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Asian Development Bank

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Abstract

This paper employs multivariate GARCH models with a BEKK specification to show significant shock and volatility spillovers from mature bond markets into select emerging Asian local currency bond markets. Results reveal that while the growth of individual bond markets in recent years has been impressive, the threat of financial contagion to emerging Asian bond markets from shock and volatility spillovers in mature markets is real. Although emerging Asian local bond market volatilities are more determined by their own respective shocks and volatilities, in some markets the direct shock and volatility spillovers remain significant. An extended analysis also shows indirect spillovers within domestic asset markets and across economies. The results have important implications for the monitoring and coordination of policies, not just within national jurisdictions but also in regional and global settings, in order to maintain financial stability.

Keywords: Spillovers, contagion, sovereign bond yields and returns, conditional volatility, emerging Asian local currency bond markets, financial crisis

JEL Classification: G12, C14, E43, E62, G12, H62, H6

1. Introduction

While a double-track global economic growth pattern persists—as growth in advanced economies slows and emerging markets continue their rapid expansion—recent data clearly show emerging Asian growth has begun to decelerate.[1] Weakening external demand has hit many export-oriented economies. Corporate profits are down, industrial growth is declining or even contracting in some economies, and stock market values are drifting downward. However, in the midst of this gradual deceleration, bond markets have been resilient, with issuance and the value of bonds outstanding up, and yields down.

Total bonds outstanding in emerging Asia's debt markets now total over US$7 trillion. More encouragingly, corporate bond growth continues to outpace government bonds where markets are more developed. The share of local-currency-denominated bonds in the region's bond market continues to increase, and is higher than in either Latin America or the Eurozone (Table 1). This removes the possibility of currency mismatches, like those at the onset of the 1997/98 Asian financial crisis. It also helps reduce the region's over-reliance on banks for finance. In addition, it allows authorities to better use macroeconomic measures and monetary policy as effective countercyclical tools during global financial crises.

Table 1: Currency Denomination in Bond Markets by Broad Area (%)

	2000		2005		2010		2011[1]	
	Local Currency	Foreign Currencies	Local Currency	Foreign Currencies	Local Currency	Foreign Currencies	Local Currency	Foreign Currencies
Euro area	90.0	10.0	89.9	10.1	89.8	10.2	90.3	9.7
Japan	98.5	1.5	99.1	0.9	99.4	0.6	99.4	0.6
Latin America	46.0	54	59.9	40.1	71.2	28.8	70.8	29.2
Emerging Asia	88.4	11.6	91.2	8.8	94.2	5.8	94.3	5.7

[1] End-September 2011.
Note: Emerging Asia comprises India, Indonesia, the Republic of Korea, Malaysia and the Philippines.
Source: P. Turner (2012).

Is this the "new normal"? Is the trend cyclical or structural? While these are not easy questions to answer, one thing is clear: market uncertainty dominates. With the Eurozone still unsettled, the United States' (US) on-going budget and debt ceiling negotiations, a potential global food crisis looming, and slowing growth in major emerging markets such as the People's Republic of China (PRC) and India, risks and uncertainties are mounting. Indeed, financial market volatility has been high, both during the Lehman shock in 2008/09 and the current Eurozone debt crisis.

The focus of this study is to examine the nature and intensity of the spillover effects of the global financial crisis on local currency debt markets in emerging Asia. The results

[1] Emerging Asia comprises the People's Republic of China (PRC); Hong Kong, China; India; Indonesia; the Republic of Korea; Malaysia; the Philippines; Singapore; Thailand; and Viet Nam.

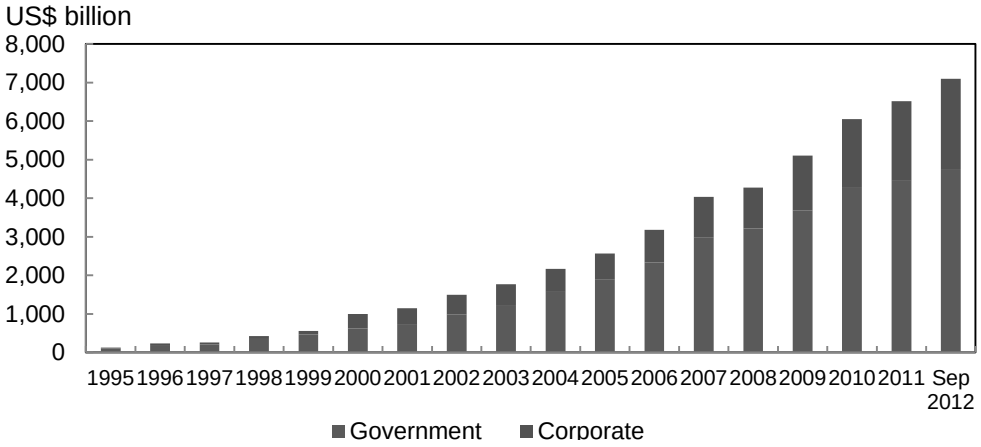
show that while debt markets are becoming more robust, volatility is on the rise. Expanding and deepening debt markets, especially corporate bond markets, can provide alternative financing with minimum risk of currency or maturity mismatches. Yet, in some countries the shock and volatility spillovers from the global financial crisis are significant, real, and need to be addressed before they create new vulnerabilities and exacerbate the on-going economic slowdown.

The first section of this paper examines the impact of crises on local debt market growth. The second looks at the impact on returns, yields, and market volatility, with several policy measures highlighted. In both sections, the analysis is descriptive. A more detailed analysis using quantitative models is conducted in the third section. The last section offers concluding remarks.

2. Crisis and the Growth of Bond Markets

Local currency bond markets in emerging Asia have grown at an annual average rate of 16.5% since 2001. By the end of 3Q12, total local currency bonds outstanding in emerging Asian markets reached US$7.1 trillion (Figure 1). At end-March 2012, emerging Asia accounted for nearly 10% of the global debt market, up from 2.4% in 1996.[2] These are encouraging developments as local bond markets are a key source of funding for both governments and domestic companies. Local banks are also turning to local bond markets to strengthen their capital bases with subordinated debt.

Figure 1: Growth of the Emerging Asian LCY Bond Market



Notes:
1. Emerging Asia includes People's Republic of China; Hong Kong, China; India; Indonesia; Republic of Korea; Malaysia; Philippines; Singapore; Thailand; and Viet Nam.
2. For India, 3Q12 data carried over from December 2011.

Source: *AsianBondsOnline*.

Deposit institutions have long been the primary source of capital in Asia, skewing the region's financial system toward banks. With expanding bond markets and their growing

[2] The Emerging Markets Bond Index (EMBI) Global gained 7.2% in 2011, making this segment the best performing asset class in fixed income worldwide.

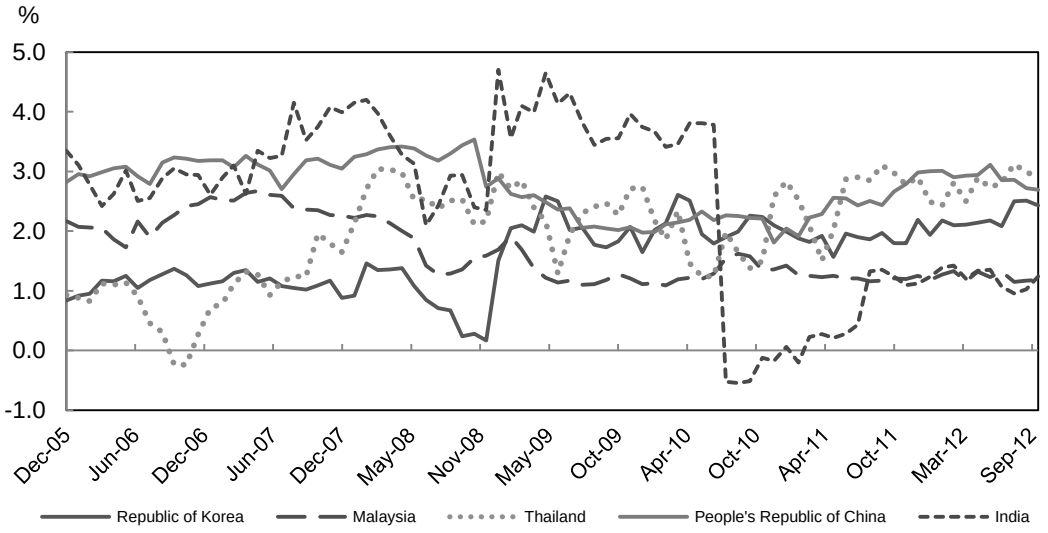
role as a "spare tire," however, the region is gradually making the transition to a more direct financing model, reducing over-reliance on bank credit. Meanwhile, corporate bond issuance has outpaced new equity offerings, despite the fact that debt sales in local markets comprise only roughly one-third of total bank lending.

Markets expanded sharply during the first half of 2009, following a significant decline in 4Q08 amid the global financial crisis (GFC). Particularly, issuance in local currency bond markets by both government and companies surged in the wake of the Lehman collapse in September 2008. Increased government issuance supported massive official stimulus programs to pump-prime affected economies. Rising capital inflows played a significant role too as the region's financial markets were considered a safe haven by investors.

A more welcome development has been the continued strong growth in corporate bond markets. From the perspective of both issuers and investors, corporate bonds are attractive. Issuers take advantage of coupon rates being below bank lending rates, while investors increasingly see this asset class as a safe heaven. This has occurred despite slowing global economic growth and investment demand in general, and widening corporate bond spreads in the wake of the GFC. The timing and factors behind this trend reflect a structural shift in local bond market development.

During the crisis, large companies tapped local bond markets to raise funds as banks turned cautious—reluctant to lend as funding conditions in global markets tightened. While large companies substituted bank loans by raising funds through bond markets, domestic borrowing costs also tilted the scale in 3avour of bond markets. Even though corporate bond spreads widened, they remained below prime lending rates in many markets (Figure 2). This allowed many firms to continue raising funds for new projects, refinance maturing liabilities, or even pre-fund some borrowing requirements.

Figure 2: Spreads between Prime Lending Rates and Corporate Bond Yields



Sources: Bloomberg LP; EDAILY BondWeb; Bank Negara Malaysia; International Monetary Fund; and ThaiBMA.

Rising capital flows reinforced the trend. Seeking shelter from the turmoil in industrial countries and chasing yields, investors piled into emerging market debt, pushing yields further down. Asian markets are now enjoying developed market borrowing costs. They are evolving from return-enhancers to buffer-providers against volatile markets.

The question is: how much volatility can these markets handle before falling prey to a downward trend? Flows into local bond markets have increased partly because investors are seeking to both diversify their portfolios away from longstanding home biases, as well as take advantage of strong economic emerging market fundamentals and potential currency appreciation. But market reactions globally have increasingly been less correlated with fundamentals. Instead, market sentiment is being influenced by factors other than macroeconomic fundamentals, making policy measures less effective.

Shocks emanating from the Lehman collapse and the Eurozone crisis led yields across emerging Asian local bond markets to spike, as market sentiment worsened and foreign funds withdrew. These shock spillovers also caused liquidity to contract and collateral asset values in many markets to fall. With uncertain conditions in industrial countries continuing—and yields at historic lows—capital flows again increased to emerging Asia, where returns remained higher. The resulting market fluctuations and volatilities complicated investor decisions and affect market sentiment. This can reduce the effectiveness of policy measures. If this situation is prolonged, the region's economies will be vulnerable to potential new shocks. For many export-oriented Asian countries, where growth has already been depressed by falling external demand, this can pose a serious problem.

While shock and volatility spillovers in local currency bond markets may be evident from the volume side, what happens to yields?

3. Crisis, Yields, and Volatility Trends

To describe yield dynamics during the GFC, the trend for 5–10 year benchmark government bond yields of selected Asian markets was compared with US Treasuries, German Bunds, European Union (EU) composite government bonds, and US and EU high-yield corporate bonds with similar maturities.[3]

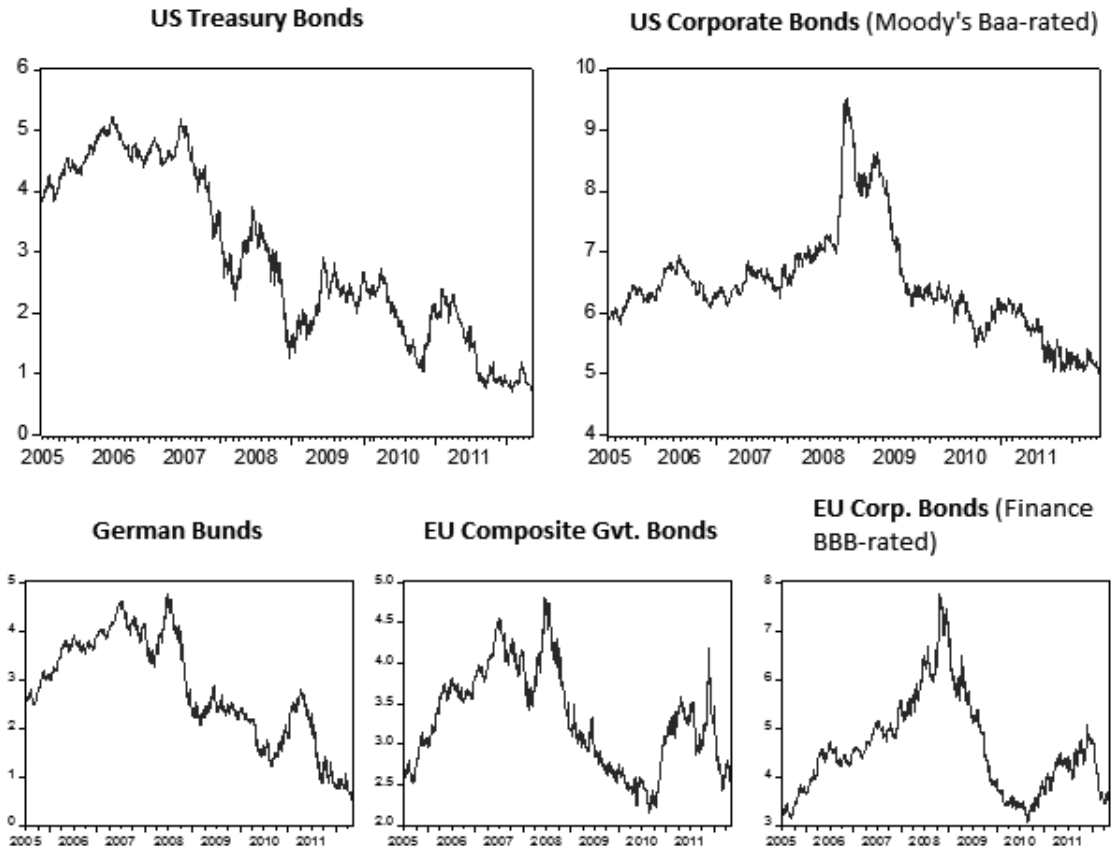
It is clear that global market turmoil following the Lehman shock in September 2008 rattled both mature and emerging market economies (Figure 3a). US and EU high-yield corporate bonds saw substantial jumps in yield during this period. The subsequent recovery was then followed by another yield spike for EU high-yield corporate bonds when the Greek situation reached a new nadir in September 2011.

Contagion from these two shocks spread toward the bond markets of emerging Asia. During the 2008/09 Lehman crisis, government bond yields in the Republic of Korea, Malaysia, and Thailand increased by as much as 2 percentage points each, while those

[3] With liquidity in local markets higher in the belly of the curve (i.e., the 3–7 year bracket), 5-year bonds for Asian debt are used. However, 10-year bond yields were used for Japan.

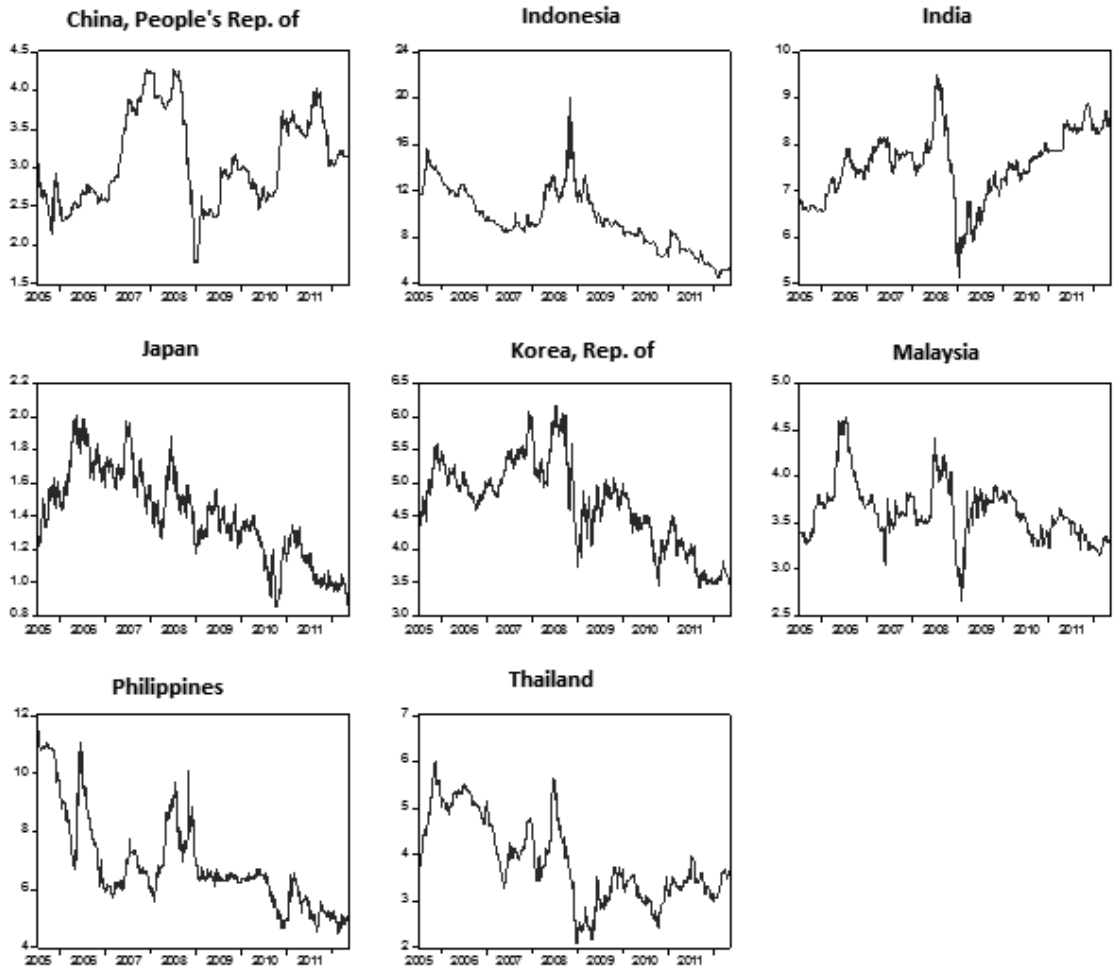
in Indonesia increased as much as 9 percentage points and in the Philippines by 4 percentage points (Figure 3b). Indonesian and Philippine benchmarks somewhat followed the yield trends of US high-yield corporates (with Indonesia's benchmark yield rising slightly more), suggesting a comparable asset categorization.

Figure 3a: Yield Trends for the EU, Germany, and the US



EU = European Union, US = United States.
Source: Bloomberg LP.

Figure 3b: Benchmark Government Bond Yields of Selected Asian Countries



Source: Bloomberg LP.

During the Lehman shock in September, Indonesia's rupiah bond market was the region's worst hit as the entire yield curve shifted upward, with rates rising to a range of between 11.3% and 13.6% along the length of the curve. Fears of a sharp economic slowdown, together with rising domestic inflation and abrupt withdrawals of foreign funds, drove down bond prices and led to a sudden evaporation of market liquidity. As market conditions became very volatile in 4Q08, Indonesian authorities cancelled all scheduled local debt auctions.

Yields on government bonds in the Republic of Korea also shot up amid a liquidity shortage in local financial markets, which was exacerbated by an increase in foreign investors' risk aversion. Authorities responded aggressively by launching stimulus packages, slashing base rates, improving liquidity by reducing issuance of central bank bonds, implementing currency swap agreements and reverse purchases, and boosting the Bank Recapitalization Fund to improve bank capital.

In the PRC, the government bond yield curve shifted upward after the September 2008 shock, with rates at the short-end jumping by more than 2 percentage points. However, a massive stimulus package, a slew of rate cuts, lowered reserve requirements, and falling consumer price inflation in February–March 2009 led to the yield curve shifting back below its pre-September 2008 level.

Indian government securities yields began to firm up in March 2008, tracking policy rates in the wake of inflationary pressures as the benchmark yield reached a peak of 9.5% in mid-July 2008. The failure of Lehman Brothers and subsequent global developments, followed by sharp reductions in policy rates, resulted in a softening of government security yields coupled with higher turnover in the secondary market.[4] However, the increased borrowing requirements of the central and state governments, on account of various countercyclical fiscal measures taken to stimulate the economy, resulted in a huge supply of government securities impacting on interest rates. The yield, which had touched a low of 5.1% on 5 January 2009, rose to 7.2% in early September 2009 amid concerns over excess supply and inflationary expectations.

The Reserve Bank of India subsequently employed a combination of measures involving monetary easing and the use of innovative debt management tools, such as synchronising the Market Stabilisation Scheme (MSS) buyback auctions and open market purchases with the government's normal market borrowings and the de-sequestering of MSS balances. By appropriately timing the increase of liquidity in the financial system to coincide with the auction of government securities, the Reserve Bank of India ensured the relatively smooth conduct of the government's market borrowing program, resulting in a decline in the cost of borrowing in 2008/09 for the first time in 5 years (Sinha 2010).

Japan faced some temporary liquidity squeeze in the interbank and corporate debt markets at the peak of the post-Lehman crisis. This put some upward pressure on funding costs. But as authorities took steps to support credit and liquidity, financial market conditions returned to normal conditions.

Thus, authorities across the region generally employed an array of both conventional and unconventional policies to revive growth and stabilize capital markets to help shield them from the shocks emerging from international financial markets during the 2008/09 crisis. Massive fiscal stimulus aimed at boosting domestic demand and investment, monetary easing and other measures to ease short-term liquidity, and curbs on speculative activities in foreign exchange markets were some of the measures used to stabilize economies and secure investor confidence.

It is important to note that fiscal stimulus in most countries did not undermine fiscal sustainability; neither did stimulus finance raise major issues for policymakers. Liquidity remained abundant in most regional bond markets as the continued strong appetite for debt from local investors substituted for reduced foreign demand. Where domestic yield curves steepened sharply and long-term liquidity dried up, some judicious shortening of

[4] The repo rate was reduced from 9.00% to 4.75% between October 2008 and April 2009 and the reverse repo rate was reduced from 6.00% to 3.25% between December 2008 and April 2009.

debt maturity profiles helped raise financing for stimulus policies while not adding substantially to rollover and interest rate risks. Government debt managers did deviate from their stated objectives, but continued their practice of publishing issuance calendars with large amounts of long-term tenors. The Philippines and Malaysia also eased mark-to-market rules on banks and financial institutions—the major holders of their respective government securities—following the relaxation of rules by the International Accounting Standards Board (IASB) and other standard setters for illiquid assets in the US.

The Philippine central bank responded to the Lehman shock with regulatory forbearance. It allowed financial institutions to reclassify investments in debt and equity securities from the "held for trading" or "available for sale" categories to either "held to maturity" or "unquoted debt securities classified as loans" (Guinigundo 2010).

The combination of orthodox and non-orthodox policies was credible in large part due to earlier policy frameworks—on regulation, debt issuance, and currency flexibility, among others—making balance sheets less vulnerable to market price shocks. Also, domestic markets remained confident that these exceptional measures were merely temporary (Turner 2012). To some degree, this lessened the upward pressure on longer-term yields as national authorities made clear that fiscal stimulus would be withdrawn as circumstances allowed. This also helped contain the yield fluctuations (volatility spillovers).

The impact of the Eurozone crisis, however, is a rather different story. As the debt crisis in Europe mounted in 2011 and 2012, Asian benchmark yields approximated their pre-September 2008 levels. The severe stress and consequent recovery from the 2008/09 crisis, plus the steady growth of local bond markets in the aftermath of the GFC, ignited a debate over whether emerging Asian debt markets were truly resilient.

The yield uptick in markets like Indonesia and the Republic of Korea has been attributed to the sudden outflow of foreign funds, reluctance of domestic institutional investors to step in to bridge the liquidity gap, and changes in market sentiment due to turmoil in global financial markets.[5] More importantly, however, volatility returned as well. Apart from the volatility of cross-border capital flows and increased deleveraging by European financial institutions, central banks and debt management authorities largely view the impact of the Eurozone debt crisis as being transmitted through heightened uncertainty and financial market (BNM 2012).

This financial market contagion also hit the PRC, where the bond market was hurt by fears of a sharper-than-expected growth slowdown and rising market uncertainty. As a result, yields rose nearly 40 basis points (bps) at the short-end of the curve from end-July through end-August 2012.

Despite slower economic growth, the Reserve Bank of India raised interest rates 13 times between March 2010 and November 2011 to reduce high inflation, which had remained over 10% throughout 2010. In addition to foreign investors' flight to safety in

[5] Yields on government bonds in Indonesia, Malaysia, and Thailand began to edge up in July and August 2012 on renewed uncertainty, despite the continued decline in US and German bond yields.

the latter half of 2011, India's inability to reduce inflation also discouraged foreign investment during this period (Christensen 2012).

Thus, the spillovers from the GFC and the Eurozone debt crisis, in terms of shock and volatility, into emerging Asia's bond yields are evident. The extent of these spillovers, however, remains unexplored. While one can visually compare the yield movements during the two crises, volatility clustering and leverage effects commonly observed in high frequency financial data can distort any conclusion. Moreover, the significance of movements caused by spillovers from a crisis and those caused by the persistence of own-shocks is still unknown. Yet, policy measures to address the problems may be different. The distinction between shock spillovers and volatility spillovers also needs to be made.

In examining the spillovers of a shock in one market on another, generalized autoregressive conditional heteroskedastic (GARCH) models have been used extensively. For our purpose, the first step is to use a univariate GARCH model to extract conditional variances of the shock sources (yields on 5-year US Treasuries, German Bunds, and US and EU high-yield corporate bonds) and of the impacted markets (yields on local currency government bonds in eight Asian countries).[6]

It is clear that yields on 5-year US Treasuries and German Bunds were affected by the Lehman shock in late 2008 (Figures 4a and 4b). The volatility spike for German Bunds was smaller compared with that for US Treasuries. Together with the observed downward trends, the heightened variability of yield returns for these two markets implies a flight to safety and liquidity by investors. The huge financial market stress drove down investor sentiment, making most, if not all, investors take refuge in less risky government securities in the US and Germany. In the meantime, the volatilities of US and EU high-yield corporate bond returns began to rise.

In the run-up to the Eurozone sovereign debt crisis, volatility spiked again. The region's fiscal woes only intensified financial market uncertainty, resulting in prolonged and wider yield–return variability. The EU composite bond market shows a different volatility pattern as the spikes observed during the Eurozone debt crisis are more prominent for the composite than for German Bunds. Considering that the EU composite bond contains all rated sovereigns from the Eurozone, the higher volatilities reflect the large

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[6] Volatility patterns of bond yield returns across different periods are indicated by the conditional variances obtained from a univariate AR(1) - GARCH(1, 1) process. The mean equation is an AR(1) process $y_t = \alpha_0 + \alpha_1 y_{t-1} + \varepsilon_t$ where y_t is the bond yield return.

Variances of the returns obtained from the mean equation are then modelled as a GARCH process to generate the conditional variances. The GARCH equation is represented by

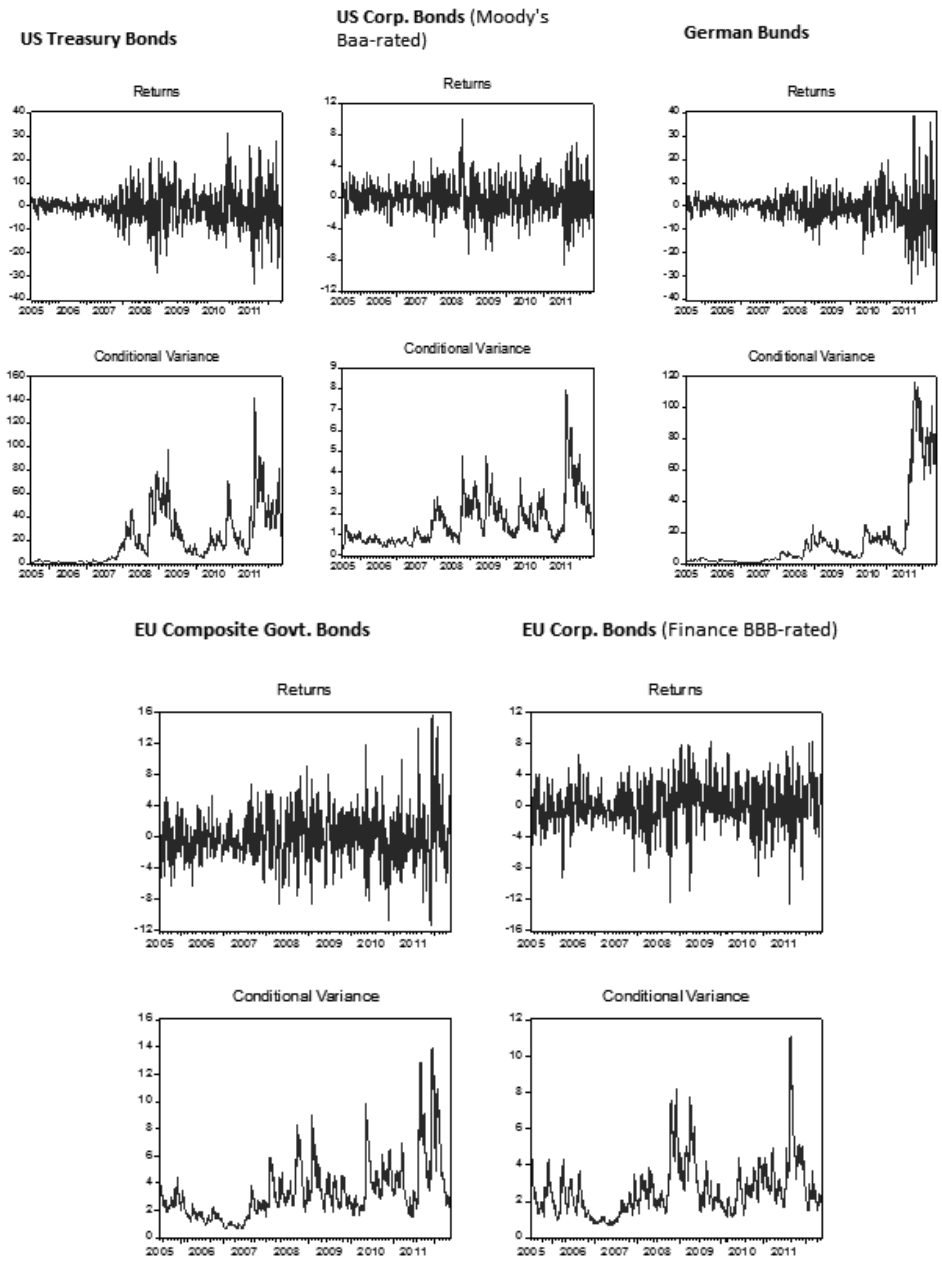
$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 \sigma_{t-1}^2,$$

where σ_t^2 is conditional variance of the time-series and ε_t^2 is squared residuals. The square of past residuals (ε_{t-1}^2) refers to the AR term and the lagged variances (σ_{t-1}^2) refer to the GARCH term.

Conditional variances are used instead of unconditional variances to address the issue of volatility clustering and leverage effect that are commonly observed in high frequency financial data.

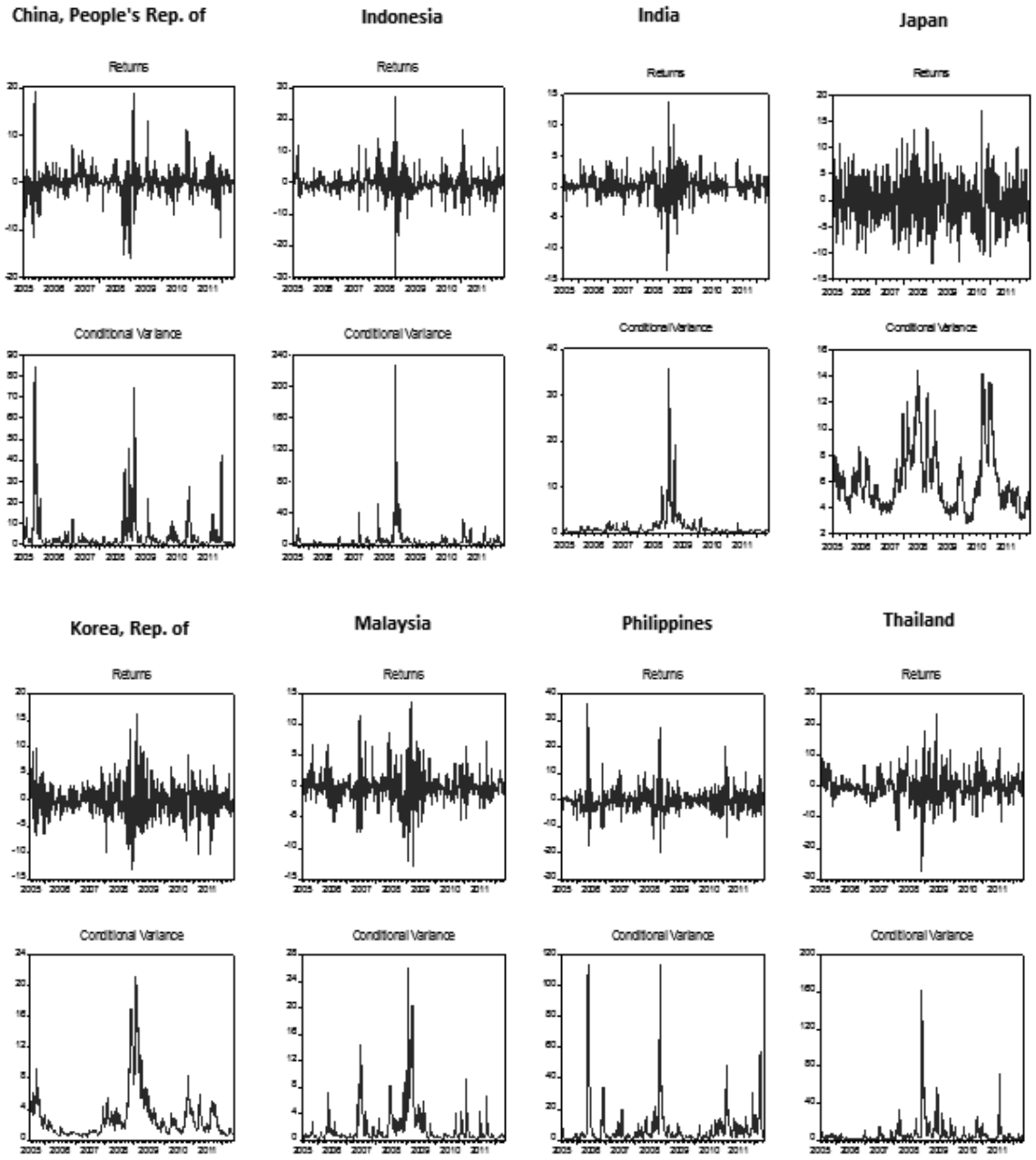
risk premiums that investors attached to Portugal, Ireland, Italy, and Spain. These heightened fluctuations spiked substantially in September 2011.

Figure 4a: Volatility Patterns of Government and Corporate Bonds—the EU, Germany, and the US



EU = European Union, US = United States.
Source: ADB's Office of Regional Economic Integration.

Figure 4b: Volatility Patterns of Government Bonds of Selected Asian Countries



Source: ADB's Office of Regional Economic Integration.

How did crises in the US and Eurozone affect Asia? Markets in selected countries showed marked spikes in volatility during the Lehman collapse and the Eurozone sovereign debt crisis. Volatilities in yield returns may not have been as sharp or persistent when compared with those of the shock sources (US Treasuries, German Bunds, and US and EU corporate securities). Nonetheless, it is clear that there remains

underlying yield volatility in Asian markets despite yields having levelled off since the end of 2008.

But how do we know if the above trends are due to spillovers or own-market persistence? Are the spillovers significant in terms of shock and volatility?

4. Measuring Shock and Volatility Spillovers and Own-Market Persistence

This section attempts to capture the shock and volatility spillover impact of the Lehman collapse and Eurozone crisis on emerging East Asian domestic debt markets.

4.1 Related Literature

With an increasingly integrated global financial system, shocks to individual asset markets are frequently affecting not only other asset markets in the same country but also markets in other countries. For example, it is often cited by market participants and policymakers that “when Wall Street sneezes, Asian markets catch the flu.”

Such spillover or contagion effects have been observed during the past several financial crisis periods in mature and developing markets, and again during the current global financial crisis that started in developed countries (Rai 2011).

The early econometric studies looked into whether asset market co-movements become stronger during crisis periods compared with tranquil periods, and investigated the direction of international spillovers (Hartmann, Straetmans, and Vries 2004).

These studies in financial market linkages investigated the interdependencies in conditional first moments, or spillovers in the conditional mean equation (e.g., Eun and Shim 1989, Koch and Koch 1991). In more recent studies, there has been considerable focus on the relationship in conditional second moments, or the international transmission of financial market volatility.

Volatility transmission could be the result of contagion, as proposed by King and Wadhwani (1990). They found evidence of an international volatility contagion effect where the correlation between market movements in different countries and general levels of volatility were positively related. An explanation put forward is that, for example, agents do not assess the economic implications of news from an overseas market for themselves and simply respond by “shooting first and asking questions later” (Shiller, Konya, and Tsutsui 1991). Other studies have couched the volatility transmission issue as a signal extraction problem, where agents in the local market have to extract from any news event that portion of the news that is relevant to their market.

Engle, Ito, and Lin (1990) examine the phenomenon of volatility clustering in foreign exchange markets, making a distinction between what they term “heat wave” and “meteor shower” effects. The former refers to volatility that is not transmitted to other

markets; the latter refers to volatility that is transferred between markets. The Engle et al. study finds more evidence for meteor shower than for heat wave behavior in the foreign exchange data in their study.

There is a large literature examining the international transmission of equity market volatility and a growing literature examining the international transmission of bond market volatility (Steeley 2006). The studies that have examined the interdependence of equity market volatility typically use the framework of GARCH time series models. Hamao et al. (1990) discovered that shocks to the volatility of financial market returns in one country could influence both the conditional volatility and the conditional mean of the returns in another country. Koutmos and Booth (1995) observed asymmetric volatility relations between the financial markets of the US, UK, and Japan, where the influence of negative shocks was different in both scale and direction to positive shocks. This kind of volatility asymmetry has become known as the "leverage effect" (Black 1976; and Christie 1982), since an increase in a firm's debt to equity ratio will lead to both an increase in the risk and required return on equity that, ceteris paribus, will reduce the value of equity. Studies by Bekaert and Wu (2000) and Brailsford and Faff (1993) are representative of the global nature of this empirical phenomenon.

The GARCH modeling framework has also been applied to analyzing volatility spillovers between equity portfolios for a single country, sorted by market capitalization. Studies by Conrad et al. (1991) and Kroner and Ng (1998) for the US equity market, and Chelley–Steeley and Steeley (1996) for the UK equity market, have found a further form of asymmetry in the transmission of volatility. While past shocks to the volatility of large firm portfolios appeared to influence the volatility of small firm portfolios, the reverse was not found to be the case. Alli et al. (1994) have applied the same technique to examine volatility spillovers between different sectors of the US oil industry.

In contrast to studies of global equity markets, analyses of the interdependence of international bond markets are relatively few in number. Ilmanen (1995) used a linear regression model to forecast the excess returns of long-term international bonds. The excess returns were found to be highly correlated, indicating considerable integration among international bond markets.

Borio and McCauley (1996) and Domanski and Kremer (2000) investigated international bond market spillovers in volatile periods. Borio and McCauley examine a number of factors that might explain the rise in volatility during the bond sell-off in 1994. They investigate four types of market dynamics: volatility persistence, relationships in the direction of market movements, foreign disinvestment, and volatility spillover effects from other markets. Borio and McCauley found that volatility persistence had strong explanatory power. They also found that capital flows contributed to a rise in bond volatility in 1994, especially for European countries that experienced a sell-off of government bonds.

Domanski and Kremer (2000) addressed the issue of how asset price linkages can be measured when they are subject to periodic changes during periods of market stress. They find that the more tranquil periods are influenced by independent country-specific shocks. During these times international price correlation tends to be lower. But strong

turbulence usually lashes global markets like a meteor shower. Asset prices in high volatility periods are driven by a common factor, the international shock and therefore a higher degree of co-movement.

Clare and Lekkos (2000) used a VAR model to measure the interaction between US, UK, and German bond markets, and found that transnational factors were more important during times of instability. Driessen et al. (2003) analyzed the bond markets of the US, Japan, and Germany using a principal components analysis. Dungey et al. (2006) studied the contagion in international bond markets during the Russian and the Long-Term Capital Management (LTCM) crises in the late 1990s. Using a latent factor model and a new data set spanning bond markets across Asia, Europe, and the Americas, they quantified the contribution of contagion to the spread of these crises. The maximum amount of contagion experienced by any of the countries investigated was about 17% of the total volatility in bond spreads, with the main effects due to the Russian crisis. The results also show that both emerging and developed markets experienced contagion during these crisis periods.

Bond markets, however, have been the setting for some of the key developments in GARCH methods, such as the ARCH-M model (Engle et al. 1987) and the Factor-ARCH model (Engle et al. 1990). ARCH methods were also used to examine the properties of certain theoretical models of the yield curve (Steeley 1990; and Chan et al. 1992). The application of these methods to the study of bond market integration has, however, been more recent (Laopodis 2002; Christiansen 2004; and Skintzi and Refenes 2005). While Laopodis (2002) and Christiansen (2004) assumed constant correlation structures, Skintzi and Refenes (2005) modeled a time-varying (parametric) correlation structure among bond market volatilities, using a model previously applied to foreign exchange by Darber and Deb (2002).

In this study, a GARCH modelling framework is used to examine the interdependence between selected Asian local currency bond markets and US and EU government and corporate bonds.

4.2 Data

All daily data are extracted from Bloomberg covering the period between June 2005 and May 2012. The time series covers from before the GFC through the on-going Eurozone sovereign debt crisis. Week-on-week return data are used and continuously compounded returns are computed as

$$r_{i,t} = log\left(\frac{y_{i,t}}{y_{i,t-5}}\right) * 100$$

Week-on-week returns are computed for benchmark 5-year government bond yields of the PRC, Indonesia, Republic of Korea, Malaysia, Philippines, and Thailand; for 5-year US Treasury bond yields; for 5-year German Bund yields; for 5-year EU composite government bond yields; for US high-yield corporate bond yields (with a Baa rating from Moody's); and for EU high-yield corporate bond yields (mainly financial sector bonds).

4.3 Methodology

GARCH models are commonly used in volatility transmission studies as they accommodate conditional variances and heteroskedastic error terms common in financial time series data. Multivariate GARCH models have been used to investigate volatility and correlation transmission, and spillover effects, in studies of contagion (Tse and Tsui 2002; and Bae, Karolyi, and Stulz 2003).

A vector autoregressive (VAR) process for week-on-week bond returns is initially estimated, given the serial correlation found in the returns time series. Results of the Schwarz information criterion have been used to determine the optimal lag-length for the VAR estimation. The conditional mean equation is represented as

$$R_t = \alpha + \sum_{k=1}^{p} \Phi_p R_{t-k} + \varepsilon_t \quad (1)$$

where R_t is an $Nx1$ vector of week-on-week returns for each of the benchmark local currency bond yields, Φ_p is a matrix of parameters, and $(\varepsilon_t|\mathrm{I}_{t-1}) \sim (0, H_t)$ is an $Nx1$ vector of random errors or innovations in each local currency bond market at time t given past information I_{t-1} (Karolyi 1995).

The diagonal elements of the matrix Φ_p measure own market lagged impacts; the off-diagonals capture the effect of lagged return in one market on the current movement in the market being observed (cross-mean spillovers).

The resulting residual vectors are modeled as multivariate GARCH, where the NxN conditional variance–covariance matrix H_t is estimated using the unrestricted version of the Baba–Engle–Kraft–Kroner (BEKK) model defined in Engle and Kroner (1995). The BEKK model has the attractive property that the conditional variance–covariance matrix is positive definite by construction. The model has the form

$$H_t = CC' + \sum_{j=1}^{q} \sum_{k=1}^{K} A'_{kj} \left(\varepsilon_{t-j} \varepsilon'_{t-j}\right) A_{kj} + \sum_{j=1}^{p} \sum_{k=1}^{K} B'_{kj} H_{t-j} B_{kj} \quad (2)$$

where A_{kj}, B_{kj}, and C are NxN parameter matrices, and C is lower triangular. The decomposition of the constant term into a product of two triangular matrices is to ensure positive definiteness of H_t. The BEKK model is covariance stationary if and only if the eigenvalues of $\sum_{j=1}^{q} \sum_{k=1}^{K} A_{kj} \otimes A_{kj} + \sum_{j=1}^{p} \sum_{k=1}^{K} B_{kj} \otimes B_{kj}$, where $\otimes$ denotes the Kronecker product of two matrices, are less than one in modulus. The summation limit K determines the generality of the process. Whenever $K > 1$, an identification problem arises because there are several parameterizations that yield the same representation of the model. Engle and Kroner (1995) give conditions for eliminating redundant, observationally equivalent representations.

With this specification, the conditional variances and covariances depend on the lagged values of all the conditional variances and covariances across bond market returns, as well as the lagged squared errors and cross-products of error terms (Brooks 2008). In this specification, C is a matrix of c_{lm} constants, A_{kj} is a parameter matrix of a_{lm}

elements indicating the extent of market shock spillovers, and B_{kj} is a parameter matrix of b_{lm} elements capturing market volatility spillovers between markets l and m.

Estimation of the BEKK model—via maximum likelihood (ML)—involves somewhat heavy computations due to several matrix inversions. The number of parameters, $(p+q)KN^2 + N(N+1)/2$, in the full BEKK model is still quite large. Obtaining convergence may therefore be difficult because log-likelihood is not linear in parameters. There is the advantage, however, that the structure automatically ensures positive definiteness of H_t, so this does not need to be imposed separately. Partly because numerical difficulties are so common in the estimation of BEKK models, it is typically assumed $p = q = K = 1$ in applications.[7]

4.3.1 Direct Spillover Model

To estimate the direct transmission between US and EU markets to local currency bond markets in Asia, bivariate GARCH models are estimated. For the impact from the Lehman collapse, the US Treasury and US corporate bond markets are used as the two main sources of shocks and spillovers. For the Eurozone crisis, perturbations in German Bunds, EU composite government bonds, and the European corporate bonds (mainly financial sector) markets are used to examine their fallout on emerging East Asia's domestic debt markets. Three time periods are defined: (i) pre-crisis period from July 2005 to August 2008, (ii) Lehman collapse period from September 2008 to March 2009, and (iii) peak of Eurozone debt crisis period from September 2011 to May 2012.

Consider the bivariate first order $(K = 1)$ BEKK model

$$H_t = CC' + A'\varepsilon_{t-1}\varepsilon'_{t-1}A + B'H_{t-1}B \tag{3}$$

Expanding this to matrix representation

$$\begin{bmatrix} h_{11,t} & h_{12,t} \\ h_{21,t} & h_{22,t} \end{bmatrix} = \begin{bmatrix} c_{11} & c_{12} \\ c_{21} & c_{22} \end{bmatrix}\begin{bmatrix} c_{11} & c_{21} \\ c_{12} & c_{22} \end{bmatrix} + \begin{bmatrix} a_{11} & a_{21} \\ a_{12} & a_{22} \end{bmatrix}\begin{bmatrix} \varepsilon_{1,t-1} \\ \varepsilon_{2,t-1} \end{bmatrix}\begin{bmatrix} \varepsilon_{1,t-1} & \varepsilon_{2,t-1} \end{bmatrix}\begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} + \begin{bmatrix} b_{11} & b_{21} \\ b_{12} & b_{22} \end{bmatrix}\begin{bmatrix} h_{11,t-1} & h_{12,t-1} \\ h_{21,t-1} & h_{22,t-1} \end{bmatrix}\begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix}$$

where $h_{12,t} = h_{21,t} = h_{cov,t}$

The representations of the main diagonal elements of the conditional variance–covariance matrix H_t would be

$$h_{11,t} = (c_{11}^2 + c_{12}^2) + \left(a_{11}^2\varepsilon_{1,t-1}^2 + 2a_{11}a_{21}\varepsilon_{1,t-1}\varepsilon_{2,t-1} + a_{21}^2\varepsilon_{2,t-1}^2\right) + \left(b_{11}^2 h_{11,t-1} + 2b_{11}b_{21}h_{cov,t-1} + b_{21}^2 h_{22,t-1}\right)$$

[7] Most financial time series volatility clustering characteristics are aptly modeled by a GARCH(1,1) process (i.e., $p = q = 1$). This implies that conditional variances and covariances depend on one period lag values of all the conditional variances and covariances across bond market returns, as well as one period lag squared errors and cross-products of error terms. Setting $K = 1$ allows mathematical tractability of the model.

$$h_{22,t} = (c_{21}^2 + c_{22}^2) + \left(a_{12}^2 \varepsilon_{1,t-1}^2 + 2a_{12}a_{22}\varepsilon_{1,t-1}\varepsilon_{2,t-1} + a_{22}^2 \varepsilon_{2,t-1}^2\right) + \left(b_{12}^2 h_{11,t-1} + 2b_{12}b_{22}h_{cov,t-1} + b_{22}^2 h_{22,t-1}\right)$$

where $h_{11,t}$ and $h_{22,t}$ are the conditional variance equations of markets $l = 1$ and $m = 2$.

The parameters of most interest to this study would be the off-diagonal elements of A and B – corresponding to the a_{lm} $(where\ l \neq m)$ elements indicating the extent of market shock spillovers, and b_{lm} $(where\ l \neq m)$ elements capturing the market volatility spillovers between markets l and m.

4.3.2 Indirect Spillover Model

We are aware that financial market interactions and spillovers during crisis periods are not limited to direct spillovers. Substantial cross-asset market transmissions and interactions can occur during times of heightened market uncertainty and stress, adding to the overall instability of the financial system.

We extended our analysis to investigate the channels through which the shocks and volatilities of source markets get transmitted to Asian local currency bond markets. The aim is to identify significant direct or indirect channels of shock and volatility propagation.

A broader view of financial market interactions, spillover, and contagion during the Lehman collapse and Eurozone debt crisis periods also necessitates the use of multivariate GARCH (MV GARCH) analysis of a group of domestic financial markets partnered with an international source market. In line with the previous estimation technique, this exercise also employs the unrestricted version of the BEKK model ($p = q = K = 1$) to estimate the $5x5$ conditional variance–covariance matrix H_t.

For the impact from the Lehman collapse, the US Treasury (**UST BM**) and US high-yield corporate (**USC BM**) bond markets are used as the two main sources of shocks and spillovers. For the Eurozone debt crisis, perturbations in the German Bund (**Ger BM**), EU composite government bond (**EUCG BM**), and European corporate bond (**EUC BM**) markets are used to examine their fallout on selected Asian asset markets.

The group of domestic markets considered are the local bond (**BM**), domestic equity (**EQM**), domestic currency (**FXM**), and domestic money (**MM**) markets.

The time periods are defined the same as above.

The emphasis is on shock and volatility spillovers, particularly in local bond markets. However, the results are rich enough to show shock and volatility persistence and spillovers within domestic markets, and from source market to domestic markets.

4.3.3 Cross-Asian-Market Spillover Model

To illustrate cross-Asian-market spillovers, we have again employed an MV GARCH analysis of a group of domestic financial markets partnered with the Japanese

government bond market. In line with the previous estimation technique, this exercise also employs the unrestricted version of the BEKK model ($p = q = K = 1$) to estimate the $5x5$ conditional variance–covariance matrix H_t.

The group of domestic markets considered are the local bond (**BM**), domestic equity (**EQM**), domestic currency (**FXM**), and domestic money (**MM**) markets.

5. Summary of Results

5.1 Direct Spillovers

By running the bivariate GARCH models, it becomes clear that while Asian government bond returns and volatilities are more determined by the dynamics of their own respective markets, the contagion from the Lehman and Eurozone crises remain significant in some countries. The shock spillovers from the Lehman collapse affected six Asian markets—the PRC, Thailand, Malaysia, Republic of Korea, India, and Philippines—whereas spillovers from the Eurozone crisis affected four markets—the PRC, Thailand, Republic of Korea, and Indonesia (Tables 2 and 3). The strongest shock spillovers during the Eurozone crisis were in the PRC. In fact, across emerging Asia the shock spillover coefficients were generally higher during the 2008/09 crisis than during the Eurozone crisis, except for the PRC.

Table 2: Shock and Volatility Spillover Coefficients (Significant at the 5% level)

Source Market/Country	Shock Spillover				Volatility Spillover			
	Lehman collapse		EU debt crisis		Lehman collapse		EU debt crisis	
	Asian Mkt.	Coefficient	Asian Mkt.	Coefficient	Asian Mkt.	Coefficient	Asian Mkt.	Coefficient
US Treasury Bond (10-year)	Malaysia	0.1013						
	Thailand	0.0523						
	PRC	0.0149						
US High-Yield Corporate Bond	Malaysia	0.4867			PRC	0.8546		
	Korea, Rep. of	0.3875						
	India	0.2541						
	Philippines	0.2021						
German Bunds (10-year)			PRC	0.0139			India	0.0007
			Thailand	0.0092				
			Indonesia	0.0053				
			Korea, Rep. of	0.0011				
EU Composite Government Bond (10-year)			PRC	0.1619			Japan	0.8064
							Korea, Rep. of	0.0869
							Thailand	0.0353
EU High-Yield Corporate Bond			PRC	0.0956			Philippines	1.9797
			Thailand	0.0426			Thailand	0.3600

Source: ADB's Office of Regional Economic Integration.

Table 3: Shock and Volatility Persistence Coefficients (Significant at the 5% level)

Source Market/Country	Own Shock Persistence				Own Volatility Persistence			
	Lehman collapse		EU debt crisis		Lehman collapse		EU debt crisis	
	Asian Mkt.	Coefficient	Asian Mkt.	Coefficient	Asian Mkt.	Coefficient	Asian Mkt.	Coefficient
US Treasury Bond (10-year)	Thailand	0.3013			Japan	0.9905		
	Indonesia	0.1384			Philippines	0.8849		
	India	0.1303			Korea, Rep. of	0.8808		
	PRC	0.1281			Indonesia	0.8416		
	Korea, Rep. of	0.0883			PRC	0.7849		
	Philippines	0.0843			India	0.7128		
					Thailand	0.6589		
					Malaysia	0.5795		
US High-Yield Corporate Bond	Thailand	0.3969			Indonesia	0.8464		
	India	0.2888			Philippines	0.8207		
	PRC	0.1352			Korea, Rep. of	0.7942		
	Indonesia	0.1343			Thailand	0.6674		
	Philippines	0.1198			Malaysia	0.6556		
	Malaysia	0.0580			PRC	0.5574		
	Korea, Rep. of	0.0480			India	0.5315		
German Bunds (10-year)			Indonesia	0.3037			Korea, Rep. of	0.8562
			Malaysia	0.1359			PRC	0.8340
			Philippines	0.0923			India	0.8159
			Korea, Rep. of	0.0880			Malaysia	0.7330
			India	0.0840			Indonesia	0.7185
			Japan	0.0821			Thailand	0.5692
			PRC	0.0638				
EU Composite Government Bond (10-year)			Indonesia	0.1694			Philippines	0.8859
			India	0.1194			Thailand	0.8331
			Malaysia	0.0846			PRC	0.8161
			Philippines	0.0633			Indonesia	0.8016
			Korea, Rep. of	0.0559			India	0.7984
			Thailand	0.0337			Malaysia	0.7455
							Korea, Rep. of	0.6476
EU High-Yield Corporate Bond			PRC	0.2155			Korea	0.8649
			Indonesia	0.2010			India	0.8373
			Malaysia	0.1535			Malaysia	0.7918
			Japan	0.0920			Indonesia	0.7606
			India	0.0799			PRC	0.6928
			Philippines	0.0653			Japan	0.5501
			Korea, Rep. of	0.0469				

Source: ADB's Office of Regional Economic Integration.

Judging from the magnitude of coefficients, during the GFC, the most significant and biggest shock spillovers came from the US high-yield corporate bond market. The most affected markets were those in the Republic of Korea, Malaysia, India, and Philippines (coefficients ranging between 0.2 and 0.5). Similarly, there were shock spillovers from EU high-yield corporates in the PRC and Thailand, and from EU composite bonds in the PRC. In terms of volatility spillovers, US corporate bond movements affected the PRC market significantly in the 2008/09 crisis, whereas during the Eurozone crisis, EU corporate (financial) bonds most significantly affected markets in the Philippines (coefficient close to 2.0) and Thailand (0.4).

This highlights the uncertainty that accompanies the transmission of spillovers from the Eurozone debt crisis into Asia's local currency bond markets. This is why Asian authorities should be aware and prepared for any possible disruptive impacts of these spillovers.

The shock and volatility persistence of own-markets was generally similar during the two crises. The own shock persistence in Thailand and the Philippines was stronger in 2008/09, with Thailand having the highest coefficient, than in 2011. In Indonesia, the Republic of Korea, and Malaysia, the effect of the Eurozone crisis was stronger, with Indonesia having the highest coefficient. In terms of own-volatility persistence, during the two crises, the results of all countries were significant, but EU corporate bonds appear to transmit significant volatility persistence only into the Republic of Korea, Malaysia, Indonesia, and PRC.

These results clearly show that prior-period shock and volatility have manifested themselves in own-market performance.[8] The persistence of prior-period volatilities are more distinct than the prior-period shock, with values for own-shock coefficients averaging 0.2 and those for own-volatility averaging 0.8, suggesting that market perception about return fluctuations is more pronounced during bouts of financial market stress.

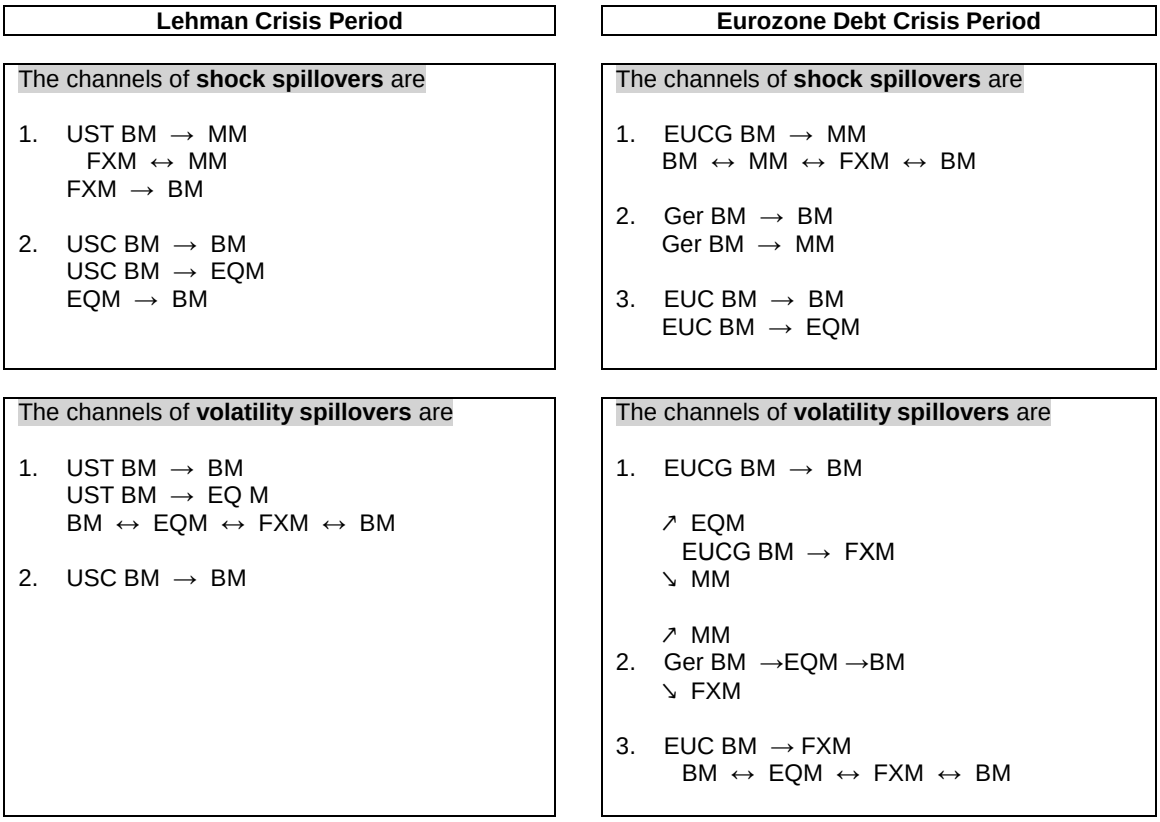
5.2 Indirect Spillovers

Figure 5 shows the significant channels of shock and volatility spillovers from sources in mature markets and across Asian financial markets as implied by our MV GARCH estimates.[9]

[8] Unlike in the preceding section, however, here the volatility clusters that tend to appear during a crisis are taken into account and are reflected in the larger coefficient.

[9] See Appendix for the table of significant shock and volatility spillover coefficient values.

Figure 5: Observed Shock and Volatility Spillovers Across Emerging Asian Financial Markets



BM = local bond market, EQM = domestic equity market, EUCG BM = European Union (EU) composite government bond market, EUC BM = European corporate bond market (mainly financial sector), FXM = domestic currency market, Ger BM = German Bund market, MM = domestic money market, USC BM = United States (US) high-yield corporate bond market, UST BM = US Treasury bond market.
Note: → shows unidirectional spillover; ↔ shows two-way market feedback and/or spillover.
Source: Authors' compilation.

- Apart from the direct shock spillovers of US and EU government bond markets into Asian local bond markets, the multivariate GARCH estimates reveal significant transmission of shock spillovers during both the US and Eurozone crisis periods into domestic money markets. During the Lehman crisis, there were significant spillovers into domestic money markets in the PRC, Indonesia, Republic of Korea, Philippines, and Thailand. During the Eurozone crisis, in addition to the PRC, Indonesia, Philippines, and Thailand, there was also a direct spillover into the Malaysian money market.

- The results highlight the liquidity crunch that occurred during the two crisis periods. During the Lehman crisis, the US and Eurozone interbank markets froze as fear engulfed market participants, creating stress in the funding and execution of capital market transactions. The liquidity crunch experienced by financial institutions in mature markets evidently had ripple effects on Asian domestic money markets.

- The shocks delivered by US and EU government bond markets to Asian domestic money markets eventually found their way to Asian foreign exchange markets and local bond markets. There was significant spillover feedback between the domestic currency and money markets.[10] Since most Asian banks have substantial holdings of local government bonds, any instability in currency and money markets translates into instability in local bond markets.

- On the other hand, the US and Eurozone corporate bond markets generated shock spillovers directly in Asian local bond markets. This validates investor perceptions that most Asian government bonds are in the same asset class as high-yielding US and EU corporate bonds. During the Lehman crisis, the US high-yield corporate debt market impacted Indonesia, the Republic of Korea, Malaysia, and the Philippines. The disturbances in the high-yield corporate market in the Eurozone in 2011/12 generated shock spillovers in the same four markets plus the PRC and Thailand.

- The US and EU corporate bond markets also generated shock spillovers in Asian domestic equity markets, which further supports the high-yield classification.

- There are significant shock spillovers from the other domestic asset markets in local bond markets. During the Lehman crisis, equity markets showed significant shock spillovers in local bond markets, particularly when taken alongside the US corporate bond market (i.e., the high-yield market). The currency market also showed significant shock effects on the bond market, particularly when the US Treasury bond market is the source.

- The US and EU government bond markets have direct volatility spillovers in Asian local bond markets. Their values are generally larger than the shock spillovers. During the Lehman crisis, there was a direct volatility spillover from US Treasuries into the markets of the PRC, Indonesia, Philippines, and Thailand. During the Eurozone crisis, in addition to the PRC, Indonesia, Republic of Korea, and Thailand, volatility in the EU composite government bond market also spilled over into Malaysia.

- During the Lehman crisis period, the US corporate bond market had significant volatility spillovers into all local bond markets included in this exercise. Moreover, there was a high degree of spillover across domestic financial markets, suggesting heightened contagion in this crisis period.

- During the Eurozone debt crisis period, the EU government bond market showed significant volatility spillovers not just into Asian local bond markets, but also into domestic equity, currency, and money markets, demonstrating the real and broader threat of financial market contagion from mature markets.

[10] To further investigate claims of tightening in the US dollar funding market at the height of the GFC, we have used the MV GARCH model to observe spillovers between US dollar Singapore Interbank Offered Rate (SIBOR) and local money markets. Results show significant shock and volatility spillovers between the two funding markets, implying that instability is transmitted across onshore and offshore money markets.

5.3 Cross-Asian-Markets Spillover

In Table 4, we illustrate the case of cross-market spillovers of perturbations in mature bond markets through the shock and volatility spillovers from the Japanese government bond (JGB) market into other regional markets.

Table 4: Shock and Volatility Spillover from the Japanese Government Bond (JGB) Market

Lehman collapse

Shock Spillover to:

BM		EQ		FX		MM	
Country	Coeff.	Country	Coeff.	Country	Coeff.	Country	Coeff.
cn	0.48364	in	0.10798			id	0.06831
ph	0.18402	kr	0.02186			in	0.11682
		ph	0.06975			my	0.04963
		th	0.03065			th	0.00030

Volatility Spillover to:

BM		EQ		FX		MM	
Country	Coeff.	Country	Coeff.	Country	Coeff.	Country	Coeff.
cn	0.12008	cn	0.79109	cn	0.00010	id	0.00852
my	0.09945	in	0.62809	kr	0.21907		
ph	0.09478	kr	0.39716	my	0.00136		
		my	0.05817	ph	0.01961		
		th	0.02364	th	0.00106		

EU sovereign debt crisis

Shock Spillover to:

BM		EQ		FX		MM	
Country	Coeff.	Country	Coeff.	Country	Coeff.	Country	Coeff.
kr	0.00782	kr	0.00857	id	0.00078	in	0.00746
th	0.00951			in	0.00603		
				kr	0.00124		

Volatility Spillover to:

BM		EQ		FX		MM	
Country	Coeff.	Country	Coeff.	Country	Coeff.	Country	Coeff.
id	0.00241	cn	0.09530	cn	0.00056	id	0.00093
kr	0.03360	th	0.15165	id	0.00716	in	0.00340
				in	0.00436	my	0.02705
				kr	0.00951		
				ph	0.00082		

BM = local bond market, cn = People's Rep. of China, EQ = domestic equity market, FX = domestic currency market, id = Indonesia, in = India, jp = Japan, kr = Rep. of Korea, MM = domestic money market, my = Malaysia, ph = Philippines, th = Thailand.
Note: Coefficients significant at 5% level.
Source: Authors' calculations.

Despite the rise in public debt, JGB yields have remained low and stable, supported by steady inflows from the household and corporate sectors, high domestic ownership of JGBs, and safe-haven flows amid heightened sovereign risks in Europe.

In the near-term, the JGB market faces domestic and external risks. Domestically, a decline in funds supplied from the corporate sector, where financial surpluses are abnormally high, could push up JGB yields. An increase in market volatility could also push banks to shorten the maturity of their JGB holdings or reduce their JGB exposure to limit losses. Given the high correlation between yields on JGBs and other sovereign debts, sudden rises in global risk premiums could spillover and affect the JGB market. All these factors could eventually contribute to a sustained rise in yields, worsen the public debt dynamics, and pose a risk to financial stability.

Over the medium-term, the market's capacity to absorb new debt is likely to diminish as the population ages and risk appetite recovers. Japan's large pool of domestic savings, stable investor base, and high share of domestic ownership of JGBs has helped maintain stability in the JGB market. But these 24eighbours factors could diminish over time as an aging population reduces household savings and risk appetite recovers.

Without a significant policy adjustment, the stock of gross public debt could exceed household financial assets in around 10 years, at which point domestic financing may become more difficult (Lam and Tokuoka 2011).

- During the Lehman collapse, the JGB market generated significant shock spillovers in Asian domestic equity and money markets, and volatility spillovers in domestic equity and currency (FX) markets.

  The liquidity crunch that ensued after the Lehman collapse diverted investor attention to assets like JGBs as a safe haven and prompted them to hold on to relatively large cash positions as protection from market turmoil and uncertainty. Results show that such movement into the JGB market apparently caused heightened volatility in money markets as investors fled equity markets.

- In the Eurozone debt crisis, the JGB market showed significant shock and volatility spillovers into domestic FX markets in Asia.

  Prior to the Eurozone debt crisis, Japan had been on a path of deflation and a strong yen. The sustained high level of government expenditures and deficits prevented a further decline in Japan's economy. Central government bonds and borrowing, plus its guaranteed debts, rose dramatically during the crisis period.

  A strong yen, deflation, and rising government debt have led to a short-term equilibrium that may not necessarily be sustainable. The Japanese government has adopted policies to offset the destabilizing effects of deflation due to a strong yen. Hence, Japan's national debt has marched upward along with the value of yen; it is expected to top JPY1,000 trillion in 2012, or the equivalent of 215% of GDP.

  The sustainability of Japan's deflationary path depends on the market's confidence in Japan's debt market. As Japanese institutions and households hold almost all of the government's debts, their faith in the government's creditworthiness is the fuel for Japan's seemingly harmless deflationary spiral.

  However, the challenges faced by Japan's major exporters and emerging trade deficits suggest a change from the current path. Considering the significant FX spillovers, any sudden transition from a strong to a weak yen would likely be a serious shock to Japan's 25eighbours in the region.[11]

[11] Many studies (Xie 2012; Ito 1999) have cited the yen's devaluation between 1995 and 1997, which was due to a correction of the excessive appreciation in previous years while also being in line with weak domestic fundamentals, as one of the factors triggering the 1997/98 Asian financial crisis.

6. Conclusion

Local currency bond markets in emerging East Asia have come a long way since the 1997/98 Asian financial crisis. During the recent GFC, these markets emerged as a key source of funding for government stimulus policies and domestic companies. But the Lehman shock in 2008 and the on-going Eurozone debt crisis have tested the resilience of these markets and demonstrated that the threat of financial contagion is real. A closer analysis shows that the direct shock and volatility spillovers from both crises into Asian markets were quite significant.

The results also reveal that shocks and volatilities from crises affecting mature debt markets are not just transmitted into Asian local bond markets, but also to other Asian domestic asset markets. The vulnerability of local bond markets is driven by the direct linkages between troubled mature markets and local bond markets in Asia, and more importantly by cross-asset market spillovers within the domestic setting.

The significant cross-market spillovers expose domestic bond markets and other local financial asset markets to contagion threats as any direct spillover into one market may channel through and ultimately find its way into other markets. The feedback and transmission of spillovers highlight the importance of coordination among domestic financial policymakers and regulators to address any market pressure and maintain financial stability. Apart from direct and indirect spillovers, there are also cross-market spillovers in the region as illustrated by spillovers from the JGB market.

The three models included in this study highlight the enormity of challenges faced by policymakers in national, regional, and global institutions. While there are several direct and indirect implications of these spillovers, some issues stand out. First, the persistence of volatility could reduce the attractiveness of this new asset class as it directly impacts investor perception of the collateral value of local currency bonds.

Second, any significant shock spillovers and spikes in volatility lead to volatile capital outflows from local markets—with a direct impact on liquidity. However, in emerging Asia, the liquidity gap from the withdrawal of foreign funds is not immediately filled by domestic investors. In most markets, the size of the domestic investor base is large but over-concentrated. This, in fact, constrains liquidity in secondary markets.

What is needed is to address the problem of a liquidity crunch during periods of market stress by promoting investor diversity and at the same increasing the supply of tradable securities (ADB 2012). Implementing this objective will involve the relaxation of rules to allow domestic institutional investors, such as insurance companies and pension funds, to buy government, quasi-sovereign, and high-quality corporate debt, and the promotion of the development of a local high-yield debt market. Some steps have been undertaken in this direction in the PRC, India, and Thailand in the last few years.

Third, the spillovers and persistence of volatility could raise borrowing costs and lead the private sector to postpone using local markets for funding for new investment.[12] From this perspective, even though the economies of emerging East Asia thus far are doing relatively better than in other parts of the world, policymakers cannot be complacent. As far as challenges in the bond market are concerned, policymakers need to take steps to improve liquidity to make local markets more resilient and supportive of productive activities in the real sector.

Fourth, the continued robust capital inflows into the region further expose markets to contagion risks. The flow of funds from global capital markets presents opportunities for growth in the real sector when properly channelled into productive investments; it also raises concerns over capital flight risks. And even with the right policies, volatile capital flows may not be preventable, especially when factors beyond domestic controls dominate. When this happens, the resulting vulnerabilities cannot be dealt with by national policies or surveillance, or a reliance on domestic safety nets alone; regional surveillance and regional financial safety nets are also required. This is where cooperation and coordination between national, regional, and global institutions for monitoring global capital flows needs to be strengthened.

Finally, as the region moves toward greater financial integration, the results of this exercise underscore the importance of strengthening national markets and building stronger safety nets. Global market volatilities get transmitted to domestic asset markets and expose the region to contagion risks. From a risk-sharing viewpoint, financial integration may be beneficial as pressures in one market can be more easily diffused into other markets. On the other hand, it heightens contagion threats since a strain in one market can be shared across the region. To better stave off pressures on the region's markets and minimize the spread of contagion, strong domestic and regional safety nets are needed.

[12] This follows Keynes' argument that while individual shareholders can liquidate their portfolios, the market as whole cannot. As a result, firms are constrained by the short-term fluctuations of asset prices due to speculative activity.

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Appendix - Indirect Spillovers

Table A: Shock Spillovers and Persistence (significant at the 5% level)

Lehman collapse

Recepient Market	Country	Source Market: BM	EQ	FX	MM	US Treasury
BM	cn		0.0897			0.0759
	id	0.1663		0.2687		
	kr		0.0439	0.1166	0.0039	
	ph	0.2708		1.5465		
	th	0.4092	0.0083	3.4587		
EQ	cn		0.3517	10.2232		0.0299
	id	0.0767	0.2217			
	kr		0.0302			
	ph	0.0226	0.2207			0.0064
	th	0.0094	0.1088	2.3164		
FX	cn	0.0001		0.1703	0.0001	
	id	0.0096	0.0492	0.0579		
	kr			0.2046		
	th	0.0009		0.1085	0.0040	0.0001
MM	cn	0.8424	0.1672	60.1780		0.0578
	id	0.0004	0.0027	0.0188	3.0717	0.0040
	kr	0.1285	0.1667		0.7429	0.0144
	ph	0.0725			0.0516	0.0446
	th	0.0001	0.0028	0.4005	11.1316	0.0014

EU sovereign debt crisis

Recepient Market	Country	Source Market: BM	EQ	FX	MM	EU composite government bond
BM	cn	0.2187	0.0135		0.0004	0.0318
	id	0.0675	0.0211	0.2591	0.0873	
	kr		0.0203		0.0489	
	my	0.2043	0.0018			
	ph	0.1304			0.0022	
	th	0.0707	0.0120			
EQ	cn					0.0084
	id	0.0039	0.0079	0.0211		
	kr		0.0923	0.2658		0.0023
	my		0.1490			
	ph		0.1395	0.1984	0.0062	
	th		0.0855	0.1687		
FX	cn	0.0003	0.0003	0.0591		
	id	0.0010	0.0018	0.1866	0.0015	0.0005
	kr	0.0004	0.0026	0.0131	0.0025	
	my		0.0097	0.1029	0.0173	
	ph	0.0006	0.0042	0.0250		0.0006
	th		0.0011	0.0630		
MM	cn			189.4008	0.0912	0.5252
	id	0.2031	0.1316	0.0388	4.0678	0.0323
	kr	0.0443			0.0706	
	my	0.0666	0.0641	0.1070	0.0323	0.0098
	ph	0.0224	0.1325	1.3572	0.1286	0.0123
	th	0.0031	0.0125	0.1149	5.0510	0.0001

Recepient Market	Country	Source Market: BM	EQ	FX	MM	German Bunds
BM	cn	0.2277		10.7284		0.0002
	id	0.1676		0.0599	0.2775	
	kr		0.0101			0.0007
	my	0.1847				0.0000
	ph	0.0375				
	th		0.0318		0.7992	0.0004
EQ	cn			5.4637		0.0002
	id	0.0208	0.0271	0.3054		
	kr		0.0462	0.6158		
	my	0.1251	0.1081		0.1037	
	ph	0.0125	0.1621		0.0031	
	th	0.0095	0.0430			
FX	cn		0.0003	0.0270	0.0000	
	id		0.0147	0.0328	0.0045	
	kr	0.0020		0.0189		
	my	0.0266	0.0511		0.0104	
	ph		0.0070			
	th	0.0031				
MM	cn	1.5956	4.0717	113.1182	0.1254	
	id	0.4800	0.0154	0.4742	1.3250	0.0002
	kr	0.0431			0.3739	
	my			0.0950	0.2687	0.0004
	ph	0.0263	0.2376	5.7405	0.1726	0.0007
	th	0.0000	0.0000		1.7978	0.0000

Recepient Market	Country	Source Market: BM	EQ	FX	MM	US Corp
BM	cn	0.0192	0.0493	22.0932	0.0227	
	id		0.1792	0.1334	0.2383	0.3183
	kr		0.0719	0.0736		0.3066
	my	0.0274			0.2732	0.3196
	ph	0.0534	0.2961		0.0093	0.0659
	th	0.0822	0.0429	12.0191	0.3489	
EQ	cn		0.0388	28.8173		0.5073
	id		0.7445		0.5255	0.3084
	kr	0.0539	0.0180	0.0612		0.2843
	my		0.0456		0.0086	0.0378
	ph	0.1764	0.0852		0.0820	
	th		0.1917	1.6150		
FX	cn	0.0000		0.5707	0.0000	0.0013
	id	0.0158	0.0284	0.2974		
	kr	0.0087		0.1890		0.0270
	my		0.0034	0.0923	0.0039	0.0022
	ph	0.0134			0.0022	
	th	0.0005		0.0186	0.0028	
MM	cn		0.4052		0.0236	
	id				0.0986	
	kr	0.0412	0.0533		0.8638	0.1765
	my	0.0580	0.1121	2.2800	2.2344	0.8813
	ph	0.2445	0.5423	1.5327	0.1682	
	th	0.0000		0.0005	4.5599	0.0012

Recepient Market	Country	Source Market: BM	EQ	FX	MM	EU corp
BM	cn	0.5181		1.6111		0.0315
	id	0.2389		0.3717		0.0181
	kr	0.0078	0.0325		0.4358	
	my	0.1769		0.0186		0.0018
	ph	0.1091		1.8479	0.0106	0.0165
	th		0.0371			0.0426
EQ	cn		0.0404	10.4054	0.0005	0.0199
	id	0.0928	0.5270	2.7579	0.1290	
	kr	0.0095	0.1327	0.4387	0.0528	0.0164
	my		0.0256			0.0020
	ph	0.0071	0.2860	0.1313		
	th		0.0556	0.0692		0.0088
FX	cn	0.0002			0.0000	
	id	0.0018	0.0150		0.0174	
	kr					0.0033
	my				0.0123	
	ph			0.0645		
	th				0.1341	
MM	cn		2.2416		0.2051	2.9383
	id	0.1021			0.3203	0.0074
	kr	0.0481			0.1783	0.0034
	my			0.1572	0.0757	0.0300
	ph	0.0818	0.0730	1.0690	0.0844	
	th	0.0000	0.0000	0.0006	1.5821	0.0000

BM = local bond market, cn = People's Rep. of China, EQ = domestic equity market, FX = domestic currency market, id = Indonesia, in = India, jp = Japan, kr = Rep. of Korea, MM = domestic money market, my = Malaysia, ph = Philippines, th = Thailand.
Source: Authors' calculations.

Table A.1: Volatility Spillovers and Persistence (Significant at the 5% level)

Lehman collapse

Recepient Market	Country	BM	EQ	FX	MM	US Treasury
BM	cn	0.2049	0.0581		0.0251	0.0104
	id	0.8642	0.2312			0.0301
	kr	0.4739	0.4852	0.1425		
	ph	0.3056			0.0114	0.0320
	th	0.6111				0.0296
EQ	cn	0.1263	0.0684	29.9823		0.0976
	id		0.0485			0.0659
	kr	0.6017	0.7370	0.6771		
	ph	0.2771		5.1957	0.0430	0.0348
	th		0.9007	4.6840		0.0073
FX	cn			0.6400	0.0000	
	id	0.0077	0.1030	0.6870		
	kr	0.1698	0.1509	1.0927		
	ph		0.0038		0.0076	
	th	0.0009	0.0037			0.0023
MM	cn	0.5049			0.3318	0.0275
	id		0.0006		0.0634	
	kr				0.4310	
	ph	0.1295	1.5485		0.4055	
	th	0.0001	0.0003	0.0018	0.0044	

EU sovereign debt crisis

Recipient Market	Country	BM	EQ	FX	MM	EU composite government bond
BM	cn		0.3137	16.7443		0.0240
	id	0.0466	0.0241	4.0671		0.0016
	kr		0.1019	0.2127	3.2675	0.0523
	my	0.7894	0.0035	0.0200	0.0053	0.0017
	ph	0.8540	0.0606		0.0027	
	th	0.5891	0.0052			0.0415
EQ	cn	0.4638	0.1322	19.4184		
	id	0.4103	0.4027		0.0359	0.0024
	kr		0.8594	0.0300	0.1894	
	my		0.1086	0.7452		0.0594
	ph		0.0432	6.5700	0.0140	0.0385
	th		0.8932	0.0379		0.0137
FX	cn	0.0015		0.1208		0.0011
	id	0.0726	0.0893	0.1589		
	kr	0.0071	0.0010	0.8832	0.0778	
	my	0.1054		0.5458		0.0012
	ph		0.0844	0.2470		0.0093
	th			0.8225		0.0030
MM	cn			156.8631	0.3689	7.4547
	id				0.0083	
	kr	0.1265	0.0264	0.0573	0.0245	0.0020
	my	0.0165				0.0150
	ph	0.0203			0.7158	0.0453
	th		0.0001			

Recipient Market	Country	BM	EQ	FX	MM	German Bunds
BM	cn	0.5360	0.0247	10.0487	0.0006	
	id	0.7053	0.0054		0.3696	
	kr	0.5149	0.1193	0.2993		0.0025
	my	0.8326				
	ph	0.8898				
	th	0.1615		7.4780		0.0025
EQ	cn	0.0808	0.0587	57.0317	0.0020	0.0012
	id		0.8929			
	kr	0.2293	0.9890			0.0002
	my		0.2812	0.1585	0.2265	0.0009
	ph		0.6959	0.7921	0.0049	
	th		0.9166			
FX	cn		0.0087		0.0000	
	id			0.8636	0.0051	
	kr	0.0283		0.9160	0.0095	0.0000
	my		0.0365	0.1146	0.0198	0.0003
	th	0.0160	0.0145			
MM	cn		3.7219	676.3852	0.4909	
	id	0.0262	0.0028		0.0203	0.0000
	my	0.0775	0.3047	2.3164	0.1416	
	ph			1.3549	0.6658	0.0003
	th		0.0000	0.0000	0.2853	

Recepient Market	Country	BM	EQ	FX	MM	US Corp
BM	cn	0.4538	0.1795	5.3379		0.2189
	id	0.3975		1.9775		1.0190
	kr	0.6173			0.0083	0.1149
	my	0.5539	0.4939	1.1450	0.1253	0.2550
	ph	0.2803		0.4188	0.0644	0.3909
	th		0.1436	54.7333	0.0171	0.6379
EQ	cn	0.4971	0.3819	32.5360	0.0806	
	kr	0.1186	0.6367	0.0504	0.0012	0.3565
	my	0.1915	0.4009		0.0199	0.0794
	ph			10.0616		
	th	0.0540	0.6036		0.0576	0.2226
FX	cn	0.0001	0.0000	0.2788	0.0000	0.0005
	id	0.0235	0.0492	0.4500		0.1028
	kr	0.0321	0.0041	0.9108	0.0005	
	my		0.0469	0.1057		0.0608
	ph	0.0049	0.0345	0.4771		0.0373
	th	0.0056	0.0012	0.0267	0.0006	0.0215
MM	cn		0.0857		0.5498	0.6732
	id				0.3648	
	kr				0.4687	
	my					0.0073
	ph	0.2699		2.7186	0.0977	3.8639
	th		0.0000		0.0247	

Recipient Market	Country	BM	EQ	FX	MM	EU corp
BM	cn	0.2880		7.6736		0.0329
	id	0.1062	0.0978	0.6723	0.1326	
	kr	0.2165		0.2669	3.4559	
	my	0.7847			0.0068	
	ph	0.6798		0.3031	0.0073	0.0222
	th	0.2057				
EQ	cn			44.1673		
	id	0.0254	0.2389		0.3135	0.2060
	kr	0.2018	0.1156	3.3536	0.6469	
	my	0.0040	0.8867		0.0126	
	ph		0.6070		0.0006	0.0133
	th	0.0202	0.8968			
FX	cn		0.0077			0.0014
	id	0.0105	0.0090	0.4777	0.1033	
	kr	0.0407	0.2263	0.0589	0.0324	
	my			0.4124	0.0982	0.0082
	ph	0.0007	0.0035	0.6481		0.0204
	th					0.0301
MM	cn			379.4810	0.6553	
	id	0.3289	0.0962		0.1054	
	kr	0.0559				0.0210
	my	0.0452	0.2771	0.9354	0.1632	
	ph	0.1018	0.0128		0.7993	
	th				0.2954	

BM = local bond market, cn = People's Rep. of China, EQ = domestic equity market, FX = domestic currency market, id = Indonesia, in = India, jp = Japan, kr = Rep. of Korea, MM = domestic money market, my = Malaysia, ph = Philippines, th = Thailand.

Source: Authors' calculations.

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