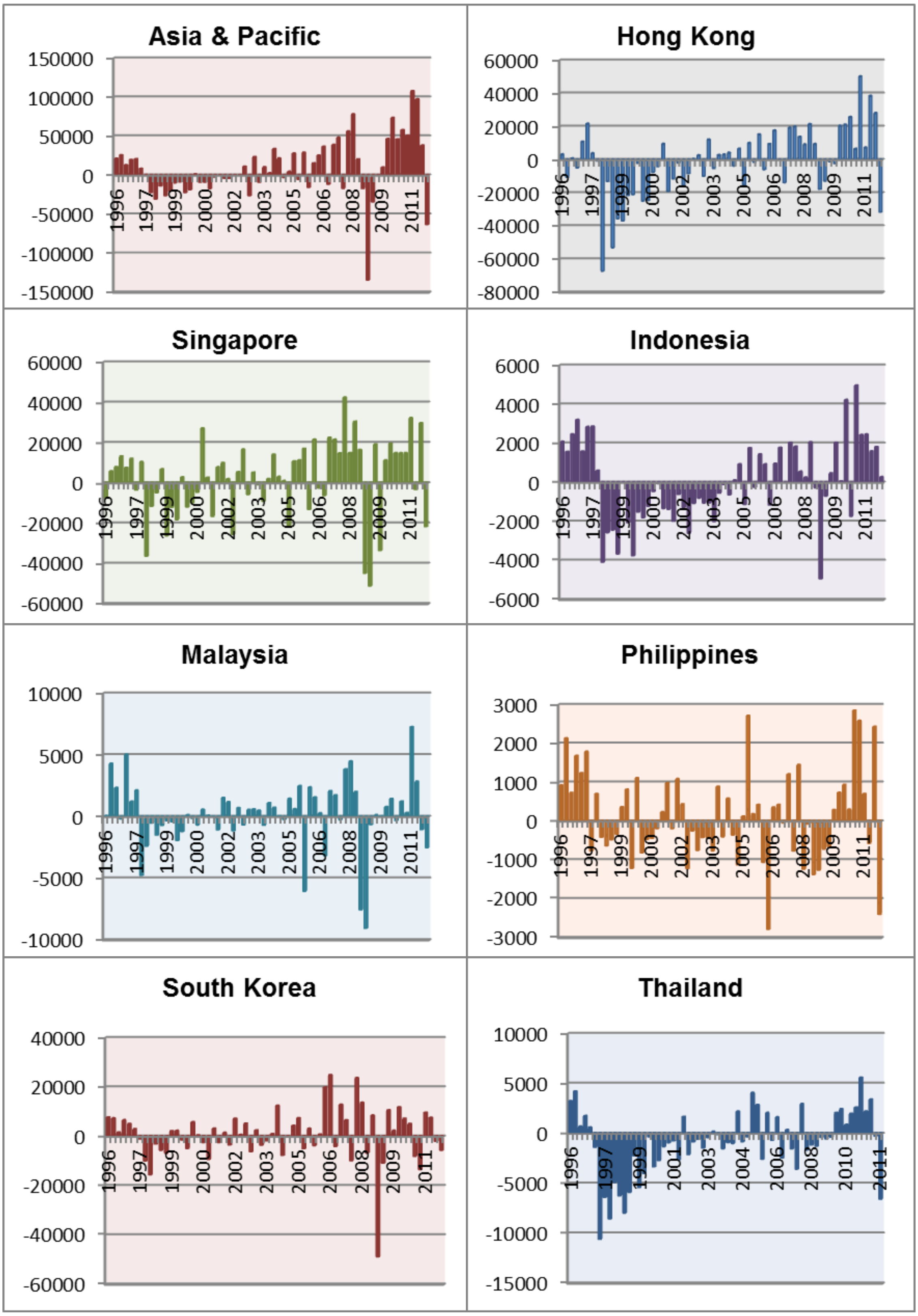
Notes: *, ** and *** denote significance at 1%, 5%, and 10% levels, respectively

Appendix 3.8 – Unconditional correlation tests (Dungey et al., 2004) for CDS

	TL	ID	PH	ML	KR	HK
Constant	0.011	-0.011	-0.020	0.004	0.001	0.002
	(0.038)	(0.034)	(0.030)	(0.026)	(0.032)	(0.137)
α_1	0.227*	-0.241**	0.113	-0.129*	0.335***	0.302
	(0.116)	(0.104)	(0.094)	(0.080)	(0.094)	(0.425)
β_{TL}		-0.024	0.117	0.384***	0.177**	
		(0.084)	(0.073)	(0.056)	(0.078)	
β_{ID}	-0.032		0.734***	0.118	-0.029	-0.236
	(0.107)		(0.051)	(0.072)	(0.091)	(0.330)
β_{PH}	0.182	0.868***		0.006	0.116	0.016
	(0.115)	(0.063)		(0.080)	(0.099)	(0.381)
β_{ML}	0.617***	0.145	0.006		0.623***	0.124
	(0.103)	(0.105)	(0.094)		(0.084)	(0.414)
β_{KR}	0.218**	-0.027	0.092	0.479***		0.077
	(0.102)	(0.093)	(0.082)	(0.059)		(0.421)
β_{HK}	-0.043	0.002	0.014	0.008	0.069**	0.466
	(0.039)	(0.036)	(0.031)	(0.027)	(0.033)	(0.363)
β_{US}	-0.065	-0.045	0.039	0.051*	0.051	0.029
	(0.045)	(0.041)	(0.036)	(0.031)	(0.038)	(0.162)
β_{GR}	0.058	0.018	0.012	-0.030	0.014	0.064
	(0.043)	(0.039)	(0.035)	(0.030)	(0.037)	(0.157)
θ_{TL}		0.513***	-0.563***	0.088	-0.738***	0.354
		(0.119)	(0.102)	(0.063)	(0.102)	(0.513)
θ_{ID}	0.581***		-0.066	-0.443***	0.597***	-0.001
	(0.146)		(0.075)	(0.097)	(0.117)	(0.564)
θ_{PH}	-0.908***	0.098		0.478***	-0.567***	0.098
	(0.163)	(0.098)		(0.103)	(0.146)	(0.650)
θ_{ML}	1.154***	-1.229***	1.108***		0.529***	-0.779
	(0.134)	(0.187)	(0.148)		(0.147)	(0.867)
θ_{KR}	-1.117***	0.836***	-0.536***	0.012		-0.148
	(0.141)	(0.131)	(0.128)	(0.087)		(0.166)
θ_{HK}	0.048	-0.002	-0.008	-0.017	-0.061	
	(0.046)	(0.041)	(0.036)	(0.031)	(0.039)	
θ_{US}	0.059	0.051	-0.042	-0.047	-0.059	-0.059
	(0.046)	(0.042)	(0.037)	(0.031)	(0.039)	(0.166)
θ_{GR}	-0.113	0.137**	-0.108*	0.103**	-0.121*	0.597**
	(0.077)	(0.068)	(0.060)	(0.052)	(0.065)	(0.270)
R2	0.892	0.914	0.931	0.994	0.895	0.139325
F-Statistic	109.38	140.79	176.80	222.728	112.08	2.126
p-value	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.01]
DW Stat	1.87	1.99	2.01	1.78	1.62	2.20

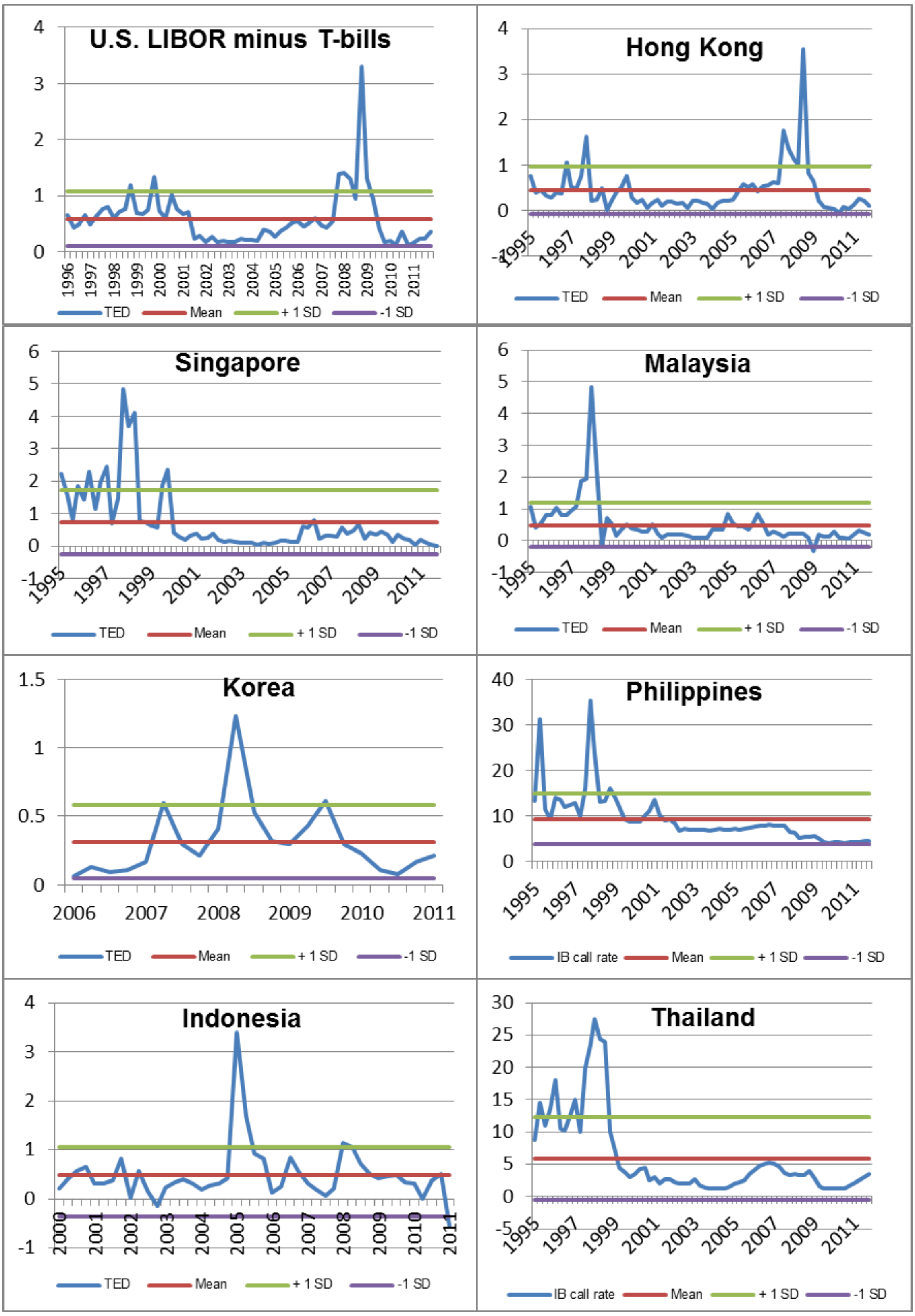
Notes: *, ** and *** denote significance at 1%, 5%, and 10% levels, respectively

Appendix 4.1 – The reversals in foreign banks' lending to East Asia



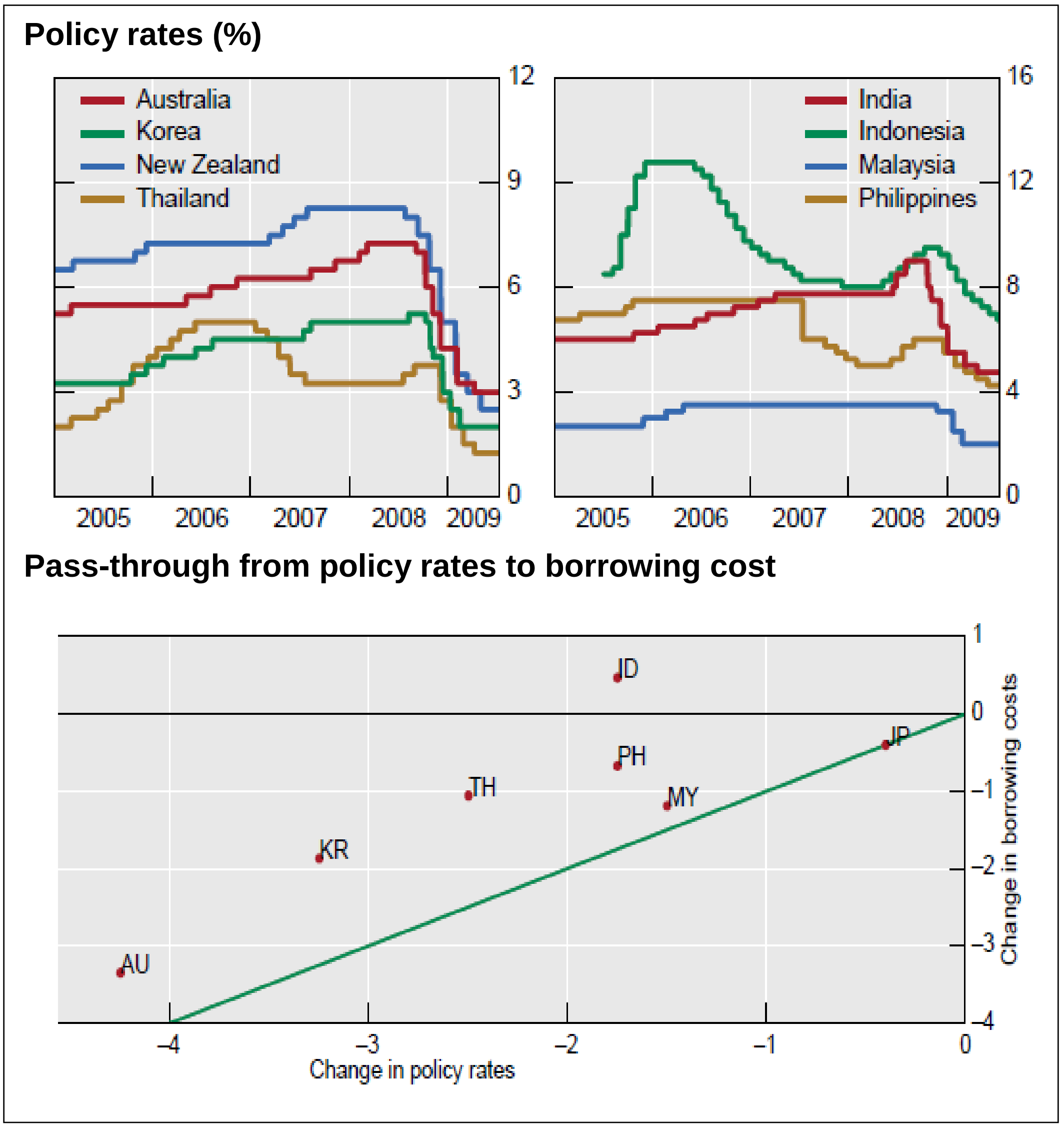
Source: BIS Locational banking statistics

Appendix 4.2 – Interbank market tensions



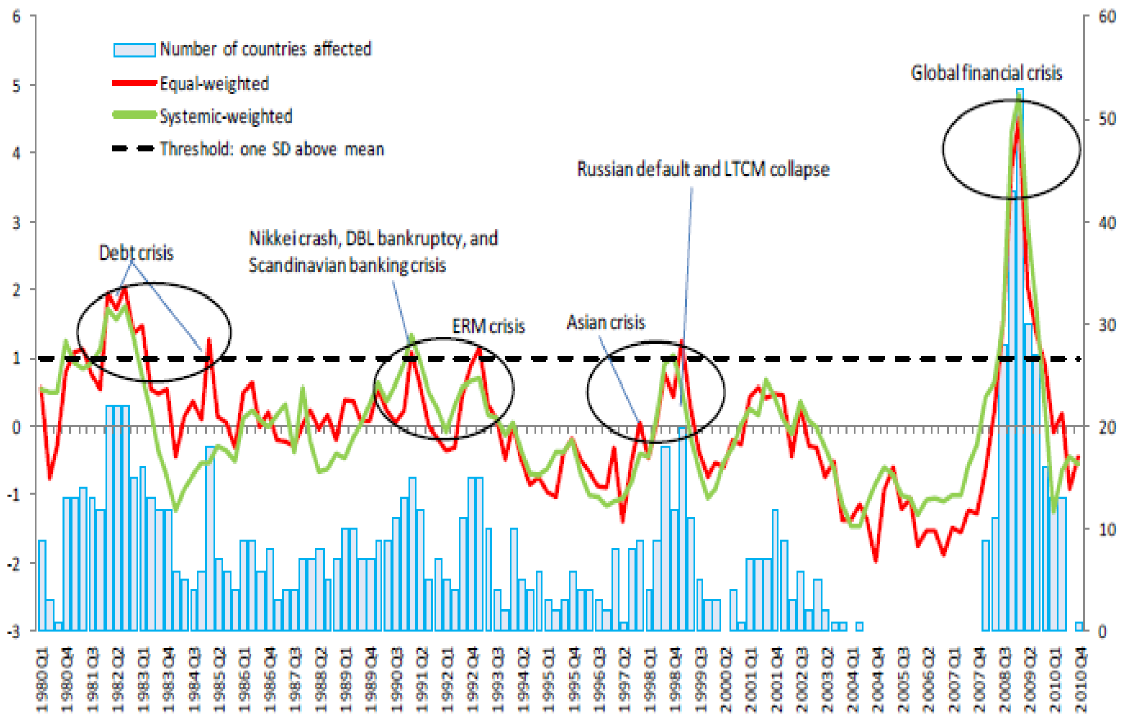
Source: Datastream

Appendix 5.1 – Pass-through from policy rate cut to borrowing cost in East Asia



Source: Filardo et al. (2009)

Appendix 6.1 – Systematic weighted and Equal-weighted Global Systematic Crisis Indicators



Source: IMF (2011).

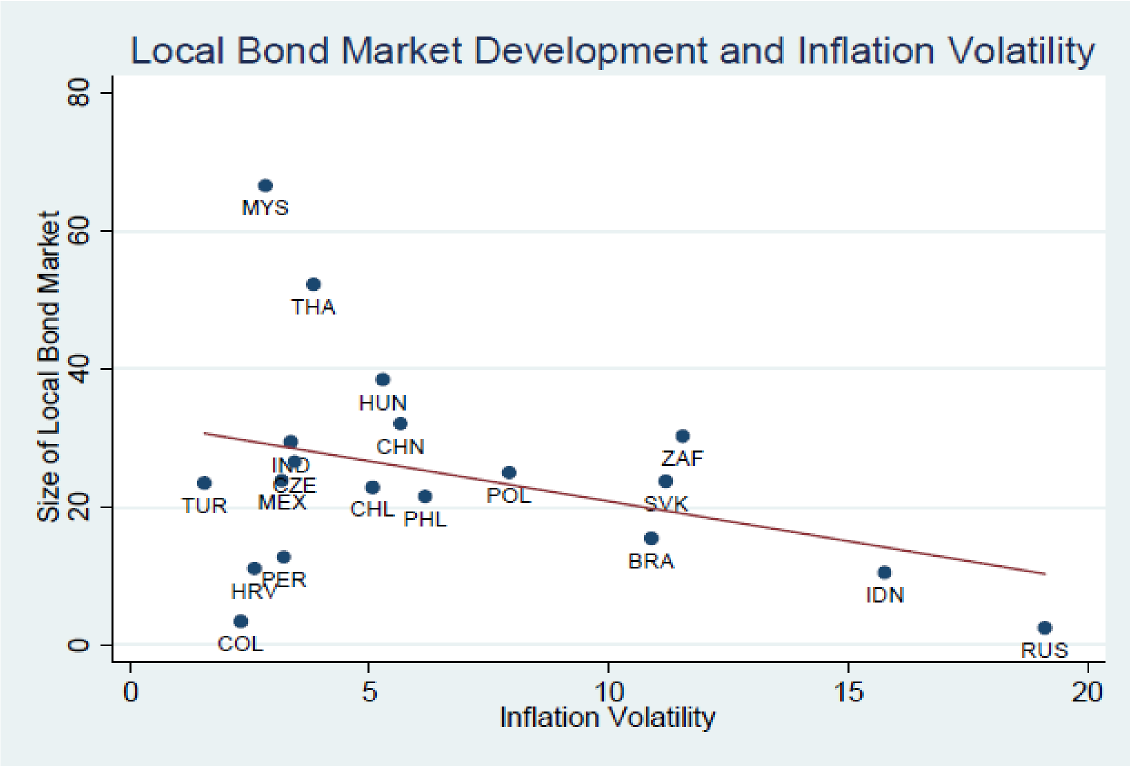
__Notes__: Systematic crisis indicator is constructed by combining and aggregating financial and real indicators at the country level. The country-level crisis indicator is a simple average of the Financial Stress Index –FSI (for AEs) or Exchange Market Pressure Index – EMPI (for EMEs) and real GDP growth. Both are normalized to ensure that both financial and real indicators carry the same weight in composite indicator. A country is considered to affect by crisis if its composite indicator is one standard deviation above mean.

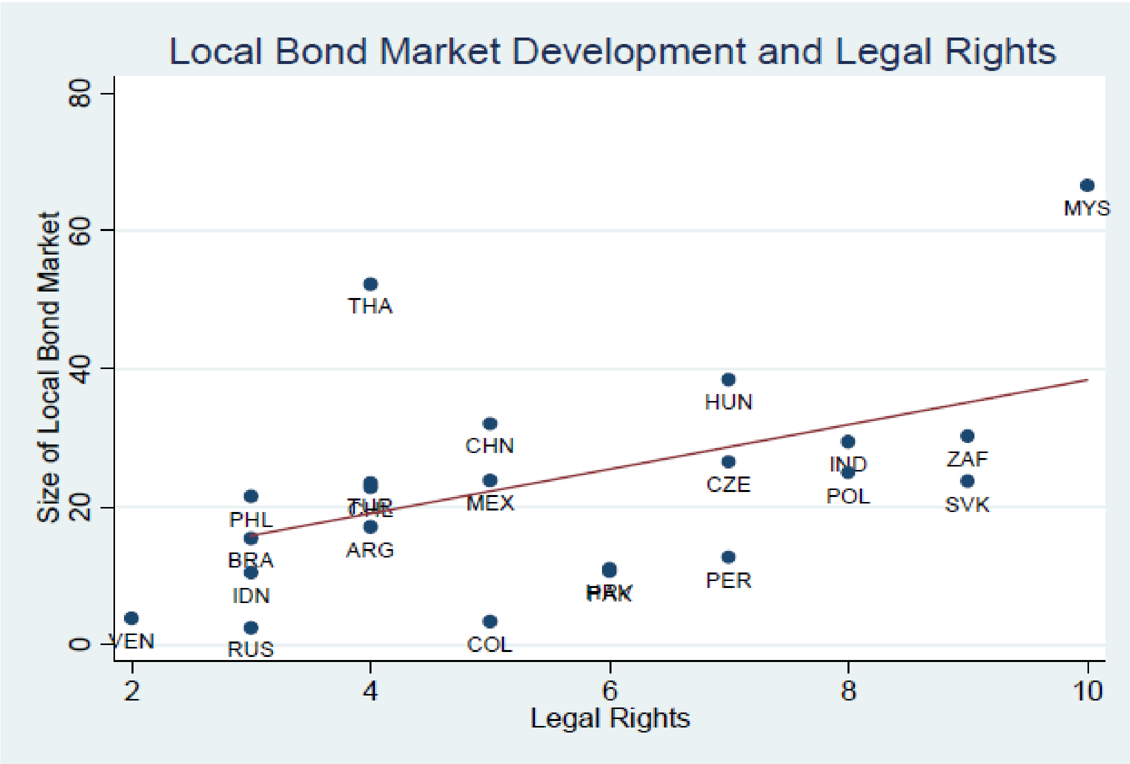
Weighting for systematic crisis indicator is applied either by "systematic importance" or by equal weights. Systematic importance focuses on countries or financial systems important for global stability[70]. The notion of "systemic" was

[70] See Integrating Assessment Under the Financial Sector Assessment Program into Article IV Surveillance, IMF Paper, August 2010 and Guidance to Assess the Systemic Importance of Financial Institutions, Markets and Instruments: Initiative Considerations, IMF/BIS/FSB, 2009

applied to construct the global economic and financial stress indices, weighting economic stress by PPP-based GDP, and financial stress by financial openness. Conversely, equal weighting countries allow the possibility that even a small country could be a centre of a systematic crisis because a shock could be rapidly transmitted from a core node of financial network from which country may be linked, as well as lead international investors to reappraise risks in similarly-situated, but not directly connected to other core nodes.

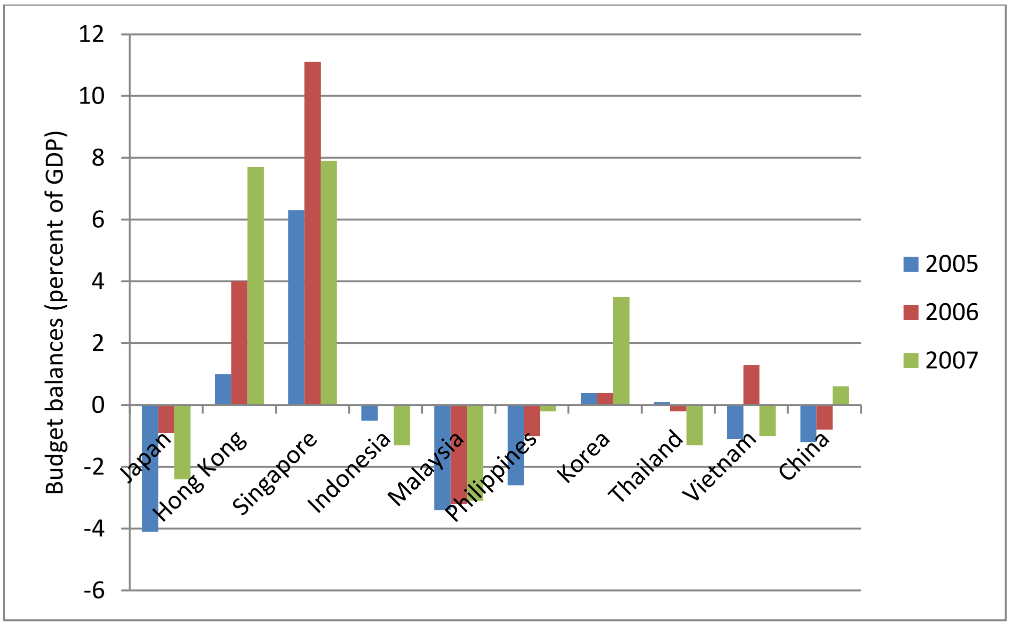
Appendix 6.2 – Determinant of Local Bond Market Development





Source: Burger et al. (2010)

Appendix 6.3 - Budget balances in East Asia



Source: ADB, Statistics for Dynamic Policy Making

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