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International financial integration and price discovery in emerging markets : evidence from three working papers

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&
Price Discovery in Emerging Markets
Evidence from Three Working Papers

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International Financial Integration
&
Price Discovery in Emerging Markets
Evidence from Empirical Working Papers

by

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ABSTRACT

The theme of this research is international financial integration with particular emphasis on the integration of financial markets in the emerging markets with international markets. *A priori* one should expect that emerging markets are becoming more integrated with international markets over time. This is because many emerging markets implemented financial liberalisation programmes from the 1980s onwards. The policy choice can be explained by an expected positive relationship between the level of financial development and economic growth. Specifically, emerging market authorities have deregulated banking sectors, liberalised equity markets, and opened capital accounts.

The research is written as three working papers. The first working paper uses an event study methodology to determine whether the announcement of mergers and/or acquisitions (M&A) of ownership stakes in target banks in the emerging markets by acquiring banks from industrialised nations (international banks) generates value for bank shareholders. Returns to target bank acquiring bank shareholders as well as joint weighted abnormal returns are calculated across a sample of 74 M&A transactions involving 46 target banks over the period 1998 to 2005. The results find it is difficult to find so-called "win-win" situations where target bank and acquiring bank shareholders realise significant positive returns. Whereas target bank shareholders mostly realise a value gain, the same is not true for acquiring bank shareholders implying there is no evidence of a redistribution of wealth from emerging markets to industrialised markets. Joint returns are significantly lowered when majority control is acquired, and when large target banks are acquired. Joint return significantly increases when international banks acquire minority control in emerging market banks.

The second working paper employs a multivariate asymmetric BEKK GARCH model to jointly estimate the conditional mean and conditional variance of FX returns for the Japanese yen, Swiss franc and British pound *vis-à-vis* the US dollar from 1975 to 2005. US macroeconomic news announcements are significant in the FX price discovery process with larger increases in consumer prices and short-term interest rates positively affecting spot returns. These relationships are not observed when the US is in recession. Currency depreciation affects the variance of spot returns (but not always in the same direction) and the effects are larger when the US economy is in recession. Shocks in "home" markets are more important in explaining the variance of returns though there is evidence of cross-border volatility transmission. News effects are persistent for at least one day. The dynamics of FX volatility show that conditional volatility, covariance and correlation coefficients between FX returns are time varying with clearly visible patterns.

The GARCH methodology is used to jointly estimate conditional price discovery and volatility transmission processes in the BRIC countries in the third working paper. Asset prices are fairly predictable with lagged currency movements and local stockmarkets movements significant. The research establishes the importance of US macroeconomic fundamentals in pricing assets in emerging markets. Whilst spillover effects are observed between markets, the variance of asset price returns is more responsive to own market news. The conditional variance of FX returns is lower than local stock market returns, and is responsive to episodes of financial crisis and changes in exchange rate regime. Conditional covariances and correlations are time-varying. On average, correlations tend to be fairly small in magnitude suggesting the integration process is far from complete, but this is good news for investors wishing to internationally diversify risk.

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LIST OF ABBREVIATION & STATISTICAL GLOSSARY

1. **AR= Autoregressive Errors**
2. **ARCH= Autoregressive Conditional Heteroscedasticity**
3. **Autocorrelation= a mathematical tool used frequently in signal processing for analysing functions or series of values, such as time domain signals.**
4. **BEKK GARCH= Baba Engle, Kroner, Kraft, Generalised Autoregressive Conditionally Heteroskedasticity**
5. **BRICs=Brazil, Russia, Indian, China countries**
6. **CEEs=Central East Europe**
7. **CBMA=Cross-Border Merger and Acqusistions**
8. **EME=Emerging Market economy**
9. **Endogenous variables= an endogenous variable is a variable that appears as a dependent variable in at least one equation in a structural model. In a path diagram, endogenous variables can be recognized by the fact that they have at least one arrow pointing to them.**
10. **Exogenous variables= an exogenous variable is a variable that never appears as a dependent variable in any equation in a structural model. In a path diagram, exogenous variables can be recognized by the fact that they have no arrows pointing to them.**
11. **Heteroskedasticity=a sequence or a vector of means of error are randomness distributed. In statistics, when the standard deviations of a variable, monitored over a specific amount of time, are non-constant.**
12. **Homoscedasticity=the complement of Heteroskedasticity, a sequence or a vector of random variables is Homoscedasticity if all random variables in the sequence or vector have the same finite variance. This is also known as homogeneity of variance.**
13. **Volatility: can either be measured by using the standard deviation or variance between returns from that same security or market index. Commonly, the higher the volatility, the riskier the security. How volatility is measured will affect the value of the coefficient used, i.e estimate volatility transmission from GARCH(1.1), by conditional mean, variance, covariance, and correlations.**

PART I: OVERVIEW OF THE THESIS

PART I

1. INTRODUCTION

I.1. Background Policy Context

The current study has been stimulated by the process of international financial integration, particularly between emerging markets and developed markets. A priori financial integration is an expected outcome of the policy of financial liberalisation. Financial liberalisation is a broad term which may be broken down to into constituent parts: banking sector deregulation, equity market liberalisation, and capital account liberalisation. Authorities in a large number of emerging market countries embraced financial liberalisation during the 1980s and 1990s because it is expected to yield higher rates of economic growth. The empirical record testifies that the rate of banking sector and stock market development is a significant predictor of future growth rates (King and Levine, 1993; Levine and Zervos, 1998; Beck and Levine, 2004; Levine, 2004).

Equity market liberalisation (EML) is an important structural change that, if effective, affects the level of stock market development. Generally speaking, EML removes restrictions on the flow of equity investment in and out of a country (Henry, 2000; Bekaert and Harvey, 2003) and may be considered a specific form of capital account liberalisation (Chari and Henry, 2004). Recent empirical evidence finds that EML, on average, leads to a 1 percent per annum increase in real per capita GDP growth although the relatively strong rate of growth may reflect an interaction between EML and macroeconomic reforms and financial development (Bekaert et al, 2005a). Nevertheless, there is considerable heterogeneity in growth rates following EML with the highest rates accruing to countries that have better institutional

frameworks and relatively more developed financial systems. The final point reaffirms the importance of building a robust and effective institutional environment which helps financial markets to function efficiently (see Levine, 2004).

The process of "globalisation" has put increasing pressure and incentives upon countries to seriously evaluate the internationalisation of services (Claessens and Jansen, 2000). In other words, countries must consider opening their markets in services to international competition and the impact that growth in the cross-border provision of services will have on domestic economies and the international economy at large. The internationalization of services is being facilitated via regional trade agreements and negotiations taking place as part of the General Agreement on Trade and Services (GATS). Financial services are an important part of this trend and are crucial for savings, efficient resource allocation, and growth. The debate about further opening financial markets intensified after the 1997 Asian crisis. The speed at which the crisis spread between countries, and eventually across regions -- from the Asian flu to the Russian virus to the Brazilian crisis[1] – revealed severe structural problems inherent in emerging market banking and corporate sectors. These events raised concerns about the "safety net" of international diversification and the risk that vacillations in private capital flows reflected the irrational behavior of global investors. But, it intensified the discussion surrounding the benefits and risks of the internationalisation of services and international financial integration.

[1] Asian flu: The East Asian financial crisis was a period of economic unrest that started in July 1997 in Thailand and affected currencies, stock markets, and other asset prices in several Asian countries, many considered East Asian Tigers. It is also commonly referred to as the East Asian currency crisis or locally as the IMF crisis although the latter is somewhat controversial.
Russian virus: Russian Government's default collapse in 1998, when stock markets around the world experienced abrupt, though short-lived, downfalls
Brazilian crisis: The Brazilian crisis is an important example of the existing links between economics, IMF agreements, and democratic politics.

Table A Summary of three Empricial Working Pap

Main research areas → / *Financial system segments ↓*		EMERGING MARKETS INTEGRATION AND FINANCIAL LINKAGES WITH INDUSTRIAL NATIONS		FINANCIAL INTEGRATION AND PRICE DISCOVERY
		Research Questions& Selected	**Description& measurement**	**Result**
FINANCIAL INTERMEDIARIES	Working Paper I **Bank**	***Do Cross-Border bank M&A(CBMA) create value?** ***What is potential wealth creation?** ***How is value [gain/loss] from CBMA between Acquirer and Target Shareholders?** ***Does Stock Market Announcement generate value?** ***Does the acquisition of majority control drive value?** **--Berger (2006) Buch, DeLong (2001);** **--Bonin et al (2004) ;** **--Clarke et al (2003) ; Claessens & Jansen (2000) ; Berger et al (2000)**	**-Sample & Data** **-- Acquisitions Monthly; 1998-2005, Daily returns** **-- SDC Thompson, Datastream, BankScope** **-- 74 transactions from 46 EME Banks** **-- 7 windows Event Study** $R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it}$ $R_{it} = \alpha_i + \beta_1 D - control_{i,t-1} + \beta_2 T - assets_{i,t-1} + \beta_3 A - assets_{j,t-1}$ $+ \beta_4 EMEbull_{t-0.5} + \beta_5 EMEbear_{t-0.5} + \beta_6 ICbull_{t-0.5} + \beta_7 ICbear_{t-0.5} + \varepsilon_{it}$ Note: Di where i=1…5; i=targetbank;j=acquiringban ➢ **Brown & Warner (1980) DeLong & DeYoung (2000);Cybo-Ottone & Murgia (2000) Chari et al (2005)**	**Redistributed wealth from Acquirer-Target** **50% of acquired assets were in Asia** **73% values of Latin American assets accounted** **√Abnormal return to target bank is positive & large** **√Win-win situations are very hard to find** **√Cost of accusations in Asian is lower than CEEs &Latin America Region**
FINANCIAL MARKETS	Working Paper II&III **Stock & FX Markets**	*** What is the role of US macroeconomic news in FX price discovery?** * How does domestic and cross-border news affect the conditional volatility of FX returns? **Fama (1970); Engle et al (1990); Ito et al(1992) Evans & Lyons (2005); Patton (2006)** ***BRICs - Brazil, Russia ,India and China** *Do US macroeconomic fundamentals affect the price discovery process in emerging? *What the empirical evidence and effect on currency and volatility return is after quantified modeling on asymmetric BEKK GARCH? *How is the news volatility transmission process? **-- Karolyi (1995); Anderson & Bollerslev (1998a)** **-- Nelson (1991); Bekart & Harvey(1997), ABDV(2003)**	**Summary of equations** $R_t = \beta_0 + \sum_{i=1}^{l} \beta_i rfx_{t-i} + \sum_{i=1}^{l} \beta_i rds_{t-i} + \sum_{i=1}^{l} \beta_i ris_{t-i} + \sum_{i=k}^{k} \beta_k MP_k + \varepsilon_t$ $h_t = \omega + (\alpha + \delta k_{t-1})\varepsilon_{t-1}^2 + \beta h_{t-1}$ $H_t = C'C + A'\varepsilon_{t-1}\varepsilon_{t-1}'A' + D\xi_{t-1}\xi_{t-1}'D' + BH_{t-1}B'$ $Let\ \xi_{t-1} = k_{t-1}\varepsilon_{t-1}\ \ \varepsilon_t \mid \Omega_{t-1} \sim N(0, H_t)$ **Let kt-1=1 if εt–1<0, and kt-1=0 ,or ω>0, ≥α0, α+≥δ0,≥β0** **--Engle (1982); Bollerslev (1986);** **—Glosten et al (1993)**	**Policy implications** **--Industrialised markets:** **Under market competition--Looking for** **(a) higher profits(b)diversify earnings & risks** **(c) behaviour finance management** **-- Emerging Market** **Under equity market liberalisations, Financial deregulation –Anticipate** **(i) capital market cost reduction** **(ii) penetration investment flow** **(iii) convergence to asset class** **-- Effects on efficiency, financial stability, growth& wealth distributions** **Across countries asset allocation Strategy** **-- Results summary :** 1.Price discovery -- FX markets more integrated and predictable than domestic stock markets **-- Conditional volatility is time varying** 2. Volatility transmission and volatility dynamics 1. **FX markets more integrated and predictable than domestic stock markets**

I.2. AIMS OF THE STUDY - THE "CHART -MAP"

Having established the policy context within which this research is to be carried out, a Chart-Map is presented to summarise the structure of this thesis. The thesis is written as three working papers which, although independent, are tied together by the theme of international financial integration. The objectives of the Chart-Map are listed below:

A. to define the scope of the current research;

B. to identify research questions which will be addressed in the working papers; and

C. to highlight some of the most relevant findings and policy implications.

The "Chart-Map" has three broad dimensions: (i) the columns describe the main broad research areas; (ii) the rows describe the main segments of a financial system; (iii) the large and shaded inner box describes the main broad approaches and factors that apply to all dimensions defined by research areas (i) and (ii) above. The columns in the Chart-Map show the main research questions, methodologies and data, results and policy implications from each of the three working papers.

3. Structure of the Thesis

The thesis is structured as three working papers. The aims and objectives of each working paper are discussed below together with background rationale for each study and a brief review of the salient literature. Short discussions of the data used in this study and the methodologies applied follow. A conclusion will end the thesis.

WORKING PAPER I

"Do win-win outcomes exist? A study of cross-border M&A transactions in emerging markets"

Incentives for the research

The Asian crisis of 1997 and subsequent Russian and Brazilian crises of 1998 lead to further rounds of liberalising reforms in domestic financial sectors. IMF financial support to troubled economies was conditional upon recipient countries removing any remaining barriers to competition such as restrictions on foreign investors and foreign ownership of domestic financial institutions. The nationalisation of a number of financial institutions in Asia and their restructuring and eventual privatisation has given foreign investors new opportunities to penetrate retail banking markets. Stabilisation programmes and privatisation programmes in both Latin America and Central and Eastern Europe in the early to mid-1990s had allowed foreign banks access to those markets. Prompted by increasingly competitive banking markets in the US and Europe, international banks looked for new and profitable sources of earnings. Events in the 1990s meant that previously restricted markets "opened up" to international banks. The difference between the wave of foreign bank entry into emerging markets in the 1990s and 2000s compared with previous waves is the current wave is giving international banks access to largely underdeveloped retail banking markets.

Thus, the main research objective is to determine how stock markets value the acquisition of a target bank in an emerging market by an international bank. An event study methodology will be used to construct abnormal returns to target bank shareholders, acquiring bank

shareholders, and joint abnormal returns to the combined bank which are weighted by each bank's respective market capitalisation (following Chari et al, 2004).

Research Questions

1. Does cross-border M&A yield significant returns to bank shareholders?
2. How is the value generated by cross-border M&A distributed between the shareholders of the acquiring bank and target bank, respectively?
3. Does the percentage of stake acquired in a target bank affect shareholder returns?

Related Literature

The international consolidation of the banking industry is following hard on the heels of the extensive domestic consolidation process that has taken place mostly in the US and Europe since the mid-1980s (see Berger et al, 1999, 2000). During the 1990s, foreign direct investment became the largest single source of external finance for many emerging markets (Goldberg, 2004). Prompted by financial liberalisation programmes - including bank privatisation and a more relaxed treatment of foreign ownership - and the expansion into emerging markets by corporate clientele, international banks have increasingly penetrated emerging markets. Throughout the 1990s and into the new millennium, banks from industrialised countries have been acquiring banks in emerging market economies at an increasing pace: recent survey evidence reports that international banks are tending to enter emerging markets by acquiring an ownership stake in target institutions (BIS, 2004).

Greater competitive pressures in industrialised countries' banking systems are forcing banks to seek out new, profitable investment strategies in other markets (BIS, 2004). Emerging markets, although they tend to be perceived as higher-risk, higher expected return investments, offer considerable opportunities for expanding bank credit and sourcing of relatively cheap customer deposits. Emerging markets entry can diversify earnings streams and risks for acquiring banks. However, stockmarket valuation of M&A transactions considers the expected future profitability of the investment. Slager (2004) finds the decision to retreat from international markets is valued more highly by stockmarkets than lowly profitable international investments. Evaluations of expected profitability will be influenced by perceptions of country risk – especially political risk – expectations of the acquiring bank's future strategy in the emerging markets, and the structure of the host banking system. Certainly, there are numerous difficulties associated with acquiring a target on a cross-border basis. Berger et al (2000) refer to operational diseconomies of operating a subsidiary from distance. Similarly, Buch and DeLong (2004) argue that "information costs" affect cross-border bank mergers significantly. For instance, differences in language, culture, legal system, bank regulation and supervision could have a detrimental impact on cross-border M&As. Thus, higher information costs may prevent the realisation of potential synergy gains and lower the probability of a successful M&A.

Notwithstanding, the increase in the level of foreign ownership of domestic banking assets has been dramatic, particularly in the transition economies and some Latin American countries (Bonin et al, 2005). However, the pattern of foreign bank entry is uneven and reflects intertemporal differences in regulatory reforms across emerging markets: Latin

American and Central and Eastern Europe (CEE) emerging markets have allowed and received the most foreign bank entry (Clarke et al, 2003). Foreign bank shares of total banking system assets has rapidly increased over time with foreigners controlling the majority of banking assets in some Latin and CEE emerging markets (see Clarke et al, 2003; Barth et al, 2001). The resolution of emerging markets financial crises involved implementing policies that – at the very least - offer a more liberal treatment of foreign ownership which has stimulated an increase in cross-border M&A transactions. This is most certainly the case in emerging Asia.

The existing empirical literature regarding the value creating effects of bank M&A transactions points to mixed evidence from the US where the majority of studies have been carried out (see Pilloff and Santomero, 1998). The evidence suggests the value gains created by M&A transactions are distributed in favour of target bank shareholders at the expense of acquiring bank shareholders (see Berger et al, 1999). This feature explains why joint returns may be insignificantly different from zero (Houston and Ryngaert, 1994). Whilst there are only a few European studies, they offer a cross-border perspective. Contrary to US experience, the empirical record states that M&A transactions in Europe add significant value. Gains accrue to target bank shareholders with no significant value destruction for acquiring bank shareholders (Cybo-Ottone, 2000; Beitel and Schiereck, 2001).

It is important to determine whether M&A transactions involving acquiring banks from industrialised countries and target banks in emerging markets create value, and how value is distributed between the respective shareholders since distribution may involve a transfer of

wealth between countries. Recent empirical evidence from the non-financial sector shows that the acquisition of majority control in emerging market firms does create value for shareholders, but value gains are unevenly distributed in favour of shareholders of acquiring firms in industrialised countries which involves a transfer of wealth from emerging markets (Chari et al, 2004). This is contrary to evidence on the distribution of gains in US and European banking where target bank shareholders received the greater proportion of the distribution of value. Although the volume of cross-border bank M&A activity in emerging markets is not as extensive as in the non-financial sector - due partly to regulatory restrictions and information asymmetries/the opacity of bank value (Focarelli and Pozzolo, 2001) – the pace of M&A is increasing due to regulatory reforms and technological developments.

WORKING PAPER II:

"Does good or bad news matter? Implications of "News" Asymmetries in FX markets"

Incentives for the research

Issues of price discovery and volatility transmission in foreign exchange (FX) spot markets are generating considerable interest amongst researchers and practitioners. Since the 1970s, FX markets have been characterised by substantial short-term volatility, large medium-term swings, and long-term trends (IMF, 2000). These characteristics affect the decisions of firms, investors, and policymakers alike. A substantial literature examines the impact of "news" on price (first moments) and volatility (second moments) of spot rates. Exchange rate theory suggests that public news cannot predict future spot rate changes because spot rates follow a martingale process. However, information-theoretic models claim that financial markets

aggregate information – including public information – which feeds into prices via signals conveyed by cumulative order flow in the case of FX markets (Evans and Lyons, 2002). That news impacts on volatility is less controversial. Martingale conditions do not apply to second moments implying that volatility can exhibit clustering and persistence even *if* price is not predicted by public news (Engle et al., 1990; Green et al., 2000).

The process of how markets set prices (price discovery), and how quickly and effectively, prices incorporate new information (price discovery efficiency) remains opaque (Andersen et al., 2004). Recent empirical evidence sheds some light on the price discovery process in FX markets: prices are found to quickly "jump" in response to changes in macroeconomic fundamentals whilst volatility adjusts gradually (Andersen et al., 2003a). Yet, other empirical evidence finds price effects to be more persistent and lasting for days as traders reconcile an evolving market with prior expectations (Evans and Lyons, 2005). The recent literature is consistent in finding that price and volatility are more responsive to news "surprises" as expected news exerts little effect.

The current research contributes to the price discovery and volatility transmission literature by modelling the first and second order moments of FX returns over a thirty year period from 1st January 1975 to 28th December 2005, yielding a total of 8,085 daily observations. The data are noon spot rates for the Japanese yen, Swiss franc, and British pound *vis-à-vis* the US dollar. In terms of price discovery, the research investigates the relationship between FX returns and macroeconomic announcements in the US.

Thus, the research will provide further evidence on the relationship between spot prices and news, and how the transmission of news impacts on the volatility of spot returns, but over a much longer time frame than elsewhere in the existing literature. In addition, the estimated volatility dynamics are important inputs into asset allocation and international risk management decisions. One might expect that conditional correlations between FX returns have increased over thirty years because of financial market integration and technological developments in FX trading systems (Longin and Solnik, 1995). This proposition needs to be carefully examined because portfolio diversification is based on the concept of low correlation between markets. It is important to ascertain whether time variance in covariances results from an increase in the variance of volatility – implying correlations are constant (Engle and Patton, 2001). Finally, policymakers are concerned with exchange rate volatility because of its effect on financial stability.

Research Questions

1. The research investigates the relationship between spot prices and US macroeconomic news announcements to see whether public news can predict price or if it is instantaneously incorporated into price.
2. It examines the volatility transmission process across FX markets. Engle et al. (1990) contend that volatility can be explained by the arrival of (a) news arriving from other markets (the meteor shower), and (b) yesterday's news in each market (the heat wave).
3. So-called "bad news" is allowed to affect the volatility of returns. Bad news occurs on days when FX returns are negative (the exchange rate depreciates *vis-à-vis* the dollar).

4. Volatility dynamics are examined by estimating conditional variances, covariances and correlations, and by specifying a time-varying variance-covariance structure.

We re-estimate our model across periods of recession in the US to clarify if relationships are sensitive to the business cycle.

Related Literature

(S)*cheduled (macroeconomic news) releases occasionally induce large price changes, but the associated volatility shocks appear short-lived... Market participants may have different information sets, and thus differ in their interpretation of the news, but the market typically settles on a new equilibrium price after a brief period of hectic trading." Andersen and Bollerslev (1998), page 234.*

Evans and Lyons (2005) note that the literature linking exchange rates with news has two branches which address: (1) the direction of exchange rate changes; and (2) exchange rate volatility. Generally speaking, the first branch of literature has difficulty in identifying the impact of macroeconomic news on daily exchange rate returns because price is influenced by other factors. Recent empirical evidence suggests price is responsive to macroeconomic news. Andersen et al. (2003a) find evidence of instantaneous – but not long-lasting - jumps in the conditional means of ultra-high frequency, 5 minute, intraday returns on US spot rates following US macroeconomic announcements. The findings of Andersen et al. (2003a) extend to US, British and German bond, stock and foreign exchange markets (see Andersen et al., 2004).

Empirical evidence finds that bad macroeconomic news adversely affects FX markets during recessions (Andersen et al., 2004). Larger returns are positively related to news announcements – about economic and trade fundamentals in the US and monetary aggregates in Germany (Andersen and Bollerslev, 1998). Central bank management of exchange rate regimes (Humpage, 2003; Patton, 2006), re-balancing of currency portfolios (Patton, 2006), and changes in exchange rate regimes (Bollerslev, 1990; Laopodis, 1998) have been found to cause asymmetric dependence in exchange rates. Kearney and Patton (2000) find exchange rate markets more likely to transmit volatility when they are active, rather than calm.

Other papers have investigated the effects of scheduled macroeconomic news announcements on exchange rates and their volatility. Hakkio and Pearce (1985), Goodhart, Hall, Henry, and Pesaran (1993), Almeida, Goodhart, and Payne (1998) and Andersen, Bollerslev, Diebold, and Vega (2003) all find significant and long-lasting effects of macroeconomic news releases on the level of the exchange rate. However, due to the limited availability of transaction data, little has been done to examine the effects of news on trading activity. Evans and Lyons (2003) and Chaboud et al (2004) are two exceptions. The former asks how the information contained in macro news releases is incorporated into the exchange rate. For excellent reviews of microstructure issues related to FX markets, see O'Hara (1995) and Madhavan (2000).

WORKING PAPER III:

Integration, Price Discovery and Volatility Transmission: Evidence from FX & Stock Markets in the BRICs

Incentives for the research

This working paper brings together elements of the finance-growth and volatility transmission literatures and places them within the context of the integration of emerging markets with international financial markets. As a result of equity market liberalisation, emerging markets financial markets are expected to become more sensitive to news from international markets. This is expected to increase the covariance in asset price returns as the integration process deepens (Bekaert and Harvey, 2003). Similarly, financial shocks from industrial markets are expected to increase the covariance with emerging market returns (Bekaert and Harvey, 1997; Kaminsky and Reinhart, 2000; Longin and Solnik, 1995, 2001; Loretan and English, 2000). A larger covariance of returns could increase the volatility of portfolios which implies higher risks as well as higher expected returns (Karolyi and Stulz, 1996). Thus, it is important to establish the time-varying properties of covariances because financial integration and larger covariances imply there will be fewer opportunities for investors to engage in efficient portfolio diversification (Karolyi and Stulz, 1996). Whereas correlations are reported to have increased since the mid-1990s, it is important to determine their magnitude because low correlations suggest potential diversification benefits exist in emerging markets (Bekaert and Harvey, 2002; Bekaert et al, 2002).

In light of the expected dynamics arising from financial integration, interest lies in the price discovery and volatility transmission processes. The working paper specifies a multivariate

GARCH framework in which there are three types of price returns: foreign exchange (FX); local stock market; and international (US) stock market. The model enables us to jointly model the price discovery and volatility transmission processes and the interdependencies between price returns across markets and borders. Price discovery and volatility transmission is generating considerable interest amongst researchers and practitioners. Econometric advances have created multivariate frameworks within which time varying variances and covariances may be estimated without the imposition of overly restriction conditions. Accurate estimates of conditional variances and covariances are important for price determination, asset selection, and the international management of risk. International portfolio diversification is premised on the low correlation of asset returns across geographic markets. Recent empirical studies examine the interdependence of returns amongst different asset markets: stock, bond and foreign exchange (FX) markets (Andersen et al., 2004); stock and bond markets (De Goeij and Marquering, 2004). Another strand of literature models interdependencies between FX and stock markets, and considers the relationships between currency depreciations and stock returns. The bulk of studies concern developed countries and there is much less research of emerging markets. The current study partly seeks to fill this vacuum.

A multivariate GARCH framework is employed to examine the price discovery and volatility transmission processes in the BRIC group of countries: Brazil, Russia, India and China. The BRICs are considered to be among the strongest performing emerging markets and recent projections suggest that their GDP will surpass those of today's leading industrialised nations within the next 50 years (Wilson and Purushothaman, 2003; Jensen and Larsen, 2004). At the

present time the BRICs make a relevant study of conditional volatility because the authorities have implemented financial policies that are designed to increase the rate of integration of local markets with international markets.

Research Questions

There are several objectives in the third working paper which are now discussed:

1. The paper follows Andersen et al (2004) and examines whether US macroeconomic fundamentals affect the price discovery process in emerging markets' FX and equity markets. The price discovery process is modelled by considering the lagged returns from each asset market as a predictor of price. Thus, the effects of currency movements and stock market movements on asset price returns can be identified.
2. Also examined is the volatility transmission process between FX returns, local and international stock market returns. Evidence suggests volatility is more responsive to "bad news", and the asymmetry of returns is modelled following Glosten et al. (1993). This approach allows one to identify how currency depreciation affects the volatility of stock market returns and vice-versa. To date, the empirical evidence on this relationship is mixed.
3. As the rate of integration quickens, one would expect that "international" news will become a more important piece of information. The leading role played by US stock markets in the volatility transmission process amongst developed markets is well documented (Eun and Shim, 1989). The preferred econometric model specifies US stock market returns, and the interdependencies between the variance and covariance

of US returns and emerging markets returns are taken as an indication of the degree of integration.

4. It is important to establish whether volatility is time-varying. If this is true, then the modelling of covariances becomes important. The preferred GARCH model does not impose any restrictions on the variance-covariance structure which enables us to utilise the coefficients from the model to derive estimates of conditional variance, covariance, and correlation between returns. Volatility dynamics suggest that the variance of returns will decline and the covariance of returns increase as integration progresses (because of changes in diversification opportunities). This is expected to reduce risk premiums associated with emerging markets investments (Bekaert and Harvey, 1997). Likewise, it is important to establish the degree of correlation and how it is evolving because of its implications for international portfolio diversification. Bekaert et al. (2002) suggest that whereas correlations are found to increase after EML, the correlations tend to remain fairly low which implies that diversification benefits can be found in emerging markets.

Related Literature

The theoretical relationships between exchange rates, stock prices, and macroeconomic fundamentals are reviewed by Andersen et al. (2004). Generally, good domestic news, for instance, low inflation, increases in employment and production, should strengthen the domestic currency. The relationship between macroeconomic fundamentals and stock prices is less clear because stock prices are determined by three effects: expected cash flows, the discount rate, and the risk premium. It is an empirical question as to which effect exerts

dominance. There is the possibility that the relationship alters over the course of the business cycle, which again is an empirical issue.

The dynamic interrelationships between exchange rates and stock markets have produced an extensive empirical literature. However, the causality between exchange rates and stock prices is not yet rigorously established. Movements in the two markets may be related because some economic variables, for instance, interest rates, affect both which can cause a convergence of expectations among market participants. Fang and Miller (2002) suggest currency depreciation affects stock market performance via three channels: first, a depreciation currency lowers stock market returns; second, the more volatile the exchange rate, the higher stock market returns; and third, exchange rate depreciation volatility raises stock market volatility. Whereas the empirical record on the level of integration between exchange rates and stock prices is mixed (see Nieh and Lee, 2001; Muhammad and Rasheed, 2001), there is evidence of short-term relationships between exchange rates and stock prices (Nieh and Lee, 2001; Yang and Doong, 2004). Exchange rates and stock prices are more integrated in developed markets compared to emerging markets where little or no association is found (see, for instance, Ajayi et al., 1998). On the contrary, Assoé (2001) finds evidence of significant volatility spillover from FX markets to national stock markets in most emerging markets. Other studies extend the analysis of exchange rates and stock prices to include the effects of an international stock market, mostly the US, in the analysis. Regional and international factors together with currency appreciation positively affect conditional mean price returns in Asian stock markets (Chiang et al, 2000; Fang and Miller, 2002; Chiang and Yang, 2003).

There is a voluminous literature on stock market interdependence. The main findings from developed markets include the transmission of shocks from the US to other markets (Eun and Shim, 1989); an increase in the intensity of volatility transmission over time from the US to European and Japanese markets (Kearney, 2000; Baele, 2003, Kim et al, 2005); and an increase in spillover effects following stock market crashes (King and Wadhwani, 1990; Kanas, 1998). In the context of this working paper, several studies investigate the relationship between financial market integration and major deregulatory events. The volatility transmission literature concerned with spillover effects from developed markets to emerging markets reports evidence of significant next day effects on returns in Asia (Manning, 2002; Masih and Masih, 1999; Jang and Sul, 2002; Fernández-Serrano and Sosvilla-Rivero, 2001) and Latin America (Johnson and Soenen, 2003; Pagan and Soydemir, 2000). There is evidence that correlations between developed market returns and emerging market returns increase following episodes of financial crisis like the Asian Crisis of 1997 (see Tan and Tse, 2002, and Fernández-Serrano and Sosvilla-Rivero, 2002, for evidence from Asia and Latin America, respectively). However, studies find that regional integration in emerging markets is progressing at a faster pace than international integration (see Jang and Sul, 2002; Johnson and Soenen, 2002; and Ng, 2002 for Asia; see Barari, 2004, for Latin America). Finally, evidence suggests that FX and stock market interdependence is affected differently by the arrival of good and bad news. Assoé (2001) suggests that investor behaviour is more responsive to bad news about FX markets than good news but innovations in exchange rates don't affect stock market returns in developed markets.

Data Issues

Throughout this research, daily financial market data are used in the estimations. In the following paragraphs, notice is given of the type of data employed, the sources of the data, and the sizes of the samples.

Working Paper No. 1: A sample of cross-border bank M&A transactions was identified. Using information contained in the publication *Acquisitions Monthly* and SDC Thomson, 74 cross-border transactions involving acquiring banks from industrialised nations and target banks from emerging markets were identified. These transactions involved 46 target banks – in some cases international banks acquired their ownership stake in more than one transaction. Daily bank and country stock index data plus market capitalisation data were sourced from DataStream (in domestic currencies and US dollars). Further information about each transaction such as the value of the deal, stake acquired, and methods of acquisition was sourced from SDC Thomson. From the data it was possible to qualify the acquisition of individual stakes into: majority control; minority control; increasing minority control; increasing from minority to majority control; and increasing majority control.

An event window methodology is used to construct cumulative abnormal returns to bank shareholders over a three week window. Subsequently, cumulative returns are regressed against the five ownership stake variables described above and other control variables including target bank size and acquiring bank size (logarithm of total assets) which were sourced from the BankScope database.

Working Paper No. 2: Daily spot exchange rate data for the Japanese Yen, Swiss Franc, and British Pound are constructed as units of national currency per US dollar. The data are the H.10 Foreign Exchange Rate series produced by the Board of Governors of the Federal Reserve System in the US, and are noon buying rates in New York for cable transfers payable in foreign currencies. The period of analysis runs from January 1st, 1975 to December 28th 2005, yielding a total of 8,086 daily observations. In order to investigate the price discovery process in FX markets, information is collected on US macroeconomic fundamentals. Specifically, the announcement dates and times of release of four macroeconomic series was collected from different sources. The series (source) are the consumer price index (Bureau of Labour Statistics), index of industrial production, index of M2 (non M1), short-term interest rate on six month Eurodollar deposits (ED) (all Federal Reserve Board). The frequencies for the release and the (EST) times of announcements are as follows: CPI (monthly, 8.30am); IP (monthly, 9.15am); M2 (weekly, 4.30pm); ED (weekly, 9.30am). The data are announced on different days of the week and time of the month. We construct our variables as follows. First, we calculate the percentage change in the data in logarithms between time *t* and time *t-1* for the period. Next, we standardise the data by subtracting the mean from each observation and dividing by the standard deviation. The use of standardised news is employed elsewhere in the literature as it has desirable properties such as facilitating comparisons of responses of different exchange rates to different items of news, and not affecting the statistical significance of response estimates (Andersen et al., 2003a). However, we recognise that our measure of standardised news is indicative of the magnitude of each evolution for the macroeconomic indicators, and not by design an indication of surprise.

Working Paper No. 3: Daily stock index and foreign exchange index data are sourced from DataStream. The exchange rates for each of the BRIC currencies (Brazilian Real, Russian Rouble, Indian Rupee and Chinese Renminbi) are constructed as units of national currency per US dollar. The BRIC stock market indexes used are the BOVESPA (Brazil), Russian Federation Stock Exchange (Russia), Bombay Stock Exchange (India), and Shanghai Composite Index (China). The US Dow Jones Industrials Index is taken to proxy the international stock market. The data cover the 10th October 1994 to 30th December 2005 giving a total of 2,929 observations for each series. The US macroeconomic fundamentals data is the same as used in Working Paper No. 2.

Methodologies

For Working Paper No. 1, an event window approach is employed and the research follows Chari et al (2004). OLS regression techniques are used to construct measures of alpha and beta which are employed to derive predicted returns. Abnormal returns are simply the raw returns less predicted returns. Abnormal returns to target bank and acquiring bank shareholders are weighted by each bank's share of combined market capitalisation to create a measure of the joint return to shareholders. Regression techniques are later used to determine the relationship between ownership and stock market returns.

Working Papers Nos. 2 and **3** utilise the same econometric framework; a multivariate GARCH model is employed to examine the price discovery and volatility transmission processes in asset price returns, both across asset classes and national borders. GARCH methods are used to jointly model the conditional mean and conditional volatility of asset

price returns. Specifically, the model is specified according to the BEKK formulation which allows cross-market interdependencies (see Engle and Kroner, 1995). Since the covariance of asset returns is reportedly unstable over time (Longin and Solnik, 1995) the model does not impose the restriction of constant correlation (see Bollerslev, 1990). Empirical evidence suggests that conditional covariance are heteroskedastic (see, for instance, Bollerslev et al., 1988; Kroner and Ng, 1998; De Goeij and Marquering, 2004). This proposition is tested and if accepted, the use of GARCH methods is appropriate. The asymmetric behaviour of FX and stock market returns is well documented (see Nelson, 1991; Engle and Ng, 1993; Glosten et al., 1993; Bekaert and Harvey, 1997; Kroner and Ng, 1998; Brooks and Henry, 2002; Assoé, 2001; Bekaert et al., 2003; Yang and Doong, 2004). We incorporate asymmetric news effects in the spirit of Glosten et al. (1993). Similar approaches are applied by Kroner and Ng (1998), Henry (1998), Brooks et al. (2002), and De Goeij and Marquering (2004).

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PART II: THREE EMPIRICAL WORKING PAPERS

PART II :

WORKING PAPER I

Do win-win outcomes exist? A study of cross-border M&A transactions in emerging markets

Between 1998 and 2005, we identify 74 cross-border M&A transactions in which international banks acquired ownership stakes in 46 listed banks in emerging market economies (EME). A total of $1,057,515 million of bank assets was acquired for $38,172 million in Latin America, Central and Eastern Europe, and Asia. Using an event study approach, we find scant evidence of win-win situations where joint return is positive. Whereas market-adjusted return to target bank shareholders tends to be positive and large, this is offset by generally negative abnormal returns to international bank shareholders and it is the latter that drives joint return. Thus, we find no evidence of a transfer of wealth from EME shareholders. Our results show similarity with studies of US bank M&A but less so with European studies, and they run contrary to recent non-financial sector evidence from EME. Whilst win-win situations can be identified, investors should consider various factors including the size of stakes acquired, existing stakes, method of acquisition, and geography of the banks involved. The econometric evidence finds joint returns are significantly lowered when (1) majority control is acquired, and (2) when large EME target banks are acquired. Joint return significantly increases when international banks acquire minority control in EME banks.

JEL Classification: G21, G34
Keywords: Mergers and acquisitions, bank mergers, event study, abnormal return, emerging markets

1. Introduction

The international consolidation of the banking industry is following hard on the heels of the extensive domestic consolidation process that has taken place mostly in the US and Europe since the mid-1980s (see Berger et al, 1999, 2000).[2] Throughout the 1990s and into the new millennium, banks from industrialised countries (referred to as international banks) have been acquiring banks in emerging market economies (EME) at an increasing pace mainly via cross-border mergers and acquisitions (M&A). The increase in the level of foreign ownership of domestic banking assets has been dramatic, particularly in the transition economies and some Latin American countries (Bonin et al, 2005). Recent survey evidence reports that international banks are tending to enter EME by acquiring an ownership stake in target institutions (BIS, 2004).[3]

It is important to determine whether M&A transactions involving acquiring banks from industrialised countries and target banks in EME create value, and how value is distributed between the respective shareholders since distribution may involve a transfer of wealth between countries. Recent empirical evidence from the non-financial sector shows that the acquisition of majority control in EME firms does create value for shareholders, but value gains are unevenly distributed in favour of shareholders of acquiring firms in industrialised

[2] The causes of the consolidation of US and European banking as well as the possible outcomes are discussed by various authors including Berger et al (1999), Berger (2000), Berger et al (2000), Berger et al (2001), Berger and DeYoung (2001), Berger and DeYoung (2002), and Berger et al (2003).

[3] Purchasing an established branch network is one mode by which acquiring banks access underdeveloped, but potentially large, retail banking markets that exist in many EME. Other investment options include taking a minority stake in a target bank and increasing it over time, or entering into a joint venture agreement. We note that hostile takeovers in banking are very rare and foreign bank takeovers are subject to regulations which vary between countries.

countries which involves a transfer of wealth from EME (Chari et al, 2004). This is contrary to evidence on the distribution of gains in US and European banking where target bank shareholders received the greater proportion of the distribution of value. Although the volume of cross-border bank M&A activity in EME is not as extensive as in the non-financial sector - due partly to regulatory restrictions and information asymmetries/the opacity of bank value (Focarelli and Pozzolo, 2001) – the pace of M&A is increasing due to regulatory reforms and technological developments.

Whether the announcement of cross-border bank M&A transactions generates value is an empirical issue. For this purpose, we have identified 74 M&A transactions involving the acquisition of stakes in 46 listed target banks in EME between 1998 and 2005, using M&A transactions reported in *Acquisitions Monthly* with additional information about transactions and participating banks sourced from Thomson Analytics Banker One, Datastream, and BankScope. The transactions take place in three regions: Latin America, Central and Eastern Europe, and Asia. In total, $1,057,515 million of EME bank assets were sold for $38,172 million (at 2000 prices). Over 56% of EME bank assets were sold in Asia but at a lower cost to acquiring banks compared to Latin America and CEE. The acquisition of stakes in Latin American banks accounted for more than 72% of the total value of M&A transactions with Latin bank assets the most expensive to buy.[4]

Since previous existing studies focus attention on the US and Europe, we believe the present study to be one of the earliest investigations of value creation resulting from cross-border

[4] The assets of target banks, the value of deals, and cost per unit of asset for each region are as follows: Latin America ($278,994m, $27,578, $0.0988); CEE ($189,574m, $5,049m, $0.0266); Asia ($588,947m, $5,545m, $0.0094). Source: own calculations from Thomson and BankScope data.

bank M&A transactions in EME. We employ an event study methodology to measure value creation over a three week window around the announcement date of M&A transactions. The event window is used to calculate joint returns (weighted by the market capitalisations of acquiring and target banks) to the combined bank, abnormal returns to the acquiring bank, and market-adjusted returns to the target bank. A positive return implies stock markets expect value to be created by the merger. We define a win-win situation as instances where joint returns are positive, and we identify the extent to which joint returns are being driven by abnormal returns to acquiring bank and target banks, respectively.

The remainder of the paper is organised as follows. Section 2 briefly reviews the internationalisation of the banking industry and considers issues pertaining to broader foreign bank penetration in EME. Section 3 presents the event study methodology. The construction of the sample and analysis of the data are discussed in Section 4. There are two sets of empirical results: Section 5 analyses returns and Section 6 reports results from regression models which test the relationship between the acquisition of ownership in EME target banks and returns. Finally, Section 7 concludes.

2. International consolidation in banking

During the 1990s, foreign direct investment became the largest single source of external finance for many EME (Goldberg, 2004). Prompted by financial liberalisation programmes - including bank privatisation[5] and a more relaxed treatment of foreign ownership - and the expansion into EME markets by corporate clientele, international banks have increasingly penetrated EME. However, the pattern of foreign bank entry is uneven and reflects

[5] See Megginson (2005) for a review of the bank privatisation literature and a list of privatised banks.

intertemporal differences in regulatory reforms across EME: Latin American and Central and Eastern Europe (CEE) EME have allowed and received the most foreign bank entry (Clarke et al, 2003). Foreign bank shares of total banking system assets has rapidly increased over time with foreigners controlling the majority of banking assets in some Latin and CEE EME (see Clarke et al, 2003; Barth et al, 2001).[6] The resolution of EME financial crises involved implementing policies that – at the very least - offer a more liberal treatment of foreign ownership which has stimulated an increase in cross-border M&A transactions. This is most certainly the case in Asia.[7] Below we discuss several features of foreign bank entry which could influence stockmarkets' valuation of returns, first, for the acquiring bank, and, second, the target bank.

Greater competitive pressures in industrialised countries' banking systems are forcing banks to seek out new, profitable investment strategies in other markets (BIS, 2004). EME, although they tend to be perceived as higher-risk, higher expected return investments, offer considerable opportunities for expanding bank credit and sourcing of relatively cheap customer deposits. EME entry can diversify earnings streams and risks for acquiring banks. However, stockmarket valuation of M&A transactions considers the expected future profitability of the investment. Slager (2004) finds the decision to retreat from international markets is valued more highly by stockmarkets than lowly profitable international

[6] Barth et al (2001) provide an exhaustive source for the proportion of banking system assets held by foreigners in nearly 100 countries.

[7] In 1996, the degree of financial openness varied across South East Asia. The most restrictive rules on foreign bank activity were found in Korea, Malaysia and Thailand. Following the 1997 financial crisis, national banking laws have been amended to liberalise the treatment of foreign banks to such an extent that there are no longer any restrictions on foreign acquisition of majority stakes in domestic banks in Indonesia, Korea, and Thailand. For a fuller discussion of the resolution strategies adopted in SE Asia we draw the readers attention to the following papers: Claessens et al (1999), Gochoco-Bautista (1999), Gochoco-Bautista et al (2000), Hawkins (1999), Kawai and Takayasu (1999), Lindgren et al (1999), Montreevat (2000), and Oh (1999).

investments. Evaluations of expected profitability will be influenced by perceptions of country risk – especially political risk – expectations of the acquiring bank's future strategy in the EME, and the structure of the host banking system.[8]

Some empirical evidence finds foreign banks to be more efficient than domestic banks in EME with foreign bank entry conditioning the behaviour domestic EME banks; in other words, foreign competition leads to lower margins, profits, and overhead costs at domestic-owned banks (Claessens et al, 2001). It is uncertain how stockmarkets would value an increase in competitive conditions in EME banking systems given international banks' strategic goals of exploiting arbitrage opportunities and specialising in market segments where they hold comparative advantage over domestic banks. The implementation of international best practice and technology is expected to raise efficiency in the target bank and it is reasonable to assume that investors' value improving bank efficiency. However, we note several important caveats. First, there are suggestions that foreign ownership stakes need to be very large (over 70%) if a target bank is to be successfully restructured and achieve improvements in cost efficiency (Claessens and Jansen, 2000). Second, Berger et al (2000) emphasise the existence of diseconomies arising from operating a subsidiary at distance which may prevent foreign-owned banks from operating efficiently.[9] Berger et al note that such diseconomies are more likely to be overcome by acquiring banks that originate in highly competitive and well regulated environments.

[8] This type of evaluation is a complex task owing to informational asymmetries and data availability.
[9] Operational diseconomies associated with distance are heightened by barriers relating to the following: culture, language, currency, the host regulatory and supervisory structure, and explicit and/or implicit rules against foreign banks (Berger et al, 2000).

There may be hostility in EME markets towards foreign ownership of domestic banks. Market reaction could reflect sentiments towards the sale of national champions which maybe perceived as a loss of cultural identity; there could be concerns about the future strategy for the target bank; foreign banks are often thought to lack loyalty to the host EME and exit in times of financial distress; domestic banks may lose market share because they cannot compete effectively against better resourced foreign-owned banks. On the contrary, the market may value so-called reputation effects, if the acquiring bank is a renowned financial institution, and the re-branding of [often formerly troubled] domestic banks. Foreign bank entry is associated with an improvement in the range and quality of financial products and services, and an improvement in the regulatory and supervisory environment in the EME (see Clarke et al, 2003).

The existing empirical literature regarding the value creating effects of M&A transactions points to mixed evidence from the US where the majority of studies have been carried out (see Pilloff and Santomero, 1998, for a review). The evidence suggests the value gains created by M&A transactions are distributed in favour of target bank shareholders at the expense of acquiring bank shareholders (see Berger et al, 1999). This feature explains why joint returns may be insignificantly different from zero (Houston and Ryngaert, 1994). Whilst there are only a few European studies, they offer a cross-border perspective. Contrary to US experience, the empirical record states that M&A transactions in Europe add significant value. Gains accrue to target bank shareholders with no significant value destruction for acquiring bank shareholders (Cybo-Ottone, 2000; Beitel and Schiereck, 2001).

3. Event study methodology

Typically, three methodologies have been employed to quantify the effects of M&A activity: (1) dynamic efficiency studies (see Berger and Humphrey, 1997); (2) operating performance studies (see Altunbas and Marqués Ibáñez, 2004); and (3) event studies (see Cybo-Ottone and Murgia, 2000, and Pilloff and Santomero, 1998). Since our objective is to quantify whether the announcement of cross-border M&A transactions creates value, the current study belongs to the third category.

Daily share price data are used to construct three measures of returns over a three week event-window around the announcement date of the M&A transaction. A three week window is selected because of relatively low liquidity in EME stockmarkets. Returns are cumulative across a period that begins one week prior to the week of the announcement and ends one week following the week of the announcement.[10] In order to better approximate returns to international investors, returns are denominated in US dollars.

Following, we employ the market model to estimate alpha and beta and construct predicted return accordingly. Equation [1] is estimated over a period of twelve months for the acquiring bank and target bank, respectively. The period begins eighteen months before and ends six months prior to the announcement date so that the coefficients are not biased by the [impending] M&A announcement. Abnormal return is measured as the difference between actual return and predicted return. Joint return is defined as the sum of acquiring bank and target bank abnormal return weighted by each bank's share of joint market capitalisation.

[10] We construct alternative event-windows: 3 days, 5 days, 7 days, and 5 weeks. Our preferred window is 3 weeks. We also calculate domestic currency returns and re-estimate equation [2]. The results are consistent with those presented in this paper. Further information is available from the authors upon request.

Return to target bank shareholders is measured by market-adjusted return (raw return minus market return). In this paper, we report cumulative returns across the 3 week event window.

$$R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it} \qquad [1]$$

where R_{it} is the daily return to bank i at time t; R_{mt} is the daily return to the market m at time t; α_i is the intercept term and β_i is the estimate of beta which shows the sensitivity of the returns to each bank to market returns; and ε_{it} is the error term.

We model returns as a function of the type of acquisition strategy (size of ownership stake acquired by international banks), the asset size of the target and acquiring banks, respectively, and four control variables that identify if the EME and industrial country stockmarkets were in bull or bear periods in the six months leading up to the announcement of M&A transactions.

$$r_{it} = \alpha_i + \beta_1 D-control_i + \beta_2 T-assets_{i,t-1} + \beta_3 A-assets_{i,t-1} + \beta_4 EME-bull_{t-0.5} + \beta_5 EME-bear_{t-0.5} + \beta_6 IC-bull_{t-0.5} + \beta_7 IC-bear_{t-0.5} + \varepsilon_{it} \qquad [2]$$

where $D-control_i$ is a dummy variable i = 1 … 5 where 1 = acquisition of a majority stake, 2 = acquisition of minority stake, 3 = increasing existing minority stake (total stake less than 50%), 4 = increasing minority stake to majority stake and 5 = increasing majority stake. $T-assets_{i,t-1}$ = natural log of (real) assets of target bank; $A-assets_{i,t-1}$ = natural log of (real) assets of acquiring bank. $EME-bull_{t-0.5}$ = cumulative return in EME bull market in period six months prior to M&A transaction, 0 otherwise; $EME-bear_{t-0.5}$ = cumulative return in EME bear market in period six months prior to M&A transaction, 0 otherwise; $IC-bull_{-0.5}$ = cumulative return in industrialised country bull market in period six months prior to M&A transaction, 0 otherwise; $IC-bear_{t-0.5}$ = cumulative return in IC bear market in period six months prior to M&A transaction, 0 otherwise.

Equation [2] is estimated five times for each return measure (joint return, abnormal return to acquiring bank, market-adjusted return to target bank) to capture the relationships between the acquisition of ownership stakes and return. The interpretation of the model coefficients is as follows. A positive β_1 suggests that stockmarkets believe the acquisition of stakes in EME target banks will generate value (higher returns). Similarly, a positive β_2 implies the acquisition of large target banks in EME raises returns whereas a positive β_3 suggests that acquisitions by large international banks raise returns. The four control variables reflect the trend in EME and industrial country stockmarkets in the six months prior to each M&A transaction and whether returns are influenced accordingly.

4. Data

We compiled the sample of M&A transactions after searching *Acquisitions Monthly* and identifying cross-border transactions involving acquiring banks from industrialised countries and target banks from EME. The 74 transactions precipitated an exchange of ownership rights in 46 EME banks. To supplement our analysis, we sourced information about each transaction from Thomson One Banker Analytics which contains the SDC Mergers and Acquisitions database. We collected data on the value of the transaction, the percentage stake acquired in each transaction – which enabled us to establish a cumulative stake and classify the five types of acquisition with a dummy variable. Additional information was collected on the dollar price paid per share and the method of acquisition (open market purchase, tender offer, privately negotiated purchase, divestitures, stock swap, privatisation, other).

We collate M&A transactions and show the home origin of international (acquiring) banks, the number of target banks they purchase in *n* number of deals, and sum the value of deals by

EME within each region. The following features emerge. European banks acquired 34 EME banks over 58 separate transactions for $21,565 million whilst US banks acquired 9 banks over 11 deals for $16,480 million. A closer look at the acquiring banks implies the number of global banks (defined as acquiring banks taking ownership stakes across more than one region) is very small and comprises one US bank, one UK bank, and two Dutch banks. European banks tended to acquire stakes in CEE targets. Spanish banks acquired stakes in 10 targets in six Latin American EME.[11] The Spanish acquisitions accounted for 36% of the value of all M&A transactions in Latin America whereas the acquisition of stakes in two Mexican banks by two US banks accounted for 47%. The data suggest European, US, and developed-Asian nation banks are establishing a presence in Asian EME. European banks have acquired stakes in 10 Asian banks whilst US banks and banks from developed Asia have stakes in four banks each. More than 56% of the total value of Asian M&A transactions has been spent on acquiring stakes in 7 Korean banks. Banks have acquired stakes in Chinese and Indian targets and we suspect that further stakes will be acquired in the future (see Table 1a-c).

Table 1 here

We examine each M&A transaction and classify how international banks are entering EME. Based on the percentage stake acquired in each transaction and the cumulative stake, we suggest international banks are following five modes of entry: (1) acquisition of majority stake (13 cases); (2) acquisition of minority stake (17 cases); (3) increasing existing minority

[11] Spanish banks adopted a strategy of expansion in Latin America based on a shared cultural identity and language (de Paula, 2002).

stake (10 cases); (4) increasing minority stake to majority stake (15 cases); and (5) increasing majority stake (19 cases). The following observations are noteworthy. Banks increasingly penetrated Latin American and CEE banking systems between 1998 and 2005; cumulatively, they acquired majority control, increased from minority to majority control, or increased majority stakes in 90.48% and 70% of transactions with Latin American and CEE targets, respectively. On the contrary, international banks acquired minority stakes in 52.17% of M&A transactions with Asian targets; the acquisition of majority control was made only in 17.39% of transactions.

5. Analysis of Returns

Table 2a shows descriptive statistics for joint returns, abnormal returns to acquiring banks, and market-adjusted returns to target banks over the three week event-window. We segment the data to show M&A transactions between European and North American banks and EME targets in Latin America, Central and Eastern Europe, and Asia. We also show transactions between banks from industrialised Asian countries and Asian EME. Table 2b provides further descriptive statistics on the asset size of target and acquiring banks, and on stockmarket trends in EME and industrialised countries. The Table shows the average size of target banks in Asia is nearly three times the size of respective targets in Latin America and CEE.

Table 2a,b here

Average returns are presented again in Table 3 together with the average return accruing to the five types of ownership stake acquired by international banks. As expected, market-

adjusted returns to target bank shareholders are positive and quite large in the majority of cases. One of the problems the current study faces is the limited number of observations especially when data are finely segmented which could explain the lack of statistical significance in some instances. Nevertheless, several noteworthy points are found. Average market-adjusted return is highest for transactions in which the international bank is North American compared to European. The highest return involves North American banks and their Asian targets (11.02%). The lowest returns involve transactions amongst Asian banks (2.18%) and European and CEE banks (1.95%).

Table 3 here

Whereas shareholders of EME target banks earn substantial returns on their investments, the opposite occurs for international bank shareholders. The average abnormal returns suggest that the announcement of cross-border M&A transactions involving the acquisition of stakes in EME targets is unfavourably viewed by industrialised country stockmarkets. Generally, abnormal returns to international bank shareholders are negative yet they drive joint weighted returns to the combined bank because the international banks are considerably larger than their targets. Joint return is positive – value creating- only for North American and CEE M&A transactions – a win-win situation.

The lower panel of Table 3 shows average returns across the five ownership types. Interestingly, international banks' acquisition of majority-stakes in EME targets yields a large and significant return to target bank shareholders (7.99%), but abnormal returns to

international bank shareholders is significantly negative (-2.65%) - which drives joint returns (-2.43%). Although there are no further significant returns, the data imply that the acquisition of any type of ownership stake by an international bank yields positive returns to target bank shareholders. Surprisingly given the pattern of abnormal returns, a positive (yet insignificant) return is observed when international banks increase their existing majority holding in EME banks. This yields a joint return of nearly 1%.

Table 4 re-orders the data by the method of acquisition. In the 74 M&A transactions, there is a single method of acquisition in the majority of deals: for six deals there are two methods, and for one deal there are three methods. Over 70% of M&A transactions were carried out via open market purchases (17%), tender offers (23%) and privately negotiated purchases (30%). The remaining 30% are divided roughly equally between divestitures, stock swaps, privatisations and other (mainly undisclosed).

Table 4 here

The data in Table 4 suggest that international banks acquire larger holdings in EME targets via tender offers; the average value of tender offer M&A transactions ($1,004.73 million) is considerably greater than alternative methods except stock swaps ($2,539.07 million) and privatisations ($1,157.44 million). Tender offer deals realise the second highest market-adjusted returns to target bank shareholders (11.65%) after stock swaps (14.16%). Tender offers involving Latin American targets yield a win-win outcome, though the joint and abnormal returns are small and insignificant whereas the market-adjusted returns to target bank shareholders is the largest in the sample (20.43% and significant). Surprisingly, tender

offers produce a small, yet insignificant joint return on Asian investments where the significant market-adjusted return offsets a negative abnormal return. There is further evidence of win-win outcomes: open market purchases of Asian and CEE banks, and privately negotiated purchases of Latin American banks. Somewhat surprisingly, the acquisition of ownership stakes through privatisation realises negative returns for acquiring bank and target bank shareholders.

6. Ownership control, value creation, & cross-border M&A transactions

In this section we report the results from estimating equation [2]. The model is estimated five times for each of the ownership stake classifications (D1 to D5), and three sets of estimations are made using alternative dependent variables (joint returns, abnormal returns, and market-adjusted returns).

Table 5a here

In Panel (a) of Table 5, the dependent variable is joint returns. In the column headed D1 we observe the relationship between the acquisition of majority stakes in EME targets and joint returns. The coefficient on the variable D-CONTROL is significantly negative implying that international banks' acquisition of majority control of EME target banks significantly lowers joint returns. Furthermore, the coefficient on the variable T-assets (target bank assets) is also significantly negative suggesting that the acquisition of large EME targets is viewed unfavourably by investors. Indeed, the coefficient enters each of the five models negatively, and significantly, which suggests that any acquisition of large EME targets yields lower

returns. However, the acquisition of minority stakes (D2) in EME targets yields positive and significant joint returns (albeit at the 10% level).

Table 5b here

A similar pattern is observed in Panel (b) where the dependent variable is abnormal returns to acquiring banks. This is understandable because we have noted how joint returns are driven by the former. Again, the acquisition of majority control (D1) and T-asset are negative and significant. We observe that abnormal returns are negatively related to bull markets in industrialised countries when international banks acquire minority stakes (D2) and increase them (D3). An interpretation is that investing in an existing home country bull market is a more viable investment than acquiring minority holdings in EME targets. Finally, there are no significant relationships between control and returns, and bank size and returns when market-adjusted return to target banks is the dependent variable. In this regression, the only significant relationship is between bear markets in industrialised stock markets and market-adjusted returns. In each regression, the coefficient on IC-bear is large, and negatively significant. It suggests that returns to target banks are lower the more protracted the bear market in industrialised countries in the period six months prior to M&A transactions. This is tentative evidence that EME returns are influenced asymmetrically by trends in industrialised stockmarkets since bull markets are associated with positive albeit insignificant increases in EME target returns.

Table 5c here

7. Conclusion

We construct a sample of cross-border bank M&A transactions between international banks and target banks in EME covering 74 transactions involving 46 EME banks between 1998 and 2005. The transactions involved a small number of acquiring European and US banks, and target banks from Latin America, CEE, and Asia. Whilst over 50% of the total of bank assets was sold in Asia, Latin American targets accounted for over 72% of the total value of transactions. The cost per unit of bank assets was much greater for Latin American targets especially compared with Asian targets, which could reflect the sale of formerly troubled banks in the aftermath of the 1997 Asian crisis. It appears that international banks have consolidated and increased their majority control in Latin America and CEE whereas they have began to enter Asian markets post-1998.

We have analysed joint return to combined banks, abnormal return to international banks, and market-adjusted return to target banks. As expected, and consistent with previous studies, market-adjusted returns to target banks are positive and relatively large. This is true irrespective of the type of ownership stake acquired. However, market-adjusted returns are sensitive to the method of acquisition: tender offers and stock swaps yield the greatest returns. However, and in general, abnormal returns to international banks are negative although there are some exceptions: when North American banks acquire CEE targets, the increase of an existing majority stake, open market purchases of Asian and CEE targets, tender offers and privately negotiated purchases of Latin targets. Joint returns to combined banks are driven by abnormal returns to international banks because the latter are

considerably larger than their targets. Hence, the number of win-win outcomes is limited and the returns tend not to be statistically robust.

Our econometric objectives were (1) to determine whether cross-border M&A transactions create value and (2) to qualify the distribution of value between shareholders.

We examine (1) for five types of ownership stake. Interestingly, the acquisition of majority control of EME target banks significantly lowers return. This finding contravenes evidence from Europe but is consistent with some US research. Furthermore, it also contradicts evidence from the non-financial sector which finds acquisition of majority control in EME targets significantly raises returns. Thus, we establish a difference in the value creating effects of cross-border M&A transactions between banking and non-financial sectors in EME.

We find evidence that acquiring minority stakes significantly increases joint return. Increasing a minority stake and increasing an existing majority stake are positively, yet insignificantly, related to joint return and abnormal return to international banks. We observe a statistically significant and inverse relationship between joint return and the assets size of target banks irrespective of the type of ownership stake acquired. We are unable to find a robust statistical relationship between market-adjusted returns to target banks and any of five ownership control types which suggest returns to target banks are driven by other factors. Certainly, market-adjusted returns are significantly lowered when there is a bear period in industrialised countries' stock markets.

In terms of (2), we find no evidence to suggest there is a transfer of wealth from EME target shareholders to international bank shareholders. The implication is that industrialised countries' stockmarkets do not expect cross-border M&A transactions to create value. This finding is consistent with some US evidence yet inconsistent with the non-financial sector in EME.

The empirical evidence suggests it is difficult to discover a win-win situation from cross-border M&A transactions in banking. However, if investors are vigilant enough to consider factors such as the type of ownership stake acquired, method of acquisition, geography of international and target banks, and recent stockmarket trends, then a limited number of win-win cases can be observed. However, the returns tend not to be statistically robust. Indeed, the overall lack of robust statistical evidence points to problems associated with small samples. By construction, our sample is limited to listed banks. Nevertheless, we identified every cross-border bank M&A transaction reported in *Acquisitions Monthly* from 1998 to 2005. A few banks had to be dropped because share price data or information about the value of the deal was unavailable. The information we have presented shows how international banks are entering EME which likely reflects bank strategy.

We suggest stockmarket perceptions regarding cross-border M&A transactions in EME reflect information asymmetries associated with valuing opaque bank assets, and uncertainties associated with investing in banks in financial systems that have been under severe distress in recent times. In a small number of transactions, the acquisition of ownership rights is limited by regulations. Nevertheless, we expect the consolidation of

global banking to continue as current regulations pertaining to foreign ownership of domestic banks are eliminated over time. Similarly, more industrialised country banks facing increasingly competitive domestic markets, may seek out shareholder value in EME that offer potential for expansion and diversification. As a caveat, we note abnormal return represents market assessment of expected return from M&A transactions. Further study is required to ascertain the market's valuation of, and also the determinants of, longer-term bank performance following cross-border M&A transactions in EME.

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Table 1a: M&A activity – Targets and acquirers; Latin America

	Target bank resident in						*Acquiring bank(s)*	
	Argentina	*Brazil*	*Chile*	*Colombia*	*Mexico*	*Venezuela*	*Avg $ m*	*Value $ m*
Acquiring bank home country								
NA-LAT	**1 (1)**		**1 (1)**		**2 (2)**			**4 (4)**
n = 4	261.2		118.22		12591.12		3242.63	12970.54
Canada			1 (1)					1 (1)
n = 1			118.22					118.22
US	1 (1)				2 (2)			3 (3)
n = 3	261.2				12591.12		4284.11	12852.32
EC-LAT	**2 (7)**	**3 (7)**	**2 (3)**	**2 (5)**	**3 (3)**	**1 (1)**		**13 (26)**
n = 4	1925.58	8393.37	1058.88	551.58	2570.68	106.97	561.81	14607.07
Netherlands		2 (4)						2 (4)
n = 1		3545.77					886.44	3545.77
Spain	2 (7)	1 (3)	2 (3)	2 (5)	2 (2)	1 (1)		10 (21)
n = 2	1925.58	4847.60	1058.88	551.58	1481.58	106.97	474.87	9972.20
UK					1 (1)			1 (1)
n = 1					1089.10			1089.10
Value $ m	**2186.78**	**8393.37**	**1177.10**	**551.58**	**15161.80**	**106.97**		**27,957.02**
Mean value	**273.35**	**1199.05**	**294.28**	**110.32**	**3032.36**	-		**931.90**

Table 1b: M&A activity – Targets and acquirers; Central & Eastern Europe

	Target bank resident in				*Acquiring bank(s)*	
	Czech Republic	*Hungary*	*Poland*	*Slovenia*	*Avg $m*	*Value $ m*
Acquiring bank home country						
US			1 (3)			1 (3)
n=1			969.50			969.50
EC-CEE	4 (5)	1 (1)	5 (11)	1 (1)		11 (19)
n = 9	2186.20	25.30	1739.33	130.47		4081.30
Austria	1 (2)					1 (2)
n = 1	1158.49					1158.49
Belgium			1 (4)			1 (4)
n = 1			340.97		85.24	340.97
France	1 (1)			1 (1)		2 (2)
n = 1	996.10			130.47	563.29	1126.57
Germany	2 (2)		3 (5)			5 (7)
n = 4	31.60		1052.56		154.88	1084.16
Italy		1 (1)				1 (1)
n = 1		25.3				25.30
Netherlands			1 (2)			1 (2)
n = 1			345.80		172.90	345.80
Value $ m	**2,186**	**25**	**2,709**	**130**		**5,051**
Mean	**437.24**	-	**193.49**	-		**229.58**

Table 1c: M&A activity – Targets and acquirers; Asia

	Target bank resident in						Acquiring bank(s)	
	China	*India*	*Indonesia*	*Korea*	*Philippines*	*Thailand*	*Avg $ m*	*Value $m*
Acquiring bank home country								
US	1 (1)	1 (1)		2 (2)				4 (4)
n = 2	69.49	32.45		1980.75				2082.69
EC-Asia	1 (1)	3 (4)	2 (2)	4 (5)				10 (12)
n = 8	929.70	279.32	196.89	983.07			199.08	2388.98
France				1 (1)				1 (1)
n = 1				118.65			-	118.65
Germany		1 (1)		1 (2)				2 (3)
n = 2		146.87		432.74			48.30	579.61
Netherlands		1 (2)		1 (1)				2 (3)
n = 2		67.91		286.81			29.56	354.72
Switzerland			1 (1)					1 (1)
n = 1			131.99				-	131.99
UK	1 (1)	1 (1)	1 (1)	1 (1)				4 (4)
n = 2	929.70	64.53	64.90	144.87			100.33	1203.99
Asia-Asia			2 (2)		1 (1)	1 (2)		4 (5)
n = 3			108.47		92.68	590.38	158.31	791.53
Australia			1 (1)					1 (1)
n = 1			3.07				0.26	3.07
Singapore			1 (1)		1 (1)	1 (2)		3 (4)
n = 2			105.41		92.68	590.38	65.71	788.47
Value $ m	**999.19**	**311.77**	**305.36**	**2963.82**	**92.68**	**590.38**		**5263.20**
Mean	499.60	62.35	76.34	423.40	-	295.19		250.63

Notes:

In the first column, n is the number of banks from developed nations that have acquired EME banks. In the columns showing the EME nations, the first number is the number of target banks that were acquired. The number in parentheses is the number of transactions taken in acquiring control of the target. The figure below is the value of the transactions, denoted in real (2000 prices) US $ millions. Data in bold are sub-totals according to home region of acquiring banks, and the grand total for acquisitions in EME by region.

For example, there are two US banks which acquired targets in Asia. One US bank acquired a Chinese bank in a single transaction and the value of the transaction was $929.70 million. In total, two US banks were involved in acquiring stakes in four Asian banks in a total of four transactions worth $2,388.98 million. The average value of the US-Asian acquisitions is $199.08 million. Banks from developed nations (the US, France, Germany, the Netherlands and UK) spent $2,963.82 million in acquiring stakes in six Korean banks over seven transactions. The average value of each transaction is $423.40 million.

Source: calculated from Thomson One Bankers Analytics.

Table 2a: Descriptive Statistics – 3 week $ returns; by region

	N	Average	Std dev	Median	Minimum	Maximum
Joint weighted returns to combined bank						
EUR-LAT	26	-0.0009	0.0668	0.0048	-0.2518	0.1682
NA-LAT	4	-0.0138	0.0314	-0.0158	-0.0540	0.0305
EUR-CEE	18	-0.0197	0.0382	-0.0209	-0.0853	0.0608
NA-CEE	3	0.0603	0.0661	0.0442	-0.0114	0.1480
EUR-Asia	14	-0.0021	0.0260	-0.0036	-0.0416	0.0644
NA-Asia	4	-0.0032	0.0093	-0.0026	-0.0157	0.0079
Asia-Asia	5	-0.0108	0.0316	-0.0077	-0.0678	0.0291
Abnormal returns to acquiring bank						
EUR-LAT	26	-0.0013	0.0658	0.0060	-0.2452	0.1640
NA-LAT	4	-0.0132	0.0312	-0.0139	-0.0551	0.0301
EUR-CEE	18	-0.0195	0.0393	-0.0197	-0.0919	0.0635
NA-CEE	3	0.0603	0.0661	0.0442	-0.0114	0.1480
EUR-Asia	14	-0.0123	0.0248	-0.0068	-0.0678	0.0313
NA-Asia	4	-0.0152	0.0154	-0.0140	-0.0381	0.0052
Asia-Asia	5	-0.0025	0.0232	-0.0049	-0.0406	0.0291
Market-adjusted returns to target bank						
EUR-LAT	26	0.0537	0.1692	0.0472	-0.5363	0.3675
NA-LAT	4	0.0826	0.1114	0.0693	-0.0603	0.2519
EUR-CEE	18	0.0195	0.0994	0.0191	-0.1713	0.1959
NA-CEE	3	0.0766	0.0278	0.0769	0.0424	0.1104
EUR-Asia	14	0.0756	0.1107	0.0756	-0.1217	0.3189
NA-Asia	4	0.1102	0.2887	-0.0463	-0.0759	0.6093
Asia-Asia	5	0.0218	0.1475	0.0948	-0.2589	0.1538

Table 2b: Descriptive Statistics – Control Variables

	Average	Std dev	Median	Minimum	Maximum
Bank assets – Target banks, $ million					
EMEs	14,290.75	25,059.11	6,853.00	62.40	184,268.30
Latin	*9,299.81*	*8,607.03*	*6,543.50*	*1,469.40*	*35,385.20*
CEE	*9,027.33*	*7,029.03*	*7,709.00*	*413.90*	*22,958.90*
Asia	*25,606.39*	*41,143.93*	*4,317.24*	*62.40*	*184,268.30*
Bank assets – Acquiring banks, $ million					
Acquiring banks	459,001.14	260,199.88	408,460.80	613.60	1,276,778.00
Stock market performance 6 months prior to M&A transaction					
Bull - EME	0.1104	0.1501	0.0166	0.0000	0.6327
Bull – IC	0.0714	0.1044	0.0023	0.0000	0.4201
Bear - EME	-0.1089	0.1630	0.0000	-0.6554	0.0000
Bear – IC	-0.0413	0.0564	0.0000	-0.2170	0.0000

Source: authors' calculations. Datastream; BankScope; Thomson One Banker Analytics.

Table 3: Mean 3 week $ returns: by region & ownership holding, %

Acquiring / target location	Joint weighted returns to combined bank	Abnormal returns to acquiring bank	Market-adjusted returns to target bank
Europe-Latin America	-0.0889	-0.1340	5.3656
Europe-CEE	-1.9684**	-1.9549**	1.9522
Europe-ASIA	-0.2137	-1.2333*	7.5624**
N. A- LA	-1.3761	-1.3179	8.2574
N. A-CEE	6.0296	6.0296	7.6598**
N. A-ASIA	-0.3220	-1.5188	11.0211
ASIA-EASIA	-1.0832	-0.2490	2.1793
Control			
D1	-2.4288**	-2.6483**	7.9931**
D2	-0.5518	-0.4796	8.7817
D3	-0.1224	-0.3418	5.0414
D4	-0.4752	-0.9348	4.0399
D5	0.9146	0.6760	3.3927

Note:
D1 indicates the acquisition of majority control.
D2 indicates the acquisition of a minority stake.
D3 indicates the increase of an existing minority stake.
D4 indicates increased ownership from minority to majority.
D5 indicates increasing an existing majority stake.

*****, **, * statistically significant at 1%, 5% and 10%, respectively.**

Source: authors' calculations. Datastream; BankScope; Thomson One Banker Analytics.

Table 4: Mean 3 week $ returns; by method of acquisition

	N	Joint weighted return	Abnormal return to acquirer	Market-adjusted return to target	Value, $m	Stake bought, %	Total stake %
Open Market Purchases							
All	14	-0.0127	-0.0163	-0.0109	136.08	9.17	60.97
Latin	*8*	*-0.0346*	*-0.0350*	*-0.0770*	*111.45*	*9.11*	*63.73*
EASIA	*4*	*0.0151*	*0.0028*	*0.0700*	*143.65*	*10.78*	*41.10*
CEE	*2*	*0.0195*	*0.0206*	*0.0920****	*219.45*	*6.21*	*71.17*
Tender Offers							
All	19	-0.0053	-0.0116	0.1165***	1,004.73	44.30	76.02
Latin	*7*	*0.0007*	*0.0006*	*0.2043****	*2,298.99*	*41.76*	*69.89*
EASIA	*3*	*0.0050*	*-0.0313**	*0.0514*	*612.53*	*58.73*	*96.80*
CEE	*9*	*-0.0134*	*-0.0145*	*0.0699***	*128.82*	*41.47*	*74.66*
Privately negotiated purchases							
All	24	-0.0023	-0.0035	0.0520***	293.71	14.76	59.34
Latin	*7*	*0.0235*	*0.0226*	*0.0246*	*448.70*	*19.77*	*70.80*
EASIA	*13*	*-0.0093**	*-0.0105***	*0.0828****	*202.71*	*13.10*	*32.13*
CEE	*4*	*-0.0249*	*-0.0263*	*-0.0003*	*318.23*	*9.69*	*71.50*
Divestitures							
All	6	-0.0339*	-0.0186	0.0635	608.25	62.97	78.90
Stock swaps							
All	6	-0.0233**	-0.0330***	0.1416***	2,539.07	61.32	79.61
Latin	*5*	*-0.0269***	*-0.0260***	*0.1547****	*3,027.02*	*53.59*	*79.61*
Privatisations							
All	5	-0.0263*	-0.0256*	-0.0047	1,157.44	51.98	-
CEE	*4*	*-0.0345***	*-0.0335**	*-0.0414*	*551.63*	*59.31*	-
Other							
All	7	0.0164	0.0085	-0.0237	443.29	35.54	69.48

*****, **, and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.**

Source: authors' calculations. Datastream; Bankscope ; Thomson One Banker Analytics.

Table 5a: Dependent variable is joint weighted return, 3 week, $

	D1	D2	D3	D4	D5
Constant	0.2360***	0.2080**	0.1867**	0.1827**	0.1758*
	2.61	2.29	2.02	2.00	1.89
D-control	-0.0399**	0.0256*	0.0064	-0.0025	0.0055
	-2.43	1.66	0.35	-0.16	0.37
T-assets	-0.0126**	-0.0121**	-0.0093*	-0.0094*	-0.0093*
	-2.53	-2.35	-1.85	-1.88	-1.86
A-assets	-0.0092	-0.0082	-0.0082	-0.0078	-0.0075
	-1.50	-1.31	-1.26	-1.22	-1.17
EME – bull	0.0281	0.0262	0.0310	0.0319	0.0336
	0.58	0.53	0.61	0.62	0.66
EME – bear	0.0195	-0.0082	-0.0008	-0.0028	-0.0007
	0.45	-0.19	-0.02	-0.06	-0.02
IC – bull	-0.0604	-0.1010	-0.0796	-0.0766	-0.0670
	-0.88	-1.41	-1.10	-1.07	-0.89
IC - bear	0.0774	0.1140	0.1156	0.1121	0.1044
	0.56	0.81	0.80	0.78	0.73
R2 – adj.	10.3	6.2	2.4	2.3	2.5

Table 5b: Dependent variable is abnormal return to acquirer, 3 week, $

	D1	D2	D3	D4	D5
Constant	0.1746**	0.1361	0.1323	0.1251	0.1082
	1.99	1.52	1.48	1.41	1.20
D-control	-0.0371**	0.0113	0.0114	-0.0032	0.0136
	-2.33	0.74	0.64	-0.21	0.94
T-assets	-0.0101**	-0.0083*	-0.0069	-0.0071	-0.0069
	-2.10	-1.64	-1.44	-1.47	-1.44
A-assets	-0.0055	-0.0044	-0.0050	-0.0042	-0.0035
	-0.92	-0.71	-0.79	-0.68	-0.57
EME – bull	-0.0037	-0.0032	-0.0006	0.0003	0.0060
	-0.08	-0.07	-0.01	0.01	0.12
EME – bear	0.0401	0.0179	0.0215	0.0188	0.0218
	0.95	0.41	0.50	0.42	0.51
IC – bull	-0.0937	-0.1189*	-0.1151*	-0.1092	-0.0870
	-1.40	-1.68	-1.64	-1.57	-1.20
IC - bear	0.1016	0.1337	0.1419	0.1345	0.1181
	0.76	0.97	1.02	0.97	0.85
R2 – adj.	7.4	0.6	0.4	0.0	1.1

Table 5c: Dependent variable is market-adjusted return to target, 3 week, $

	D1	D2	D3	D4	D5
Constant	0.0982	0.1350	0.1292	0.1287	0.1602
	0.36	0.51	0.49	0.49	0.60
D-control	0.0229	0.0061	0.0004	0.0026	-0.0255
	0.47	0.13	0.01	0.06	-0.60
T-assets	0.0051	0.0026	0.0033	0.0032	0.0029
	0.34	0.17	0.23	0.22	0.20
A-assets	-0.0088	-0.0098	-0.0097	-0.0097	-0.0109
	-0.48	-0.53	-0.52	-0.53	-0.59
EME – bull	0.0344	0.0318	0.0329	0.0316	0.0194
	0.24	0.22	0.23	0.21	0.13
EME – bear	0.1959	0.2059	0.2077	0.2095	0.2063
	1.50	1.59	1.61	1.58	1.61
IC – bull	0.0998	0.1023	0.1081	0.1097	0.0696
	0.48	0.49	0.52	0.53	0.32
IC - bear	-0.7077*	-0.7254*	-0.7261*	-0.7286*	-0.7005*
	-1.71	-1.76	-1.75	-1.76	-1.70
R2 – adj.	0.0	0.0	0.0	0.0	0.0

Notes: The dependent variable is the cumulative return to target and acquirer weighted by market capitalisation, and denominated in US $ over a three week window i.e. commencing one week before and ending one week after the week of the announcement.
T statistics are shown below the coefficients.
D1 indicates the acquisition of majority control.
D2 indicates the acquisition of a minority stake.
D3 indicates the increase of an existing minority stake.
D4 indicates increased ownership from minority to majority.
D5 indicates increasing an existing majority stake.

***, **, and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

Source: authors' calculations. Datastream; BankScope; Thomson One Banker Analytics.

PART II

WORKING PAPER II

Does good or bad news matter? Implications of asymmetric news information in FX markets

Abstract

We employ a multivariate asymmetric BEKK GARCH model to jointly estimate the conditional mean and conditional variance of FX returns for the Japanese yen, Swiss franc and British pound *vis-à-vis* the US dollar from 1975 to 2005. We find that US macroeconomic news announcements are significant in the price discovery process with larger increases in consumer prices and short-term interest rates influencing spot returns. However, these relationships are not observed during recessionary periods in the US. Currency depreciation affects the variance of spot returns but not always in the same direction. These effects are much larger when the US economy is in recession. Shocks in "home" markets are more important in explaining the variance of returns although there is evidence of cross-border volatility transmission. News effects are persistent for at least one day. The dynamics of FX volatility show that conditional volatility, covariance and correlation coefficients between FX returns are time varying with clearly visible patterns.

JEL Classification: C32, F02, F31, G15

Keywords: Exchange rates, volatility transmission, GARCH, asymmetric news

1. Introduction

Issues of price discovery and volatility transmission in foreign exchange (FX) spot markets are once more generating considerable interest amongst researchers and practitioners. Since the 1970s, FX markets have been characterised by substantial short-term volatility, large medium-term swings, and long-term trends (IMF, 2000). These characteristics affect the decisions of firms, investors, and policymakers alike. A substantial literature examines the impact of "news" on price (first moments) and volatility (second moments) of spot rates. Exchange rate theory suggests that public news cannot predict future spot rate changes because spot rates follow a martingale process. However, information-theoretic models claim that financial markets aggregate information – including public information – which feeds into prices via signals conveyed by cumulative order flow in the case of FX markets (Evans and Lyons, 2002). That news impacts on volatility is less controversial. Martingale conditions which it implies forecast errors are equal to zero, In GARCH models, the first moment(conditional mean) follows a martingale but the martingale condition does not restrict non-linear dependence in second moments(conditional variance) indicates that volatility can exhibit clustering and persistence even *if* price is not predicted by public news. (See Engle et al., 1990; Green et al., 2000)

The process of how markets set prices (price discovery), and how quickly and effectively, prices incorporate new information (price discovery efficiency) remains opaque (Andersen et al., 2004). Recent empirical evidence sheds some light on the price discovery process in FX markets: prices are found to quickly "jump" in response to changes in macroeconomic

fundamentals whilst volatility adjusts gradually (Andersen et al., 2003a). Yet, other empirical evidence finds price effects to be more persistent and lasting for days as traders reconcile an evolving market with prior expectations (Evans and Lyons, 2005). The recent literature is consistent in finding that price and volatility are more responsive to news "surprises" as expected news exerts little effect.

This study contributes to the price discovery and volatility transmission literature by modelling the first and second order moments of FX returns over a thirty year period from 1st January 1975 to 28th December 2005, yielding a total of 8,085 daily observations. The data are noon spot rates for the Japanese yen, Swiss franc, and British pound *vis-à-vis* the US dollar. Our empirical investigation has five points of focus:

(1) We investigate the relationship between spot prices and macroeconomic news announcements to see whether public news can predict price or if it is instantaneously incorporated into price.

(2) We examine the volatility transmission process across FX markets. Engle et al. (1990) contend that volatility can be explained by the arrival of (a) news arriving from other markets (the meteor shower), and (b) yesterday's news in each market (the heat wave).

(3) We allow so-called "bad news" to affect the volatility of returns. Bad news occurs on days when FX returns are negative (the exchange rate depreciates *vis-à-vis* the dollar).

(4) We examine volatility dynamics by estimating conditional variances, covariances and correlations by specifying a time-varying variance-covariance structure.

(5) We re-estimate our model across periods of recession in the US to clarify if relationships are sensitive to the business cycle.

Our preferred econometric approach is to use multivariate GARCH methods to jointly model the conditional mean and conditional volatility of FX returns.[12] We apply the BEKK formulation which allows cross-market interdependencies (see Engle and Kroner, 1995). Since the covariance of FX returns is reportedly unstable over time (Longin and Solnik, 1995) the model does not impose the restriction of constant correlation (see Bollerslev, 1990). Indeed, empirical evidence finds that conditional covariances are heteroskedastic (see Bollerslev et al., 1988; Kroner and Ng, 1998; De Goeij and Marquering, 2004). The asymmetric behaviour of returns is well documented (see Nelson, 1991; Engle and Ng, 1993; Glosten et al., 1993; Bekaert and Harvey, 1997; Kroner and Ng, 1998; Brooks and Henry, 2000; and Bekaert et al., 2003). We incorporate asymmetric news effects in the spirit of Glosten et al. (1993). Similar approaches are applied by Kroner and Ng (1998), Henry (1998), Brooks et al. (2002), and De Goeij and Marquering (2004).

The results provide further evidence on the relationship between spot prices and news, and how the transmission of news impacts on the volatility of spot returns, but over a much longer time frame than elsewhere in the existing literature. In addition, the estimated volatility dynamics are important inputs into asset allocation and international risk management decisions. One might expect that conditional correlations between FX returns have increased over thirty years because of financial market integration and technological developments in FX trading systems (Longin and Solnik, 1995). This proposition needs to be

[12] Whilst we note the development of methods for estimating so-called realized volatility (see Andersen et al., 2003b) and their alleged superiority over GARCH methods in explaining the behaviour of ultra-high frequency intraday returns, our data are daily and tests support the GARCH specification.

carefully examined because portfolio diversification is based on the concept of low correlation between markets. It is important to ascertain whether time variance in covariances results from an increase in the variance of volatility – implying correlations are constant (Engle and Patton, 2001). Finally, policymakers are concerned with exchange rate volatility because of its effect on financial stability.

The remainder of the paper is organised as follows. A brief literature review is presented in Section 2. The specification of the multivariate asymmetric GARCH model is Section 3. Data analysis and specification tests are discussed in Section 4. The empirical estimates are presented and discussed in Section 5 whilst some conclusions are offered in Section 6.

2. Literature

The efficient market hypothesis claims that asset prices incorporate all available information (Fama, 1970), and price changes reflect the arrival and processing of news. The literature distinguishes between public or private news. Public news, for instance about macroeconomic fundamentals, is information that is considered common knowledge. Exchange rate theory claims that public news is impounded in spot rates almost instantaneously since returns follow a martingale process which implies that future changes are unpredictable on the basis of publicly available information (Engle et al., 1990). On the contrary, private information disseminates gradually into prices through trading as traders reconcile new information with prior expectations (see Kyle, 1985; Admati and Pfleiderer, 1988). That price does not reflect private information until the end of trading is a possible source of volatility spillovers (Engle et al., 1990).

Recent information-theoretic models examine the mechanism through which spot rates incorporate information relevant to pricing foreign currency (see Evans and Lyons, 2002, 2003, and 2005). The models are in the spirit of Kyle (1985) in the sense that information is revealed via trading. The basic contention is that "dispersed information" about the present and future state of the economy is aggregated by currency markets and transmitted into prices via signals omitted by the signed order flow of foreign exchange transactions.[13,14] Evans and Lyons (2002) suggest that fundamental information is not known publicly but agents have private knowledge about dispersed information which they feed into signed order flows. Order flow then becomes the signal to price setters (dealers) that price needs to be adjusted.

Evans and Lyons (2005) note that the literature linking exchange rates with news has two branches which address: (1) the direction of exchange rate changes; and (2) exchange rate volatility. Generally speaking, the first branch of literature has difficulty in identifying the impact of macroeconomic news on daily exchange rate returns because price is influenced by other factors.[15] Recent empirical evidence suggests price is responsive to macroeconomic news. Andersen et al. (2003a) find evidence of instantaneous – but not long-lasting - jumps in the conditional means of ultra-high frequency, 5 minute, intraday returns on US spot rates

[13] Dispersed information is micro-level information (e.g. private economic research carried out by banks) on economic activity which is spread across agents (individuals, firms, and financial institutions) and is correlated with fundamentals. Scheduled macroeconomic announcements like those applied in this paper are also a source of dispersed information (Evans, 2005).

[14] Order flow is the cumulative flow of signed currency transactions, where transactions are signed positively or negatively depending on whether the initiator of the transaction is buying or selling. See Lyons (2002) and Evans and Lyons (2002, 2003, 2005) for studies employing order flow.

[15] DeGennarro and Shrieves (1997, p. 298) cite the following influences: response to new information made available simultaneously to all market participants; reactions to trades motivated by exploitation of private information; differences in opinion regarding commonly held information; or adjustments by dealers to control their inventories. Furthermore, there is feedback between these factors which complicates matters.

following US macroeconomic announcements. The findings of Andersen et al. (2003a) extend to US, British and German bond, stock and foreign exchange markets (see Andersen et al., 2004).

Andersen et al. (2003a) qualify their findings and report that returns are influenced only by surprise announcements or unanticipated shocks to economic fundamentals. A similar conclusion is drawn by Evans and Lyons (2005) who differentiate between an instantaneous effect of "average" or "rational" news on price, and a longer lasting impact of "total" or "evolving" news. Evans and Lyons (2005) find that the arrival of macroeconomic news induces changes in the trading behaviour of various market participants and that the effect remains significant for days as market participants adjust their positions *vis-à-vis* prior expectations.

The initial failure to establish causality between public news and prices focused research efforts on the volatility (second moments) of returns. Whereas the martingale condition restricts the first moments, it does not restrict the non-linear dependence of second moments. This implies that whilst prices cannot be predicted using public information, the volatility of returns could exhibit volatility clustering, which suggests that volatility can be forecasted (see Green et al., 2000). Engle et al. (1990) explain the market dynamics of volatility: market participants' process new information with reference to earlier priors which could be based on private information which leads to a continuation of volatility in returns. There is a substantial body of empirical evidence suggesting that public news announcements are an important determinant of the volatility of returns. For instance, Andersen et al. (2003a) find

that volatilities respond to macroeconomic news announcements in around one hour whilst DeGennarro and Shrieves (1997) find private information and public news effects are important determinants of yen-dollar volatility. Similar conclusions are reported in studies of yen-dollar and Deutschemark-dollar volatility by Melvin and Yin (2000); DM-dollar volatility by Andersen and Bollerslev (1998) and Daníelsson and Payne (2002); and Euro-dollar returns (Bauwens et al., 2005).

There are reasons which suggest that FX returns are more responsive to bad news than good news. Kroner and Ng (1998) suggest this is because bad news shocks increase the flow of information which affects the covariance between returns. Evans and Lyons (2004) discuss differences in volatility emanating from micro and macro news, and suggest that [private, short-term] trading (micro news) explains exchange rate volatility to a greater extent than public news concerning economic fundamentals (macro news). This is because micro news concerning market transactions accumulates and renders minimal the short-term impact of public macro news. However, Evans and Lyons discuss an embedding effect which occurs because markets gradually absorb and process macro news. This causes rational exchange rate errors in portfolio allocations and explains the medium-term to long-term effect of macro news on exchange rate volatility.

Empirical evidence finds that bad macroeconomic news adversely affects FX markets during recessions (Andersen et al., 2004). Larger returns are positively related to news announcements – about economic and trade fundamentals in the US and monetary aggregates in Germany (Andersen and Bollerslev, 1998). Central bank management of exchange rate

regimes (Humpage, 2003; Patton, 2006), re-balancing of currency portfolios (Patton, 2006), and changes in exchange rate regimes (Bollerslev, 1990; Laopodis, 1998) have been found to cause asymmetric dependence in exchange rates. Kearney and Patton (2000) find exchange rate markets more likely to transmit volatility when they are active, rather than calm.

3. Model Specification

A wealth of literature is devoted to modelling temporal dependence in first and second order moments of asset returns. Seminal works include Engle (1982) and Bollerslev (1986) which presented the ARCH and GARCH methodologies. A multitude of methodological developments and empirical applications have emerged since (see Bollerslev et al., 1992, and Bauwens et al., 2006 for excellent reviews). We estimate a multivariate GARCH using the BEKK[16] specification of Engle and Kroner (1995), where the restriction of a symmetrical variance-covariance structure is removed and news enters the conditional variance asymmetrically following Glosten et al. (1993). The paper is one of a limited number of studies which estimate asymmetric GARCH models, in applications to: stock market volatility and spillovers (Ng, 2000), optimal hedge ratios (Brooks et al., 2002), asset returns (Kroner and Ng, 1998), and stock and bond returns (De Goeij and Marquering, 2004).

The conditional mean of foreign exchange returns are modelled as in equation [1]. Let r_t equal the continuously compounded return on a currency exchange rate over the period t–1 to t. The information set available to investors at time t–1, when investment decisions are taken, is denoted Ω_{t-1}. The expected return and volatility of returns based on those decisions are the conditional mean and variance of r_t given Ω_{t-1}, denoted $y_t = E(r_t \mid \Omega_{t-1})$ and $h_t = var(r_t \mid \Omega_{t-1})$,

[16] BEKK stands for Baba, Engle, Kraft and Kroner.

respectively. The unexpected return at time t is $\varepsilon_t = r_t - y_t$. Following Engle and Ng (1993), ε_t can be interpreted as a measure of news. An unexpected increase in returns ($\varepsilon_t>0$) indicates the arrival of good news, whilst an unexpected decrease in returns ($\varepsilon_t<0$) indicates bad news.

$$r_t = \beta_0 + \sum_{i=1}^{l} \beta_i r_{t-i} + \sum_{i=k}^{k} \beta_k MP_k + \varepsilon_t \qquad [1]$$

$$\varepsilon_t \mid \Omega_{t-1} \sim N(0, H_t)$$

where r_t is a linear function of *I* lagged values of itself, in particular, denote $r_t = \ln(s_t) - \ln(s_{t-1},)$ where S = the exchange rate index. $\ln(s_t) - \ln(s_{t-1})$ refers to the log return from the difference of today' exchange rate(s_t Information) to one day later(s_{t-1} Information),the exchange rate data are expressed as units of US dollars meaning $r_{t.>0}$ refers to depreciation of local currency and $r_{t.<0}$ appreciation of local currency. The news arising from *k* contemporaneous macroeconomic announcements and the lagged values are chosen according to the Akaike information criteria. De Goeij and Marquering (2004, p .541) note that because shocks to equation [1] are the "main actors" in multivariate GARCH models, it is important to correctly specify the conditional mean equation.

The conditional variance h_t may be modelled as a function of the lagged ε_t, implying that predictable volatility is dependent on past news, with the effect of any piece of news upon current volatility decreasing as the news becomes older or decays (Engle, 1982). In the GARCH specification introduced by Bollerslev (1986), the effect of a shock to returns decreases geometrically over time. In its simplest form, the univariate GARCH(p,q) model may be specified as follows:

$$h_t = \omega + \sum_{i=1}^{p} \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^{q} \beta_j h_{t-j} \qquad \textbf{[2]}$$

where $\omega > 0$; $\alpha_1, \ldots, \alpha_p \geq 0$; and $\beta_1, \ldots, \beta_q \geq 0$ are constant parameters, and the non-negativity conditions ensure the conditional variance is positive. Equation [2] imposes a restriction of symmetry on the conditional variance structure. This restriction is undesirable in view of the *a priori* assumption that markets do not treat good and bad news, or small and large news shocks, in an equal manner. For an asymmetric effect, the impact of a shock of any given magnitude on the covariance equation differs depending upon whether the shock is positive (good news) or negative (bad news).

Following Glosten et al. (1993), equation [2] can be re-specified to account for the possibility of asymmetric effects. Let $k_{t-1}=1$ if $\varepsilon_{t-1}<0$, and $k_{t-1}=0$ otherwise. For ease of exposition we assume p=q=1, or a GARCH(1,1) specification:

$$h_t = \omega + (\alpha + \delta k_{t-1}) \varepsilon_{t-1}^2 + \beta h_{t-1} \qquad [3]$$

$\delta>0$ implies a bad news shock has a greater impact on volatility than a good news shock. The conditions $\omega>0$, $\alpha\geq0$, $\alpha+\delta\geq0$ and $\beta\geq0$ must be satisfied in order to ensure a positive conditional variance.

For a multivariate model, let $r_{m,t}$ denote the continuously compounded return on the m'th country's exchange rate over the period t–1 to t, for m=1 ... M. The expected return is the

conditional mean of $r_{m,t}$ given Ω_{t-1}, denoted $y_{m,t} = E(r_{m,t} \mid \Omega_{t-1})$. The unexpected return at time t is $\varepsilon_{m,t} = r_{m,t} - y_{m,t}$. As before, the conditional variance-covariance matrix is measurable with respect to the information set, Ω_{t-1}, such that $\varepsilon_t \mid \Omega_{t-1} \sim N(0, H_t)$, where ε_t is an M×1 vector containing $\{\varepsilon_{m,t}\}$ for m=1 ... M, and H_t is an M×M matrix containing the conditional variances and covariances for the disturbance terms of the M equations.

We express the multivariate counterpart of equation [2] using the GARCH-BEKK specification, which guarantees that H_t is positive-definite through the imposition of quadratic forms upon the matrices of coefficients:

$$H_t = C'C + \sum_{i=1}^{p} A_i \varepsilon_{t-i} \varepsilon_{t-i}' A_i' + \sum_{j=1}^{q} B_j H_{t-j} B_j' \qquad [4]$$

C is an M×M upper-triangular matrix of coefficients, and A_i and B_j are (unrestricted) M×M matrices of coefficients. The GARCH-BEKK specification permits the estimation of spillover effects between equations. One drawback of [4], however, is it implies that only the magnitude of previous news is important in determining the current conditional variances and covariances. This is excessively restrictive because it does not allow for the very real possibility of asymmetric effects, defined as before. For a multivariate model, these can be specified as follows:

Let $k_{m,t-1}=1$ if $\varepsilon_{m,t-1}<0$ and $k_{m,t-1}=0$ if $\varepsilon_{m,t-1}\geq 0$ for m=1,... ,M.

Let K_{t-1} be an M×M diagonal matrix containing $k_{m,t-1}$ in the main diagonal elements, and 0's in the off-diagonal elements; and let $\xi_{t-1} = K_{t-1}\varepsilon_{t-1}$. As before, for ease of exposition we assume a GARCH(1,1) specification with p=q=1:

$$H_t = C'C + A'\varepsilon_{t-1}\varepsilon_{t-1}'A' + D\xi_{t-1}\xi_{t-1}'D' + BH_{t-1}B' \qquad [5]$$

In [5], D is the matrix of coefficients for the asymmetric effects. Since the symmetric and linear GARCH-BEKK model (i.e. [4] with p=q=1) is a restricted version of [5] in which D = 0, a likelihood ratio test can be used to determine the more appropriate model specification.

In the estimations that are reported below, the number of equations is M=3. We let $r_{m,t}$ denote the continuously compounded returns for the Japanese yen-US dollar rate (m=1), the Swiss franc-US dollar rate (m=2), and the British pound-US dollar rate (m=3).

4. Data Description

Our data are spot rates for the Japanese yen, Swiss franc, and British pound *vis-à-vis* the US dollar from January 1st, 1975 to December 28th 2005, yielding a total of 8,086 daily observations. The data are the H.10 Foreign Exchange Rate series produced by the Board of Governors of the Federal Reserve System in the US, and are noon buying rates in New York for cable transfers payable in foreign currencies. The literature reports that exchange rates display similar features to equities: volatility clustering, persistence, skewness, kurtosis, as

well as spillovers or volatility transmission between markets.[17] The evolution of the exchange rate indexes and continuously compounded returns are presented in Figure 1, and the patterns observed in previous studies are confirmed. We note that there is less dispersion around zero for pound-dollar returns in comparison with franc-dollar and yen-dollar returns.

Figure 1 here

The autocorrelation of returns and squared returns are shown in Table 1. Significant autocorrelations in the returns series would tell us that foreign exchange returns are predictable. They are not. Similarly, significant autocorrelations in the squared returns series would tells us that there is volatility clustering in foreign exchange returns. There is. Although the autocorrelations in the squared return series are not large, they are significant at the 5 percent level, and the fact that they are positive is highly unlikely to occur by chance.

Table 1 here

The Ljung-Box Q statistic is calculated at various lag lengths ranging from 6 to 30 days for the returns and squared returns series (see Table 2). For returns, a significant Q statistic implies that the null hypothesis of no serial correlation cannot be accepted, whilst a significant Q statistic for squared returns implies that the null hypothesis of homoskedasticity cannot be accepted. We reject the null of no serial correlation in the yen-dollar and pound-dollar returns series but not in the franc-dollar series. We overwhelmingly reject the null of no homoskedasticity in each squared return series. Returns are characterised by higher order

[17] See Engle and Bollerslev, 1986; Boothe and Glassman, 1987; Hsieh, 1989; Baillie and Bollerslev, 1989, 1990; Bollerslev and Engle, 1993; Engle et al, 1990; and Ito et al, 1992. Generally, these studies examine volatility transmission between the US dollar and the currencies of other industrial nations.

serial correlation (autocorrelation) and non randomness, and squared returns display non-linear dependency. This implies that it is appropriate to model exchange rate volatility using GARCH methods.

Table 2 here

Table 3 presents descriptive statistics for returns. The sample data show the yen and franc with small, negative and insignificant, average returns of around 0.01% per day with average return on the pound positive at 0.004%. Expressed on an annualised basis, the mean return for the yen and franc are -2.92% and -2.07%, respectively, whereas return on the pound is 0.98%. The unconditional variances are 0.4149, 0.5202, and 0.3573, for the yen, franc, and pound, respectively. Re-expressing these data as average annualised volatilities, we find the franc to be the more risky currency with annualised volatility of 11.45% compared to 10.23% and 9.49% for the yen and pound, respectively. The distributional features of returns are as expected. The null hypothesis of normally distributed returns is rejected by the Jarque-Bera, skewness, and kurtosis statistics. Yen and franc returns are negatively skewed whereas pound returns have a larger positive skew. There is evidence of kurtosis in each returns series implying that returns are showing signs of fat tails.

Table 3 here

We have sourced the announcements dates for four series of US macroeconomic data for the period from January 1975 to December 2005. Suggested by Anderson *et al* (2005) we intents to characterize the response of US, Japan Swiss, and British FX markets to real-time U.S.

macroeconomic news over 30 years horizons. The series (source) are the consumer price index (Bureau of Labour Statistics), index of industrial production, index of M2 (non M1), short-term interest rate on six month Eurodollar deposits (ED) (all Federal Reserve Board). The frequencies for the release and the (EST) times of announcements are as follows: CPI (monthly, 8.30am); IP (monthly, 9.15am); M2 (weekly, 4.30pm); ED (weekly, 9.30am). The data are announced on different days of the week and time of the month. One of the problems we faced in compiling the macroeconomic announcement data was the relative scarcity of long time series of announcement dates. Whereas other studies employ a much larger number of macroeconomic indicators, they tend to cover the period from the early 1990s for which the announcement dates and times data are much more extensive. Nevertheless, the data we have chosen give a fair reflection of real and monetary conditions in the US over the thirty year interval.

As noted above, the literature suggests that returns are sensitive to unanticipated movements in macroeconomic fundamentals. In recent studies covering the 1990s and beyond, researchers have utilised data which enables them to construct a measure of surprise by subtracting a median expectation of an economic indicator from the actual released value. In the absence of expectations data, we construct our variables as follows. First, we calculate the percentage change in the data in logarithms between time t and time $t\text{-}1$ for the full period. Next, we standardise the data by subtracting the mean from each observation and dividing through by the standard deviation. The use of standardised news is employed elsewhere in the literature as it has desirable properties such as facilitating comparisons of responses of different exchange rates to different items of news, and not affecting the statistical

significance of response estimates (Andersen et al., 2003a). However, we recognise that our measure of standardised news is indicative of the magnitude of each evolution for the macroeconomic indicators, and not by design an indication of surprise.

5. Empirical Results

5.1 Diagnostic Tests of Model Specification

The econometric model presented in Section 3 estimates the conditional mean and conditional variance of foreign exchange returns. We use likelihood tests to select a preferred model. The first test is used to decide if news should enter the conditional variance equation asymmetrically. Equations [4] and [5] are estimated and we test the null hypothesis that the joint significance of the asymmetric effects is equal to zero, that is, $\delta_{m,n} = 0$. The data strongly reject the null implying that the asymmetric model is the more appropriate model specification. We estimate the model using alternative specifications of equation [1]. That is, we specify the conditional mean equation with and without the macroeconomic variables. Tests confirm that the latter variables should be included in the model. Equation [5] was estimated using the BFGS (Broyden, Fletcher, Goldfarb, and Shanno) algorithm to maximise the log likelihood function. We also employ the quasi-maximum likelihood (QML) estimation of Bollerslev and Wooldridge (1992) which allows inference when the conditional distribution of the residuals is non-normal. Convergence was achieved after 181 iterations.

The following presentation and discussion of results are based on estimates obtained from the preferred model. Table 4 shows the distributional features of the model residuals. The

standardised residuals $(\varepsilon_1, \varepsilon_2)$ are skewed and exhibit kurtosis. The model specification in terms of adequately capturing the dynamics of the data is checked by testing the standardised residuals for the presence of serial correlation and heteroskedasticity. A correctly specified model implies the standardised residuals will be *iid* standard normal variables. Typically, univariate tests are applied independently to each series although multivariate tests have been developed but are less frequently employed (see, Kroner and Ng, 1998; Ding and Engle, 2001). We follow the former approach and carry out independent residual diagnostic tests using the Ljung-Box test and the residual or LM ARCH test (see Engle, 1982).

Table 4 here

Ljung-Box Q statistics are calculated on the standardised residuals $(\varepsilon_1, \varepsilon_2, \varepsilon_3)$, standardised squared residuals ($\varepsilon_1^2, \varepsilon_2^2, \varepsilon_3^2$), and cross-products of the standardised residuals $(\varepsilon_1\varepsilon_2, \varepsilon_1\varepsilon_3, \varepsilon_2\varepsilon_3)$. The Q statistics test for the presence of higher order serial correlation. We accept the null hypothesis of no higher order serial correlation in $\varepsilon_2, \varepsilon_3$. The model adequately captures the persistence in the variance of returns since the standardised squared residuals, in general, are serially uncorrelated (except ε_1^2). Although we cannot accept the null in two of the cross-products $(\varepsilon_1\varepsilon_2, \varepsilon_2\varepsilon_3)$, it is unreasonable to expect the model to completely account for serial correlation since the daily returns are highly leptokurtic. The residual ARCH test is used to determine the presence of autocorrelation in squared residuals. Autocorrelation is detected in ε_1^2 but not ε_2^2 and ε_3^2 . Following De Goeij and Marquering (2004), we consider the consistency of QML estimates by testing the null hypotheses: $\varepsilon_i = 0$,

$\varepsilon_i^2 = 1$, and $\varepsilon_i \varepsilon_j = 1$ where i,j = 1 ... 3. The null is accepted implying the QML estimates are consistent.

5.2 Price discovery in foreign exchange

In this section we consider the results of the conditional mean equation [1] for each exchange rate. Exchange rate returns are modelled as a function of the optimal number of lagged returns, according to the Akaike information criterion, and the macroeconomic indicators. Three of the four indicators (CPI, IP, ED) are released in the early morning whereas one (M2) is released in the late afternoon. The exchange rate data are noon spot rates. Therefore, the data are contemporaneous – on a daily basis – for three indicators whilst one has to be lagged by one day. The estimated coefficients and their standard errors are shown in Table 5a.

Table 5a here

The results show a positive and significant relationship between returns and returns lagged by one day for each exchange rate. Turning to the impact of standardised news announcements on conditional mean returns, there is evidence that returns are responsive. However, returns appear to respond to specific news, namely, the consumer price index and short-term Eurodollar interest rate. The signs on the two coefficients imply that returns are larger when the standardised news indicator is large and positive, that is, foreign exchange returns are positively associated with large, positive movements in US inflation and short-term interest

rates. Whereas pound-dollar returns are sensitive to short-term interest rate announcements. Returns on the franc-dollar are affected by both US CPI announcements and short-term interest rate announcements.

The empirical evidence suggests that macroeconomic announcements maintain an impact on foreign exchange returns collected some 2.5 to 3.5 hours later. However, we caution that this is not a generalised finding as it is applicable to specific news announcements which are variable across different foreign exchange markets.

5.3 Volatility transmission

The conditional variance equation [5] shows how persistent volatility is following the arrival of news. The error terms drawn from equation [1] enter equation [5] as innovations and represent the continual arrival of news that affects the volatility of foreign exchange returns. The specification of equation [5] allows news to affect conditional volatility asymmetrically: that is, we model that bad news (days on which returns are negative or days when the US dollar depreciates) affects conditional volatility to a larger extent than the arrival of good news. Table 5b shows the parameter estimates.

Table 5b here

The coefficients in Matrix A, α_{mn}, show the relationship between conditional volatility and innovations in the lagged squared error terms – so-called ARCH effects. As expected, and consistent with the previous empirical literature, the coefficients representing news originating in each currencies own market is positive and significant. In Matrix A there is no

evidence that news of one exchange rate's returns significantly affects the conditional volatility of returns of another exchange rate. The coefficients that measure shocks emanating from bad news are contained in Matrix D and denoted by δ_{mn}. The coefficients δ_{11} and δ_{33} show that bad news originating in the spot markets for yen and pound significantly effects the conditional volatility of returns. However, in the yen market, the volatility of returns is lowered by the arrival of bad news from the yen market whereas it is increased in the pound market when bad news arrives from that market. We observe bi-directional interrelationships in the transmission of bad news across foreign exchange markets. Bad news emanating in the yen market, significantly increases the volatility of returns in the franc market and vice-versa (δ_{21} and δ_{12}). Similarly, bad news originating in the franc market significantly lowers the volatility of returns in the market for pounds and vice-versa (δ_{32} and δ_{23}). We do not find evidence of a significant interrelationship between the markets for yen and pounds. In brief, the results indicate the asymmetric behaviour of foreign exchange returns, and offer support for previous findings in the literature on currencies and other financial market assets.

One of our aims is to investigate the volatility transmission process and to identify whether news affects the volatility of returns either on a "home" (own market) basis or cross-market basis. The "home" market hypothesis is termed the heat wave and the cross-market hypothesis the meteor shower (see Engle et al., 1990; Ito et al., 1992). We test the two hypotheses by examining the coefficients in Matrix B. The coefficients, β_{mn}, indicate the persistence of news or the rate at which news decays – GARCH effects. We have already noted that there are significant news shocks in the foreign exchange markets, but it is possible that volatility can persist in the absence of significant innovations because

persistence is responsive to the continual arrival of news. If persistence is significant, the effect of the arrival of news in the foreign exchange market lasts for at least one day (according to the GARCH(1,1) specification). An insignificant coefficient implies that the news content is absorbed by the market and decays immediately. Evidence in support of the meteor shower hypothesis will be provided should the coefficients on cross-market interrelationships be significant. As expected, news originating in each foreign market is persistent and lasts for at least one day (see β_{11}, β_{22}, and β_{33}). There is limited evidence of cross-market persistence. The relationships we observe are uni-directional. News arriving from yen market and the pound market persists in the franc market (β_{21} and β_{31}), respectively. However, the magnitude of these coefficients is relatively small. In brief, we observe some support for the meteor shower hypothesis, but it appears that foreign exchange returns are affected to a much greater extent by the heat wave hypothesis.

5.4 Volatility dynamics

To examine volatility dynamics from the preferred econometric model, we use the estimated coefficients to derive estimates of conditional volatility, covariance, and correlation between foreign exchange returns. We present our estimates using time series graphs rather than statistically. Establishing return dynamics and comovements are important issues for traders, international investors and other managers of international financial risks.

One issue is whether financial integration has resulted in an increase in the correlation between foreign exchange markets over time. If correlations are increasing, portfolio risk may also be increasing as it is becoming more difficult to optimally allocate assets because diversification is less efficient. These issues are discussed in detail by Forbes and Rigobon

(2002), Longin and Solnik (2001), Goetzmann et al (2001), and Boyer et al (1999). An asymmetric dependence between returns implies that correlations between returns are larger during episodes of financial distress compared to periods of relative stability (Hong et al., 2004). For present purposes, we note that it is important to estimate more precise, or conditional, measures of association between markets or asset returns that account for heteroskedasticity in the data.

In Figure 2 we show the evolution of the standard deviation of the volatility of returns in the right-hand side panel, and we express this as an annualised measure of conditional volatility in the left-hand side. Focusing on the annualised conditional volatilities, the mean conditional volatilities for the three spot rates lie within 1.5 percentage points of each other: 12.44% for yen, 13.20% for franc, and 11.95% for pound, respectively. The standard deviation of conditional annualised volatility is smallest for the pound (1.74%) followed by the franc (1.83%) and yen (2.04%), respectively. The Figures show that conditional volatility is time-varying. Chronologically, volatility exhibits greater variation during the 1970s and least variation in the most recent period from the end of the 1990s and beginning of the new millennium.

Figure 3 shows the evolution of conditional covariance and correlation between the volatility of exchange rates returns. Both measures exhibit time varying behaviour. The covariances are mainly positive implying there are linear relationships between foreign exchange returns. A visual inspection of the conditional covariance between yen spot and franc spot returns suggests that covariance increases sharply during episodes of economic and financial crisis,

for instance, the 1978 oil crisis, 1987 stockmarket crash, and 1997 Asian crisis. Statistically, the covariance is not an ideal measure of the strength of association between variables. Therefore, we derive the conditional correlation coefficient for the foreign exchange returns.

Figure 3 here

It is possible that the time variation observed in the covariances is due to the variance of volatility. If this is the case, the correlation between returns will be constant. However, Figure 3 shows this is not the case as the conditional correlations are highly variable over time. Generally, each of the correlations exhibits a cyclical pattern: falling in the mid-1970s; rising to the mid-1980s; gradually trending downwards in the 1990s; increasing again in the early 2000s. On average, returns between franc and pound spot rates are highest (0.6261), followed by yen and franc (0.5335) and yen and pound (0.4048) returns. A closer examination of the distributions of the correlations reveals that the upper quartile correlations range from 0.7732 to 0.9399 for franc-pound returns, 0.7147 to 0.9342 for yen-franc returns, and 0.6145 to 0.8858 for yen-franc returns. The corresponding ranges for the lower quartile are -0.4636 to 0.5468 (Franc-Pound), -0.2276 to 0.3832 (Yen-Franc), and -0.4439 to 0.2303 (Yen-Pound). Generally speaking, the empirical evidence appears to suggest correlations between foreign exchange returns are time varying but that they follow visible patterns. This finding has implications for international portfolio and risk management, and asset allocation strategies.

5.5 Price discovery, volatility transmission and dynamics in periods of recession

What effect does news have on the conditional means and variances of foreign exchange returns at different stages of the US business cycle? Recent empirical evidence suggests that US macroeconomic announcements do not exert significant effects on foreign exchange returns during periods of recession (see Andersen et al., 2004). We re-examine this issue using the thirty year period which contains a number of US recessions that should enable us to yield more robust conclusions.[18]

The sub-sample consists of 1,593 observations in recessionary periods, which is approximately 20% of the full sample. The returns data for recessionary periods exhibit considerably greater non-normality in terms of being more heavily skewed and having larger kurtosis. The mean returns are larger (though not statistically significant from zero): the daily (annualised) mean return for yen spot is -0.0582% (-14.67%); for franc, -0.0337% (-8.49%); and for pound 0.0273% (6.88%). However, the annualised variance is largest for franc spot returns (31.33%) followed by yen (28.02%) and pound (17.29%) spots, respectively.

We estimate the preferred conditional mean equation [1] and conditional variance equation [5] for the sub-sample (see Table 6a and b). The estimated coefficients in the conditional mean model confirm the earlier finding of Andersen et al. (2004) that macroeconomic news announcements are insignificant in explaining foreign exchange returns. On the contrary, bad news shocks (dollar depreciation) are highly important in explaining movements in the volatility of foreign exchange returns. Indeed, some of the coefficients in Matrix D are extremely large in comparison with our earlier estimates (in Table 5b). We observe that bad

[18] We follow Andersen et al. (2004) and define recessions as beginning when there are three consecutive monthly declines in the index of industrial production, and ending when there are three consecutive monthly increases in the index. Whereas Andersen et al. use non-farm payroll employment as their yardstick, they report similar results using industrial production data.

news originating in a currency's own market *and* news emanating in other spot markets determines the volatility of returns. Bad news originating in the yen (δ_{11}) and franc (δ_{22}) spot markets raises the conditional variance of returns in those markets whereas bad news in the pound spot market lowers the variance of pound returns (δ_{33}). Furthermore, there are bi-directional interrelationships with bad news in the yen and pound (δ_{31} and δ_{13}), and franc and pound (δ_{32} and δ_{23}) spot markets significantly affecting the conditional volatility of returns in each other and vice-versa. We find that bad news in the yen and franc spot markets significantly lower the volatility of returns in pound returns (δ_{31} and δ_{32}).

Table 6a,b here

The parameter estimates are used to derive the conditional variance, covariance, and correlation of returns. The mean conditional variances of returns increase during recessions: 20.23% *c.f.* 12.44% for yen; 21.80% *c.f.* 13.20% for franc; 15.49% *c.f.* 11.95% for pounds. The magnitude of covariance increase in recessions and there are much sharper spikes. As may be expected, the median correlation between returns increases in recessions; albeit marginally in yen (0.0544) and pound (0.0485) markets but by 0.1872 in the franc market.

6. Conclusion

In this paper, we employed a multivariate BEKK GARCH model to jointly estimate the conditional mean and variance of exchange rate returns between 1975 and 2005. A likelihood ratio test confirms the specification of asymmetric news effects which we take to be currency depreciation *vis-à-vis* the US dollar. Diagnostic tests of the model's residuals support the preferred GARCH specification.

The estimated coefficients in the conditional mean equation shed some light on the price discovery process in FX markets. Following Andersen et al (2003, 2004) we examine the impact of four US macroeconomic fundamentals on FX returns. US news announcements on the consumer price index and short-term interest rate are significantly related to FX returns but not news of industrial production and the money supply. Whereas relatively large rises in US consumer prices raise yen-dollar and franc-dollar returns it has no significant effect on pound-dollar returns. Pound-dollar returns are found to significantly increase following relatively large increases in the short-term interest rate which also significantly raises franc-dollar returns but not yen-dollar returns. The results imply that the effect of news announcements of US macroeconomic fundamentals lasts for 3.5 hours which is a longer than the time suggested by Andersen et al (2003).

In terms of volatility transmission, there are a number of significant news shocks in FX markets. Consistent with the existing literature, FX markets are more responsive to news originating in "home" markets. However, currency movements do transmit cross borders. Currency depreciation of the yen and pound significantly affects the variance of returns in the two markets but the direction of the effects is different. Yen depreciation lowers the variance of yen returns whereas pound depreciation increases the variance of returns. Yen (franc) depreciation spills over to significantly increase the variance of franc (yen) returns whilst franc (pound) deprecation significantly lowers the variance of returns to the pound (franc). The arrival of news has a persistent effect lasting for at least one day. The magnitude of persistence is considerably larger for "home" news compared with cross-border news.

We establish the dynamics of foreign exchange market returns. The conditional volatility of exchange rate returns, the covariance of returns, and the correlation coefficient between returns are all time-varying. Generally speaking, there is a sharp upward trend in conditional volatility and correlation from 1975 to the mid-to-late 1980s which probably reflects increasing integration in financial markets. Although there is variability in the 1990s, the trend is slightly downwards. It is increasing, however, in the early-to-mid 2000s though the patterns show far less dispersion compared with the 1970s and 1980s. Conditional covariance and correlations increase sharply during episodes of financial crisis – a finding consistent with the existing literature. There is great variation in correlations with negative correlations around -0.4 to positive correlations over 0.9 being observed. That there are patterns in the conditional correlations suggests this information could be useful for international portfolio and risk management purposes.

The GARCH model is re-estimated for a sub-sample of periods when the US economy was in the recession stage of the business cycle. During recessionary periods, news announcements of US macroeconomic fundamentals are insignificant in predicting FX returns, which is consistent with the findings of Andersen et al (2004). However, currency depreciation (home *and* cross border) becomes more important in influencing the variance of FX returns. Mean conditional variances of FX returns are much larger during recessionary periods and there are sharper movements in conditional covariance and correlations.

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Table 1: Autocorrelations of Returns & Squared Returns

	Returns			Squared Returns		
Lag (days)	**¥ / $**	**SF / $**	**£ / $**	**¥ / $**	**SF / $**	**£ / $**
1	0.0276	0.0190	0.0479*	0.1903*	0.1099*	0.1165*
2	0.0149	0.0029	0.0107	0.1010*	0.1132*	0.1206*
3	0.0010	-0.0003	-0.0125	0.0939*	0.0881*	0.1067*
4	-0.0004	0.0113	0.0067	0.0640*	0.0559*	0.1237*
5	0.0166	0.0036	0.0340*	0.0849*	0.0895*	0.1039*
6	-0.0097	-0.0092	-0.0110	0.0934*	0.0721*	0.1193*
7	0.0080	-0.0051	-0.0115	0.0576*	0.0720*	0.0854*
8	0.0132	0.0106	0.0078	0.0615*	0.0850*	0.0773*
9	0.0168	0.0058	0.0179	0.0990*	0.0500*	0.0662*
10	0.0447	0.0192	0.0065	0.0534*	0.0611*	0.1031*
11	0.0061	-0.0018	-0.0078	0.0715*	0.1091*	0.1368*
12	0.0052	-0.0052	-0.0126	0.0506*	0.0767*	0.0823*
13	0.0018	-0.0096	-0.0093	0.0407*	0.0617*	0.0676*
14	0.0131	0.0061	0.0042	0.0771*	0.0832*	0.0850*
15	0.0073	0.0262	0.0271	0.0494*	0.0426*	0.0907*
16	0.0018	-0.0015	-0.0098	0.0320	0.0441*	0.0897*
17	-0.0099	0.0006	0.0098	0.0462*	0.0471*	0.0738*
18	0.0200	-0.0088	-0.0085	0.0845*	0.0558*	0.0701*
19	-0.0064	0.0037	-0.0090	0.0805*	0.0471*	0.1073*
20	0.0142	0.0172	0.0195	0.0838*	0.0424*	0.1236*
21	0.0053	0.0202	0.0074	0.0653*	0.0265	0.0489*
22	-0.0029	-0.0044	0.0048	0.0541*	0.0445*	0.0710*
23	0.0114	0.0110	0.0150	0.0597*	0.0501*	0.0641*
24	-0.0047	0.0178	-0.0003	0.0632*	0.0359*	0.0489*
25	0.0196	0.0137	0.0205	0.0569*	0.0543*	0.0824*
26	0.0053	-0.0171	-0.0110	0.0728*	0.0320	0.0810*
27	0.0054	-0.0045	0.0129	0.0534*	0.0431*	0.0433*
28	0.0049	0.0073	0.0135	0.0641*	0.0522*	0.0677*
29	-0.0041	-0.0004	0.0069	0.0578*	0.0548*	0.0641*
30	-0.0143	0.0032	0.0074	0.0327	0.0719*	0.0602*

Note: * , statistically significant at the 5 percent level.

Table 2: Ljung-Box Q Statistics (6 to 30 lags) for Returns & Squared Returns

	Returns	Squared returns	Error	Squared error
¥ / $				
Q (6 lags)	10.94	608.72***	3.17	584.71***
Q (12 lags)	31.86***	830.79***	22.56**	811.59***
Q (18 lags)	37.79***	995.72***	28.56	980.81***
Q (24 lags)	41.29**	1224.88***	32.16	1206.94***
Q (30 lags)	46.86**	1386.44***	37.57	1367.55***
SF / $				
Q (6 lags)	4.83	396.20***	1.80	400.74***
Q (12 lags)	9.43	691.11***	6.28	695.68***
Q (18 lags)	16.69	851.77***	13.71	855.00***
Q (24 lags)	26.21	936.96***	22.92	939.68***
Q (30 lags)	30.79	1072.67***	27.57	1075.12***
£ / $				
Q (6 lags)	31.46***	645.71***	1.51	644.17***
Q (12 lags)	37.75***	1081.11***	7.06	1074.95***
Q (18 lags)	46.68***	1392.38***	16.26	1389.44***
Q (24 lags)	52.88***	1722.58***	22.15	1711.77***
Q (30 lags)	60.94***	1945.95***	29.89	1934.88***

Note: *, **, * statistically significant at 1%, 5% and 10%.**

Table 3: Descriptive Statistics: Exchange Rate Returns, Jan. 1975 to Dec. 2005

	¥ / $	SF / $	£ / $
Sample Mean	-0.0116	-0.0082	0.0039
Standard Error	0.6442	0.7212	0.5977
Variance	0.4149	0.5202	0.3573
Standard Error of the Mean	0.0072	0.0080	0.0066
t-Statistic (Mean = 0)	-1.6186	-1.0181	0.5796
Skewness	-0.5061***	-0.0179	0.1368***
Kurtosis (excess)	4.6497***	3.0638***	3.8274***
Jarque-Bera	7628.21***	3162.66***	4959.97***
Observations	8085	8085	8085

Note: *, **, * statistically significant at 1%, 5% and 10%.**

Table 4: Diagnostic Tests: Standardised, Standardised Squared, and Cross-Products of Residuals

	ε_1	ε_2	ε_3	ε^2_1	ε^2_2	ε^2_3	$\varepsilon_1\varepsilon_2$	$\varepsilon_1\varepsilon_3$	$\varepsilon_2\varepsilon_3$
Mean	-0.0023	-0.0100	0.0041	0.9828	1.0066	0.9888	0.8764	7.5028	0.9839
Variance	0.9828	1.0066	0.9889	5.2522	3.9348	7.5211	250.99	445614.51	37.4940
Skewness	-0.5216***	-0.1685***	0.0139	7.9476***	6.3607***	29.8023***	-21.8652***	88.8645***	-20.0647***
Kurtosis	3.4353***	1.8783***	5.6955	104.59***	75.2107***	1658.40***	1338.14***	7960.78***	1371.87***
LM ARCH test[(a)]				29.4723***	10.3386	3.1216			
t-stat for H_0: $\varepsilon_{it} = 0$	-0.2126	-0.9005	0.3721	-	-	-	-	-	-
t-stat for H_0: $\varepsilon_{it}\varepsilon_{it} = 1$	-	-	-	-0.6616	0.2607	-0.3667	-0.6989	0.8756	-0.2362
Ljung-Box Q Statistics[(b)]									
Q (6)	10.86	6.50	3.87	32.45***	11.00	3.35	120.26***	0.0046	306.92***
Q (12)	38.42***	17.78	13.56	36.60***	16.75	5.44	242.07***	0.0094	344.73***
Q (18)	45.04***	24.70	19.46	41.18***	24.36	6.64	245.84***	0.01	401.84***
Q (24)	50.26***	37.24**	24.82	44.01***	27.88	14.41	250.04***	0.02	794.85***
Q (30)	55.49***	43.43	33.07	49.76**	36.47	16.43	261.48***	0.10	828.26***

Notes:

(a) The LM ARCH test is the Lagrange multiplier test of Engle (1982) for the presence of ARCH effects in residuals. The 95% and 99% critical values from the χ^2 distribution with $df = 5$ are 11.1 and 16.7, respectively.

(b) The 95% critical values for Q(6), Q(12), Q(18), Q(24), and Q(30) are 12.6, 21.0, 28.9, 36.4 and 43.8, respectively. The 99% critical values for Q(6), Q(12), Q(18), Q(24), and Q(30) are 18.5, 28.3, 37.2, 45.6 and 53.7, respectively.

***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 5a: Conditional Mean Equation: Parameter Estimates (full sample)

		¥ / $		SF/$		£/$	
Variable		Coefficent	Std error	Coefficent	Std error	Coefficent	Std error
Constant	β 0	-0.0091*	0.0051	-0.0018	0.0055	0.0004	0.0049
Ri{1}	β 1	0.0199**	0.0097	0.0160*	0.0091	0.0524***	0.0098
Ri{2}	β 2	0.0064	0.0096	-	-	0.0115	0.0077
Ri{3}	β 3	-	-	-	-	-0.0187**	0.0076
Ri{4}	β 4	-	-	-	-	0.0090	0.0078
Ri{5}	β 5	-	-	-	-	0.0156**	0.0075
X1	β 6	0.0337	0.0258	0.0697**	0.0295	0.0184	0.0232
X2	β 7	0.0131	0.0255	0.0320	0.0250	0.0152	0.0204
X3{1}	β 8	0.0060	0.0219	0.0191	0.0322	-0.0001	0.0117
X4	β 9	0.0207	0.0110	0.0231*	0.0136	0.0206*	0.0113

Note: Ri = foreign exchange returns for i = 3 (Yen/dollar; franc/dollar; pound/dollar), noon buying rates in New York. X1 = CPI announcement (8.30am); X2 = Industrial production announcement (9.15am); X3 = M2 announcement (4.30pm); X4 = Collected bid rates for Eurodollar 6 month deposits (approximately 9.30am). All times are EST.

Table 5b: Conditional Variance Equation: Parameter Estimates (full sample)

Variable		**Coefficient**	**Standard error**	**Variable**		**Coefficient**	**Standard error**
C11	ω_{11}	0.0134	0.0104	B13	β_{13}	0.0022	0.0017
C12	ω_{12}	-0.0216	0.0197	B21	β_{21}	0.0036*	0.0022
C13	ω_{13}	-0.0386	0.0378	B22	β_{22}	0.9748***	0.0031
C22	ω_{22}	0.0342**	0.0161	B23	β_{23}	0.0097***	0.0029
C23	ω_{23}	-0.0272	0.0511	B31	β_{31}	0.0013	0.0025
C33	ω_{33}	0.0386	0.0770	B32	β_{32}	0.0016	0.0026
A11	α_{11}	0.1950***	0.0173	B33	β_{33}	0.9620***	0.0040
A12	α_{12}	0.0014	0.0138	D11	δ_{11}	-0.0638**	0.0307
A13	α_{13}	-0.0026	0.0080	D12	δ_{12}	0.0835***	0.0177
A21	α_{21}	-0.0109	0.0085	D13	δ_{13}	0.0132	0.0148
A22	α_{22}	0.1998***	0.0121	D21	δ_{21}	0.0897***	0.0135
A23	α_{23}	-0.0078	0.0108	D22	δ_{22}	0.0176	0.0166
A31	α_{31}	-0.0046	0.0080	D23	δ_{23}	-0.0357*	0.0198
A32	α_{32}	0.0016	0.0089	D31	δ_{31}	-0.0001	0.0110
A33	α_{33}	0.2116***	0.0138	D32	δ_{32}	-0.0332**	0.0136
B11	β_{11}	0.9790***	0.0035	D33	δ_{33}	0.1306***	0.0228
B12	β_{12}	0.0032	0.0033				

Table 6a: Conditional Mean Equation: Parameter Estimates (recessions)

		¥ / $		SF/$		£/$	
Variable		Coefficent	Std error	Coefficent	Std error	Coefficent	Std error
Constant	β 0	-0.0308	0.0363	0.0002	0.0471	0.0295	0.0283
Ri{1}	β 1	-0.0007	0.0251	-0.0006	0.0203	0.0168	0.0327
Ri{2}	β 2	-0.0185	0.0134	-	-	0.0066	0.0134
Ri{3}	β 3	-	-	-	-	0.0292**	0.0114
Ri{4}	β 4	-	-	-	-	0.0079	0.0144
Ri{5}	β 5	-	-	-	-	-0.0026	0.0186
X1	β 6	0.0256	0.1268	0.1624	0.1098	0.0355	0.0760
X2	β 7	-0.0599	0.0633	0.0471	0.0823	-0.0254	0.0677
X3{1}	β 8	0.0585	0.2303	0.1499	0.2039	0.0906	0.1239
X4	β 9	0.0344	0.0465	0.0499	0.0465	0.0300	0.0300

Note: Ri = foreign exchange returns for i = 3 (Yen/dollar; franc/dollar; pound/dollar), noon buying rates in New York. X1 = CPI announcement (8.30am); X2 = Industrial production announcement (9.15am); X3 = M2 announcement (4.30pm); X4 = Collected bid rates for Eurodollar 6 month deposits (approximately 9.30am). All times are EST.

Table 6b: Conditional Variance Equation: Parameter Estimates (recessions)

Variable		Coefficient	Standard error	Variable		Coefficient	Standard error
C11	ω_{11}	0.9153***	0.2974	B13	β_{13}	0.0125	0.5165
C12	ω_{12}	0.3775	0.7771	B21	β_{21}	0.1152	0.3883
C13	ω_{13}	-0.1271	0.1836	B22	β_{22}	0.3287	0.2464
C22	ω_{22}	1.0940***	0.4148	B23	β_{23}	0.4410	0.3545
C23	ω_{23}	0.1793	0.1266	B31	β_{31}	-0.0922	0.1148
C33	ω_{33}	0.0000	1.1924	B32	β_{32}	-0.2593***	0.0762
A11	α_{11}	-0.0163	0.0568	B33	β_{33}	-0.3450***	0.0658
A12	α_{12}	0.0045	0.0734	D11	δ_{11}	0.4330**	0.1754
A13	α_{13}	-0.0325	0.0923	D12	δ_{12}	0.0681	0.3564
A21	α_{21}	-0.0054	0.0493	D13	δ_{13}	0.4401***	0.1527
A22	α_{22}	0.0098	0.0836	D21	δ_{21}	5.4953*	2.9615
A23	α_{23}	-0.0062	0.0604	D22	δ_{22}	5.4547*	3.1863
A31	α_{31}	0.0747	0.3690	D23	δ_{23}	1.9802**	0.8638
A32	α_{32}	-0.0384	0.5745	D31	δ_{31}	-5.3382**	2.2286
A33	α_{33}	0.1442	0.6078	D32	δ_{32}	-5.4321**	2.5165
B11	β_{11}	0.0133	0.3937	D33	δ_{33}	-2.8339***	0.8623
B12	β_{12}	0.0090	0.3910				

Figure 1 – Evolution of Exchange Rates and Returns, Jan. 1975 – Dec. 2005

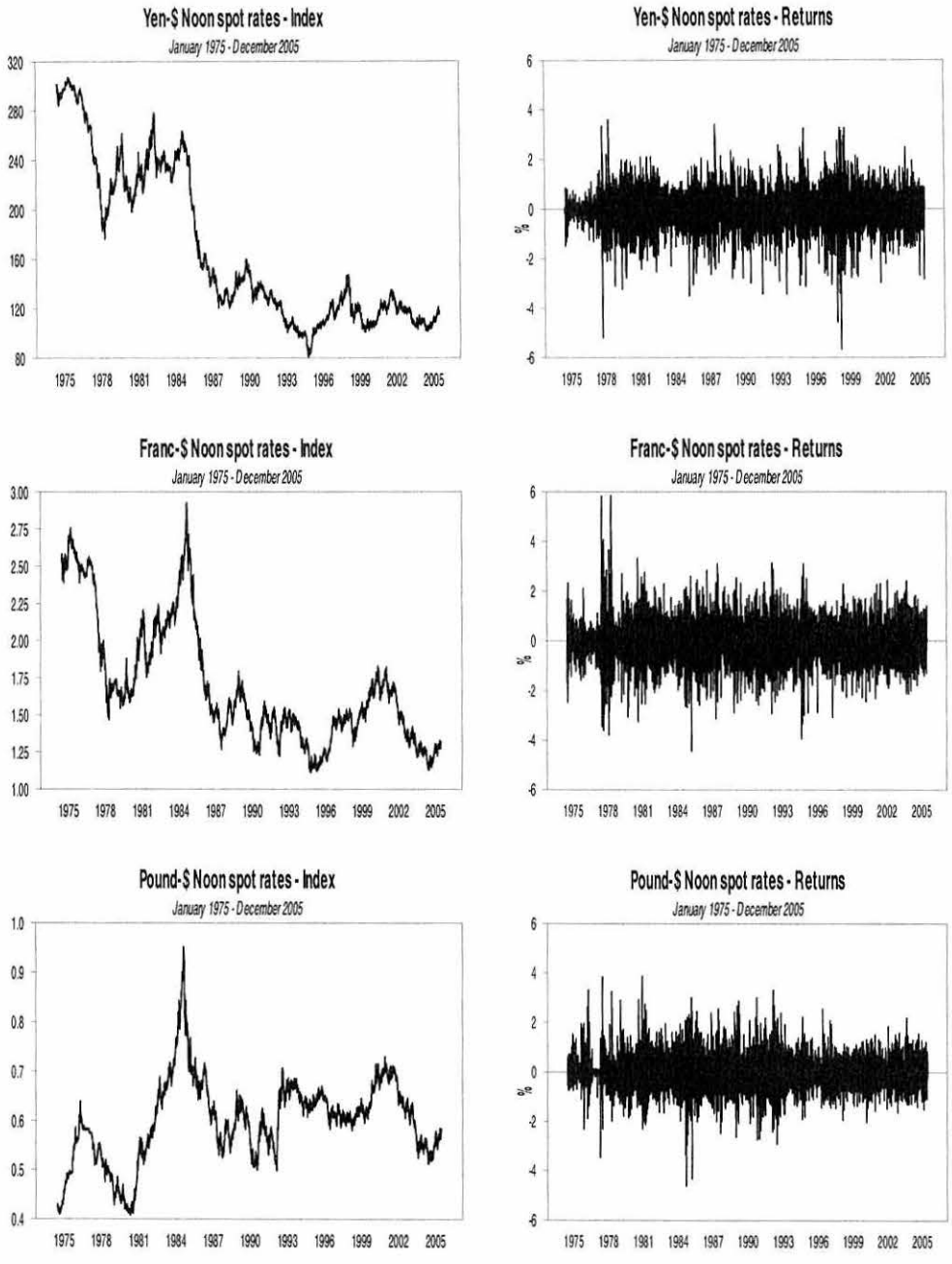


Figure 2: Conditional Volatility

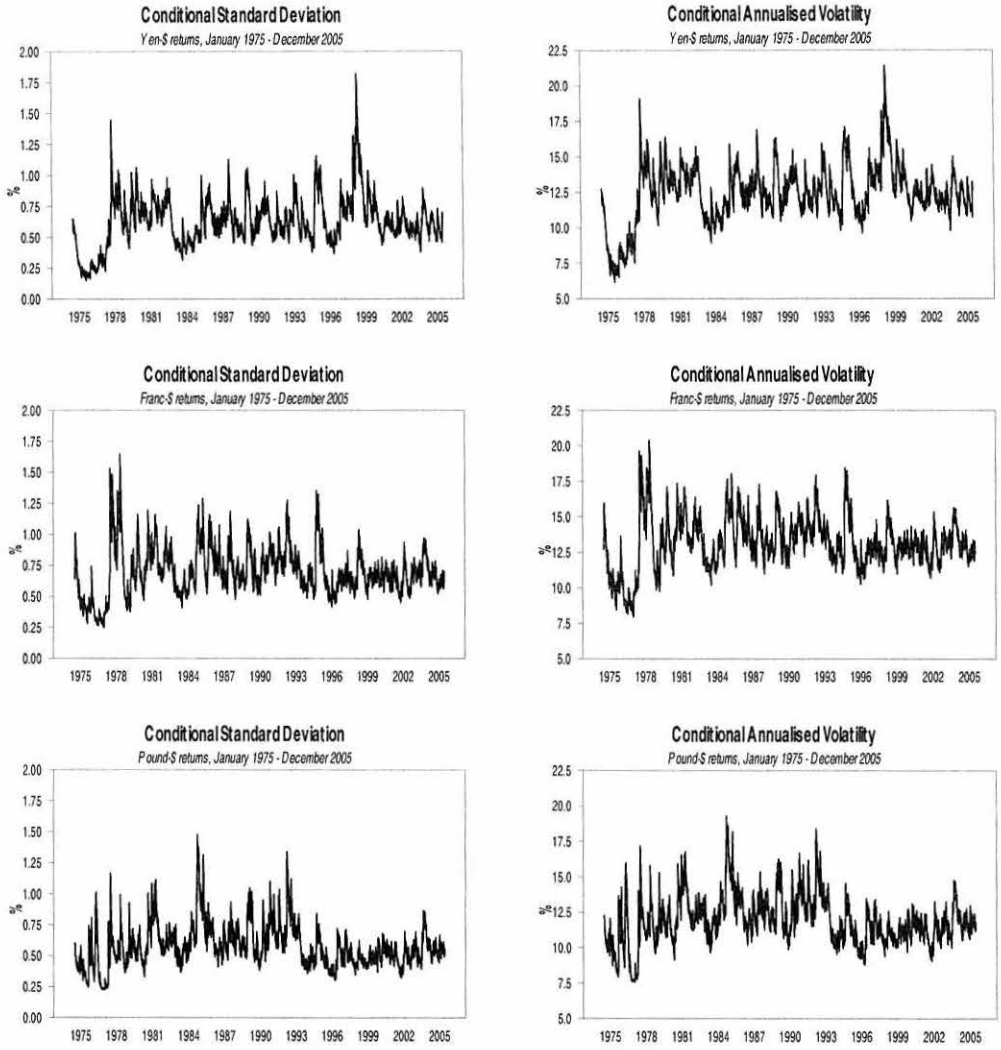
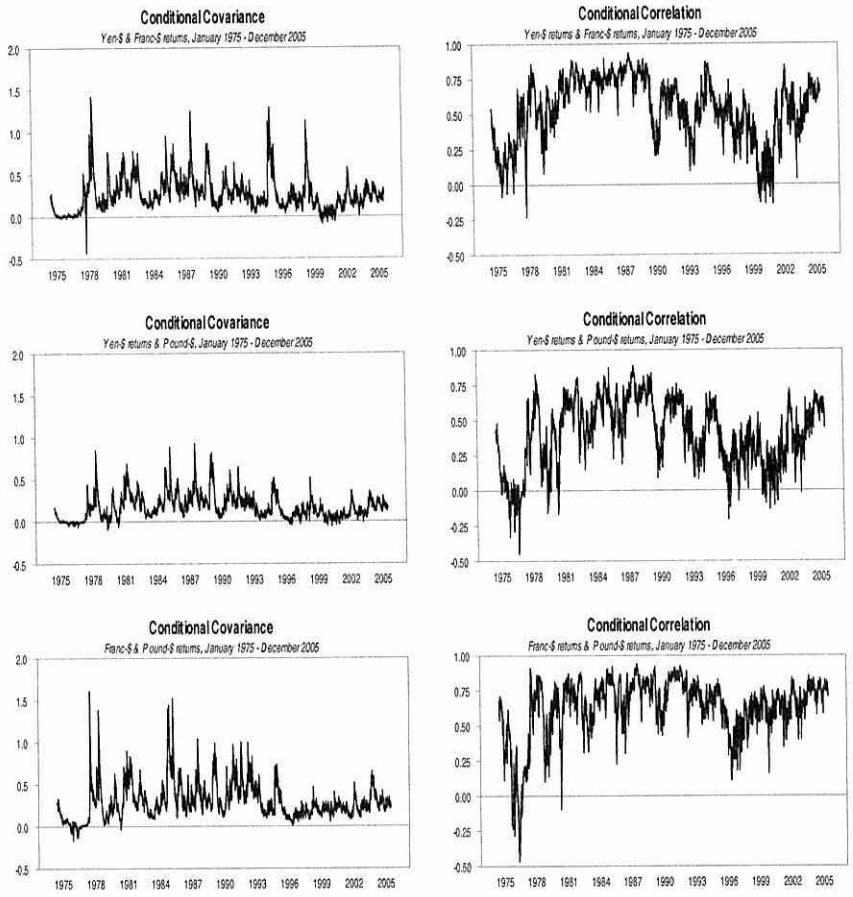


Figure 3: Conditional Covariance and Correlation



PART II

Working Paper III

Financial integration, Price discovery: Evidence between FX and Stock Market returns in the BRICs

Abstract

We jointly estimate conditional price discovery and volatility transmission processes in the BRIC countries using a multivariate GARCH model that allows for interdependencies amongst returns and a time varying variance-covariance structure. We find that asset prices are fairly predictable with lagged currency movements and local stockmarket movements significant. Furthermore, we establish the importance of US macroeconomic fundamentals in pricing assets in emerging markets. Whilst we observe spillover effects between markets, the volatility of price returns is more responsive to own market news. However, we find that volatility is affected more by bad news and that an asymmetric model framework is required. We employ the model coefficients to examine volatility dynamics. The conditional variance of FX returns is lower than local stock market returns, and is responsive to episodes of financial crisis and changes in exchange rate regime. Conditional covariance and correlations are time-varying. On average, the latter tend to be fairly small in magnitude which suggests that the integration process is far from complete, but this is good news for investors wishing to internationally diversify risk.

JEL Classification: C32, F02, F31, G15

Keywords: Exchange rates, stock markets, volatility transmission, multivariate GARCH, asymmetric news, emerging markets

1. Introduction

This paper aims to bring together elements of the finance-growth and volatility transmission literatures and place them within the context of the integration of emerging markets (EM) with international financial markets. Equity market liberalisation (EML) represents an important structural change that has altered the composition of capital inflows to EM from mostly bank lending towards portfolio flows and foreign direct investment (Lopez-Meija, 1999). As a result, EM financial markets are expected to become more sensitive to news from international markets. This is likely to increase the covariance in asset price returns as the integration process deepens (Bekaert and Harvey, 2003). Similarly, financial shocks from industrial markets are expected to increase the covariance with EM returns (Bekaert and Harvey, 1997; Kaminsky and Reinhart, 2000; Longin and Solnik, 1995, 2001; Loretan and English, 2000). A larger covariance of returns could increase the volatility of portfolios which implies higher risks as well as higher expected returns (Karolyi and Stulz, 1996). Thus, it is important to establish the time-varying properties of covariances because financial integration and larger covariances imply there will be fewer opportunities for investors to engage in efficient portfolio diversification (Karolyi and Stulz, 1996). Whereas correlations are reported to have increased since the mid-1990s, it is important to determine their magnitude because low correlations suggest potential diversification benefits exist in EM (Bekaert and Harvey, 2002; Bekaert et al, 2002).

In light of the expected dynamics arising from financial integration, our interest lies in the price discovery and volatility transmission processes. We specify a multivariate GARCH framework in which there are three types of price returns: foreign exchange (FX); local stock market; and international (US) stock market. The model enables us to jointly model the price

discovery and volatility transmission processes and the interdependencies between price returns across markets and borders. Price discovery and volatility transmission is generating considerable interest amongst researchers and practitioners. Econometric advances have created multivariate frameworks within which time varying variances and covariances may be estimated without the imposition of overly restriction conditions. Accurate estimates of conditional variances and covariances are important for price determination, asset selection, and the international management of risk. International portfolio diversification is premised on the low correlation of asset returns across geographic markets. Recent empirical studies examine the interdependence of returns amongst different asset markets: stock, bond and foreign exchange (FX) markets (Andersen et al., 2004); stock and bond markets (De Goeij and Marquering, 2004). Another strand of literature models interdependencies between FX and stock markets, and considers the relationships between currency depreciations and stock returns. The bulk of studies concern developed countries and there is much less research of emerging markets. The current study partly seeks to fill this vacuum.

We have several objectives in this paper which are discussed in the following:

1. According to the efficient market hypothesis (Fama, 1965), asset prices incorporate all available information, and price changes reflect the arrival of new information. Since prices follow a martingale process, it is assumed that public information will be impounded in asset prices almost instantaneously. This implies that future changes are unpredictable on the basis of publicly available information (Engle et al., 1990). It is important to examine this issue because the process of price discovery, and how

quickly and effectively prices incorporate new information, remains opaque even in developed markets. Evidence suggests that prices quickly "jump" to macroeconomic news surprises (Andersen et al., 2003), although there is less agreement concerning the rate at which news decays with some evidence suggesting traders reconcile the arrival of new information with prior expectations for days (Evans and Lyons, 2005). Andersen and Bollerslev (1998) and Andersen et al. (2004) provide evidence that US macroeconomic fundamentals exert a causal effect on the price discovery process of German and British FX, stock and bond markets. We follow this approach and examine whether US macroeconomic fundamentals affect the price discovery process in EM. We also model the price discovery process by considering the lagged returns from each asset market as a predictor of price. Thus, we can identify the effects of currency movements and stock market movements on asset price returns.

2. We examine the volatility transmission process between FX returns, local and international stock market returns. A volume of evidence suggests that volatility is more responsive to "bad news", and we model the asymmetry of returns following Glosten et al. (1993). This allows us to identify how currency depreciation affects the volatility of stock market returns and vice-versa. To date, the empirical evidence on this relationship is mixed. Yang and Doong (2004) note the rise in exchange rate risk and volatility associated with floating exchange rates and that stock markets tend to respond to this higher level of risk. To consider this issue, we test for significant changes in volatility before and after the Russian and Brazilian exchange rate crises in 1998.

3. As the rate of integration quickens, one would expect that "international" news will become a more important piece of information. The leading role played by US stock markets in the volatility transmission process amongst developed markets is well documented (Eun and Shim, 1986). Our models specify US stock market returns, and the interdependencies between the variance and covariance of US returns and EM market returns are taken as an indication of the degree of integration. Yang and Doong (2004) suggest that because of larger international capital flows, exchange rate returns are likely be more sensitive to news concerning stock market returns and international portfolio investments. Our model can validate such interdependence.
4. It is important to establish whether volatility is time-varying. If this is true, then the modelling of covariances becomes important. Our GARCH model does not impose any restrictions on the variance-covariance structure which enables us to utilise the coefficients from the model to derive estimates of conditional variance, covariance, and correlation between returns. Volatility dynamics suggest that the variance of returns will decline and the covariance of returns increase as integration progresses (because of changes in diversification opportunities). This is expected to reduce risk premiums associated with EM investments (Bekaert and Harvey, 1997). Likewise, it is important to establish the degree of correlation and how it is evolving because of its implications for international portfolio diversification. Bekaert et al. (2002) suggest that whereas correlations are found to increase after EML, the correlations tend to remain fairly low which implies that diversification benefits can be found in EM.

This study applies our model of conditional volatility to the BRIC countries: Brazil, Russia, India and China. The BRICs are among the largest twenty countries in the world and they are projected to become among the most powerful economies within the next 50 years (Wilson and Purushothaman, 2003; Jensen and Larsen). At the present time the BRICs make a relevant study of conditional volatility because the authorities have implemented financial policies that are designed to increase the rate of integration of local markets with international markets. For instance, Brazil and India underwent official equity market liberalisation in May 1991 and November, 1992, respectively, and have continued the reform process. Major institutional reforms have been implemented in Russia and China including the reopening and establishment of new stock exchanges.[19] Access to international capital markets has increased as corporations from each BRIC have issued American Depository Receipts (ADRs). The choice of exchange rate regime is a topical issue for EM. In the BRICs, China operated a fixed exchange rate regime - with the renminbi (RMB) tied to the US dollar - until a new regime was adopted in July 2005. On the contrary, India has pursued a managed exchange rate regime which remains intact. Brazil and Russia implemented crawling peg and currency band arrangements as part of stabilisation programmes implemented in 1994 and 1995, respectively, with the real and rouble linked to the US dollar. New floating arrangements were implemented following the 1998 FX crises.

This study contributes to price discovery and volatility transmission literature by modelling the first and second order moments of FX, domestic stock market, and international stock market returns from 30th October 1994 to 30th December 2005. This yields a total of 2,929

[19] In China, the Shanghai Securities Exchange was reopened in January 1990 followed by the establishment of the Shenzhen Exchange in March 1991. The Moscow Interbank Currency Exchange was formed in 1992 and the Moscow Stock Exchange introduced in March 1997.

daily observations. Our preferred econometric approach is to use multivariate GARCH methods to jointly model the conditional mean and conditional volatility of FX, domestic stock market, and international stock market returns.[20] We apply the BEKK formulation which allows cross-market interdependencies (see Engle and Kroner, 1995). Since the covariance of asset returns is reportedly unstable over time (Longin and Solnik, 1995) the model does not impose the restriction of constant correlation (see Bollerslev, 1990). Empirical evidence suggests that conditional covariances are heteroskedastic (see, for instance, Bollerslev et al., 1988; Kroner and Ng, 1998; De Goeij and Marquering, 2004). The asymmetric behaviour of FX and stock market returns is well documented (see Nelson, 1991; Engle and Ng, 1993; Glosten et al., 1993; Bekaert and Harvey, 1997; Kroner and Ng, 1998; Brooks and Henry, 2000; Assoé, 2001; Bekaert et al., 2003; Yang and Doong, 2004). We incorporate asymmetric news effects in the spirit of Glosten et al. (1993). Similar approaches are applied by Kroner and Ng (1998), Henry (1998), Brooks et al. (2002), and De Goeij and Marquering (2004).

The remainder of the paper is organised as follows. Section 2 establishes the volatility dynamics when markets move from a segmented state to an integrated one. Section 3 provides a brief synopsis of the theoretical relationships between exchange rates and stock prices. Section 4 offers a short review of the empirical literature examining relationships between FX and stock market returns. We present the multivariate asymmetric GARCH model in Section 5 and describe our data in Section 6. Empirical evidence is presented in Section 7 and Section 8 concludes.

[20] Whilst we note the development of methods for estimating so-called realized volatility (see Andersen et al., 2003b) and their alleged superiority over GARCH methods in explaining the behaviour of ultra-high frequency intraday returns, our data are daily and tests support the GARCH specification.

2. Volatility dynamics and EML in emerging markets

EML is an important structural change that, if effective, affects the level of stock market development, which is a significant predictor of future GDP growth, capital accumulation and productivity growth (Levine and Zervos, 1998; Beck and Levine, 2004; Levine, 2005). In general, EML removes restrictions on the flow of equity investment in and out of a country (Henry, 2000; Bekaert and Harvey, 2003) and may be considered a specific form of capital account liberalisation (Chari and Henry, 2004). Recent empirical evidence finds that EML, on average, leads to a 1 percent per annum increase in real per capita GDP growth although the relatively strong rate of growth may reflect an interaction between EML and macroeconomic reforms and financial development (Bekaert et al, 2005). Nevertheless, there is considerable heterogeneity in growth rates following EML with the highest rates accruing to countries that have better institutional frameworks and relatively more developed financial systems.

Theoretically, EML is a process of market integration with the international market. Let's consider a model of market integration in which there are two states: (1) a segmented (EM) market and, (2) an integrated (developed) market. Segmented markets are characterised by high transactions costs, illiquidity, and artificial barriers that restrict, if not prevent, foreign investment activity. The markets are dominated by local investors whose portfolios are exposed to price changes induced by domestic economic conditions. Economic shocks lead to lower prices because of limited opportunities for portfolio diversification since all stocks are linked to the domestic economy. Investors are compensated for assuming this risk via higher expected returns, which translates into a higher cost of capital. In the integrated market, investors hold an internationally diversified portfolio meaning that bad news shocks

in one country can be offset by good news shocks from elsewhere. Investors do not require a premium to compensate for individual market volatility implying that the cost of capital is lower in integrated markets (Bekaert and Harvey, 1998). EML, therefore, could reduce the risk premium on equity investments in EM via increasing the level of integration with international markets (Bekaert and Harvey, 1995).

Expected returns in EM are linked to stock market volatility (variance of returns) whereas returns are determined by how a stock interacts with every other stock in the investors' international portfolio (covariance of returns) in the integrated market. As EM financial markets move from segmented to integrated states, expected return (and cost of capital) should decrease because the volatility of EM returns is considerably greater than their covariance with international market returns (Bekaert and Harvey, 2003). Holding the variances and covariances constant, this implies that prices should rise (expected returns decrease). When EML occurs EM markets could become more sensitive to international events and covariances with international returns may increase (Karolyi and Stulz, 1996). Prices are still expected to rise because it is suggested that the covariances remain less than the variances (Bekaert and Harvey, 2003). There are two main implications of covariance dynamics: first, the covariance of EM returns with international returns increases with the degree of market integration; and second, the covariance with international returns increases in times of high global volatility (Bekaert and Harvey, 1997; Kaminsky and Reinhart, 2000; Longin and Solnik, 1995, 2001; Loretan and English, 2000).

3. Theoretical links: exchange rates, stock prices, and macroeconomic fundamentals

What does theory tell us about the relationship between exchange rates and stock prices? In flow models of exchange rates, changes in exchange rates work through the current account because they affect the international competitiveness of firms that, in turn, affects output and incomes (see Dornbusch and Fisher, 1980). Exchange rate movements affect stock prices because the latter are interpreted as the present value of future cash flows of firms, and which is influenced by the former. In stock models, innovations in stock markets affect the exchange rate via the capital account (see Branson, 1983). Exchange rates are postulated to equate the supply and demand for assets. Since the values of financial assets are determined by the present values of their future cash flows, expectations of relative currency values play an important role in their price movements, especially for internationally held financial assets. Thus, innovations in stock markets may affect exchange rates, and vice-versa.

Similarly, in portfolio balance models, it is possible for an inverse relationship between exchange rates and stock prices and a positive relationship to exist (see Lyons, 2001). The inverse relationship implies causation runs from stock prices to exchange rates. Investors hold domestic and foreign assets, including currencies, and exchange rates balance the demand for and supply of assets. A rise in domestic stock prices causes investors to demand more domestic assets and to sell foreign assets. As a result of this activity, the domestic currency appreciates. A positive relationship between stock prices and exchange rates with causality running from exchange rates to stock prices can occur if a depreciation of the domestic currency enhances the competitiveness of exports, which in turn raises domestic stock prices of exporters. This analogy may be used to explain a scenario of weak or no association between exchange rates and stock prices. If we assume the exporting company

imports many of its inputs from abroad, then its stock price may not rise because the cost of producing goods will have risen. Thus, any competitive gains from currency depreciation are offset. For non-exporting firms also reliant on foreign inputs, the situation will be worse if rising production costs cause output and income to fall. Innovations in stock prices affect the wealth and liquidity of investors (see Gavin, 1989). For instance, an increase in stock prices will lead investors to increase their demand for money. This, in turn, puts upward pressure on domestic interest rates which will attract foreign capital inflows thereby further appreciating the domestic currency. Similarly, increasing foreign demand for domestic assets will also cause an appreciation of the domestic currency.

The theoretical relationships between exchange rates, stock prices, and macroeconomic fundamentals are reviewed by Andersen et al. (2004). Generally, good domestic news, for instance, low inflation, increases in employment and production, should strengthen the domestic currency. The relationship between macroeconomic fundamentals and stock prices is less clear because stock prices are determined by three effects: expected cash flows, the discount rate, and the risk premium. It is an empirical question as to which effect exerts dominance. There is the possibility that the relationship alters over the course of the business cycle, which again is an empirical issue.

4. Studies of financial market interdependence

4.1. Interdependence between FX markets and stock markets

The dynamic interrelationships between exchange rates and stock markets have produced an extensive empirical literature. However, the causality between exchange rates and stock prices is not yet rigorously established. Movements in the two markets may be related

because some economic variables, for instance, interest rates, affect both which can cause a convergence of expectations among market participants.

Fang and Miller (2002) suggest currency depreciation affects stock market performance via three channels: first, a depreciation currency lowers stock market returns; second, the more volatile the exchange rate, the higher stock market returns; and third, exchange rate depreciation volatility raises stock market volatility. The empirical record on the level of integration between exchange rates and stock prices is mixed. Nieh and Lee (2001) apply cointegration techniques and find no significant long run relationship between stock prices and exchange rates in the G-7 countries.[21] On the contrary, Muhammad and Rasheed (2001) find a long run relationship (but no short-term relationships) for two out four south Asian countries.[22]

There is more evidence of short-term relationships between exchange rates and stock prices. Nieh and Lee (2001) use a vector error correction model and find evidence of a bi-directional interaction between exchange rates and stock prices: currency depreciation leads to lower next day stock returns is some G-7 markets and higher returns in others whereas increasing stock prices often cause next day currency depreciation. Yang and Doong (2004) confirm the interaction between movements in stock prices and future exchange rates in the G-7, but they claim the relationship is uni-directional since changes in exchange rates exert a less direct

[21] Nieh and Lee (2001) employ cointegration and vector error correction models (VECM) across the G-7 countries which are Canada, France, Germany, Italy, Japan, the UK and US. The period of analysis is from October 1993 to February 1996.

[22] Muhammad and Rasheed (2001) employ cointegration, VECM, and Granger causality methods to exchange rates and stock prices in Bangladesh, India, Pakistan and Sri Lanka. The period of analysis is from January 1994 to December 2000.

effect on stock prices.[23] Nevertheless, Yang and Doong suggest the two markets are integrated.

Exchange rates and stock prices are more integrated in developed markets compared to EM where little or no association is found. For instance, Ajayi et al. (1998) find evidence of uni-directional causality running from stock markets to FX markets in developed markets but only mixed evidence in EM. Similarly, contemporaneous determination of stock returns and FX movements are found in developed but not EM.[24] On the contrary, Assoé (2001) finds evidence of significant volatility spillover from FX markets to national stock markets in most EM.[25]

Other studies extend the analysis of exchange rates and stock prices to include the effects of an international stock market, mostly the US, in the analysis. Chiang et al (2000) find that regional and international factors positively affect conditional mean returns in Asian stock markets, and that currency appreciation leads to higher stock market returns.[26] Fang and

[23] Yang and Doong (2004) use an EGARCH model to analyse relationships in the G-7 between May 1979 and January 1999.

[24] Ajayi et al (1998) employ Granger causality tests to explore bi-directional, uni-directional, and contemporaneous relationships between stock returns and exchange rate changes for seven industrial markets and eight Asian emerging markets. They classify the following nations as industrial: Canada, Germany, France, Italy, Japan, the UK and US. Emerging markets are Hong Kong, Indonesia, Korea, Malaysia, the Philippines, Singapore, Taiwan and Thailand. The period of analysis is from April 1985 to September 1991.

[25] Assoé (2001) investigates volatility transmission between currency and stock markets in eleven emerging and five industrialised markets using a tri-variate EGARCH model. His classification of countries is as follows: the industrial nations are Canada, France, Germany, Japan and the UK; the emerging markets are Brazil, Chile, Greece, India, Korea, Mexico, the Philippines, Singapore, Taiwan, Thailand and Turkey. The period of analysis is from January 1989 to July 2000.

[26] Chiang et al (2000) employ a bivariate GARCH approach to examine the variance-covariance structure of Asian stock prices and foreign exchange rates. Innovations in national stock markets returns are predicted by local, regional and international factors: lagged national stock returns and exchange rate change (local); lagged returns in the Japanese stock market (regional); and lagged returns in the US stock market (international). The countries are Hong Kong, Indonesia, Japan, Korea, Malaysia, the Philippines, Singapore, Taiwan and Thailand, and the foreign currencies are the Japanese yen and the US dollar. The period of analysis is from January 1990 to February 1998.

Miller (2002) report a similar finding from a study of exchange rates and the Korean stock market during the period of the Asian crisis.[27] According to Chiang and Yang (2003), risk premiums in FX markets are dependent on the expected risks in national and international stock markets. Risk premiums are time-varying whilst national stock returns are explained significantly by returns in the US stock market. There is evidence of spillover effects or volatility transmission between the three markets and the correlation structure is time-varying.

4.2. Stock market interdependence

There is a voluminous literature on stock market interdependence. The main findings from developed markets include the transmission of shocks from the US to other markets (Eun and Shim, 1989); an increase in the intensity of volatility transmission over time from the US to European and Japanese markets (Kearney, 2000; Baele, 2003, Kim et al, 2005); greater regional interdependence within European markets (Kanas, 1998; Baele, 2003; Bekaert et al, 2005); the behavioural influence of foreign markets on smaller markets (Jochum, 1989) even after controlling for macroeconomic news (Connolly and Wang, 2003); and an increase in spillover effects following stock market crashes (King and Wadhwani, 1990; Kanas, 1998).

In the context of this study, several studies investigate the relationship between financial market integration and major deregulatory events. In Europe, stock market integration is associated with reduced exchange rate uncertainty (Fratzscher, 2001; Hardouvelis et al, 2002; Baele and Vennet, 2001; Kim et al, 2005), monetary convergence, (Fratzscher, 2001; Baele and Vennet, 2001); and business cycle conditions (Baele, 2003). The removal of capital and

[27] Fang and Miller's study runs from January 1997 to December 2000.

foreign exchange controls in Japan in 1980 facilitated closer integration between that country and the US (Gultekin et al, 1989). However, Ewing et al (1999) does not accept the view that eliminating trade barriers between the NAFTA (North American Free Trade Area) countries caused an increase in the co-movement of the Canadian, Mexican and US stock markets.

The volatility transmission literature concerned with spillover effects from developed markets to EM reports evidence of significant next day effects on returns in Asia (Manning, 2002; Masih and Masih, 1999; Jang and Sul, 2002; Fernández-Serrano and Sosvilla-Rivero, 2001) and Latin America (Johnson and Soenen, 2003; Pagan and Soydemir, 2000).[28] There is evidence that correlations between developed market returns and EM returns increase following episodes of financial crisis like the Asian Crisis of 1997 (see Tan and Tse, 2002, and Fernández-Serrano and Sosvilla-Rivero (2002) for evidence from Asia and Latin America, respectively). However, studies find that regional integration in EM is progressing at a faster pace than international integration, which accords with findings from Europe discussed above (see Jang and Sul (2002)[29], Johnson and Soenen (2002)[30], and Ng (2002)[31] for Asia; see Barari (2004) for Latin America). Leong and Felmingham (2003) find evidence

[28] Generally, there is support for a leading relationship from the US and Japan to Latin American and Asian markets, respectively (innovations in the US do affect volatilities in Asia). Innovations in international markets are associated with an increase in the co-movement of returns under the following circumstances: a) trade linkages - greater for markets with stronger trade linkages to international economies; b) exchange rate volatility – lower for countries suffering from exchange rate volatility (Johnson and Soenen, 2003); c) differences in institutional and financial structure (Pagan and Soydemir, 2000); greater foreign direct investment from international economies (Johnson and Soenen, 2002). On the contrary, co-movement decreases because of factors such as differentials in inflation, real interest rates and GDP.

[29] Jang and Sul (2002) find regional stock market integration to be increasing between the following Asian markets: Hong Kong, Singapore, Thailand and Indonesia.

[30] Johnson and Soenen (2002) find regional stock market integration to be increasing between the following Pacific-Asian markets: Australia, China, Hong Kong, Malaysia, New Zealand and Singapore.

[31] Ng (2002) provides evidence that emerging Asian stock markets in Indonesia, the Philippines and Thailand have become more closely linked with Singapore, and that the correlation of returns across ASEAN markets increased following stock market liberalisation.

of higher correlations of returns in developed Asian stock markets.[32] Finally, the importance of economic integration as a pre-requisite for financial market integration in EM is noted by Phylatkis and Ravazzolo (2002).

4.3 FX market interdependence

Empirical evidence suggests volatility responds asymmetrically to changes in exchange rate regimes. Bollerslev (1990) compares the volatility of five European exchange rates *vis-à-vis* the US dollar before and after the creation of the EMS (European Monetary System) in March 1979; in other words, after an increase in policy coordination.[33] Similarly, Laopodis (1998) examines volatility transmission between three EMS and three non-EMS exchange rates *vis-à-vis* the German mark before and after the unification of Germany in 1990.[34] Bollerslev (1990) finds that exchange rate volatility and conditional covariances between exchange rates increase after the creation of the EMS. On the contrary, formerly significant spillover effects between EMS currencies disappear after German unification whereas volatility persistence actually increases for non-EMS currencies. Laopodis (1998) also finds evidence of asymmetric behaviour in the volatility transmission process. Other empirical evidence concerning the transmission of volatility from the German mark to other EMS currencies is found in Kearney and Patton (2000).

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[32] Leong and Felmingham (2003) find greater interdependence in returns from the Singaporean, Korean, Japanese, Taiwanese and Hong Kong equity markets following the 1997 crisis.

[33] The EMS currencies are the French franc, German mark and Italian lira whilst the other European currencies are the British pound and Swiss franc. The pre-EMS period runs from July 1973 to March 1979 and the post EMS period from March 1979 to August 1985, thereby allowing for a comparison of volatilities under floating and fixed exchange rate regimes (see Bollerslev, 1990).

[34] The EMS currencies are the Belgian franc, Dutch guilder, and French franc; and the non-EMS currencies the Canadian dollar, Japanese yen, and US dollar. The period of analysis covers March 13th, 1979 to December 30th, 1996. In order to investigate the effects of German reunification, two sub-samples are created: from March 13th 1979 to June 30th, 1990; and July 1st 1990 to December 30th, 1996. The data exclude exchange rate realignments and speculative attacks (see Laopodis, 1998).

Evidence suggests that FX and stock market interdependence is affected differently by the arrival of good and bad news. Assoé (2001) and Yang and Doong (2004) employ EGARCH models that allow innovations to enter the variance-covariance structure asymmetrically. Assoé suggests that investor behaviour is more responsive to bad news about FX markets than good news but innovations in exchange rates don't affect stock market returns in developed markets.

5. Model Specification

A wealth of literature is devoted to modelling temporal dependence in first and second order moments of asset returns. Seminal works include Engle (1982) and Bollerslev (1986) which introduced the ARCH and GARCH methodologies. A multitude of methodological developments and empirical applications have emerged since (see the excellent reviews of Bollerslev et al. 1992, and Bauwens et al., 2006). We estimate a multivariate GARCH using the BEKK specification of Engle and Kroner (1995), where the restrictions of a symmetrical variance-covariance structure and constant correlation are removed, and news enters the model in an asymmetric manner following Glosten et al. (1993). Thus, the paper contributes to a limited set of studies which estimate asymmetric GARCH models in applications to stock market volatility and spillovers (Ng, 2000), optimal hedge ratios (Brooks et al., 2002), asset returns (Kroner and Ng, 1998), and stock and bond returns (De Goeij and Marquering, 2004).

The conditional means of FX and stock returns are modelled as in equation [1]. Let r_t equal the continuously compounded return over the period t–1 to t. In particular, We denote $R_t = \ln(s_t) - \ln(s_{t-1},)$ where S = the exchange rate index. $\ln(s_t) - \ln(s_{t-1})$ refers to the log return from the difference of today' exchange rate(s_t Information) to one day later(s_{t-1} Information)

The exchange rate data are expressed as units of US dollars meaning $r_{t.} > 0$ refers to depreciation of local currency and $r_{t.} < 0$ appreciation of local currency The information set available to investors at time t–1, when investment decisions are taken, is denoted Ω_{t-1}. The expected return and volatility of returns based on those decisions are the conditional mean and variance of r_t given Ω_{t-1}, denoted $y_t = E(r_t \mid \Omega_{t-1})$ and $h_t = var(r_t \mid \Omega_{t-1})$, respectively. The unexpected return at time t is $\varepsilon_t = r_t - y_t$. Following Engle and Ng (1993), ε_t can be interpreted as a measure of news. An unexpected increase in returns ($\varepsilon_t > 0$) indicates the arrival of good news, whilst an unexpected decrease in returns ($\varepsilon_t < 0$) indicates bad news.

$$R_t = \beta_0 + \sum_{i=1}^{l} \beta_i rfx_{t-1} + \sum_{i=1}^{l} \beta_i rds_{t-1} + \sum_{i=1}^{l} \beta_i ris_{t-1} + \sum_{i=k}^{k} \beta_k MP_k + \varepsilon_t \quad \textbf{[1]}$$

$$\varepsilon_t \mid \Omega_{t-1} \sim N(0, H_t)$$

where R_t is a linear function of I lagged values of itself, and news arising from k contemporaneous monetary policy announcements. rfx_{t-1} refers to returns to lagged foreign exchange for country l, rds_{t-1} and ris_{t-1} present returns to lagged domestic stockmarkets and lagged international stockmarket to country I. The lagged values are chosen according to the Akaike information criteria. De Goeij and Marquering (2004, p .541) note that because shocks to equation [1] are the "main actors" in multivariate GARCH models, it is important to correctly specify the conditional mean equation.

The conditional variance h_t may be modelled as a function of the lagged ε_t, implying that predictable volatility is dependent on past news, with the effect of any piece of news upon current volatility decreasing as the news becomes older or decays (Engle, 1982). In the

GARCH specification introduced by Bollerslev (1986), the effect of a shock to returns decreases geometrically over time. In its simplest form, the univariate GARCH(p,q) model may be specified as follows:

$$h_t = \omega + \sum_{i=1}^{p} \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^{q} \beta_j h_{t-j} \qquad [2]$$

where $\omega > 0$; $\alpha_1, \ldots, \alpha_p \geq 0$; and $\beta_1, \ldots, \beta_q \geq 0$ are constant parameters, and the non-negativity conditions ensure the conditional variance is positive. Equation [2] imposes a restriction of symmetry on the conditional variance structure. This restriction is undesirable in view of the *a priori* assumption that markets do not treat good and bad news, or small and large news shocks, in an equal manner. For an asymmetric effect, the impact of a shock of any given magnitude on the covariance equation differs depending upon whether the shock is positive (good news) or negative (bad news).

Following Glosten et al. (1993), equation [2] can be re-specified to account for the possibility of asymmetric effects. Let $k_{t-1}=1$ if $\varepsilon_{t-1}<0$, and $k_{t-1}=0$ otherwise. For ease of exposition we assume p=q=1, or a GARCH(1,1) specification:

$$h_t = \omega + (\alpha + \delta k_{t-1}) \varepsilon_{t-1}^2 + \beta h_{t-1} \qquad [3]$$

$\delta>0$ implies a bad news shock has a greater impact on volatility than a good news shock. The conditions $\omega>0$, $\alpha\geq0$, $\alpha+\delta\geq0$ and $\beta\geq0$ must be satisfied in order to ensure a positive conditional variance.

For a multivariate model, let $r_{m,t}$ denote the continuously compounded return on the m'th asset price over the period t–1 to t, for m=1 ... M. The expected return is the conditional mean of $r_{m,t}$ given Ω_{t-1}, denoted $y_{m,t} = E(r_{m,t} \mid \Omega_{t-1})$. The unexpected return at time t is $\varepsilon_{m,t} = r_{m,t} - y_{m,t}$. As before, the conditional variance-covariance matrix is measurable with respect to the information set, Ω_{t-1}, such that $\varepsilon_t \mid \Omega_{t-1} \sim N(0, H_t)$, where ε_t is an M×1 vector containing $\{\varepsilon_{m,t}\}$ for m=1 ... M, and H_t is an M×M matrix containing the conditional variances and covariances for the disturbance terms of the M equations.

We express the multivariate counterpart of equation [2] using the GARCH-BEKK specification, which guarantees that H_t is positive-definite through the imposition of quadratic forms upon the matrices of coefficients:

$$H_t = C'C + \sum_{i=1}^{p} A_i \varepsilon_{t-i} \varepsilon_{t-i}' A_i' + \sum_{j=1}^{q} B_j H_{t-j} B_j' \qquad [4]$$

C is an M×M upper-triangular matrix of coefficients, and A_i and B_j are (unrestricted) M×M matrices of coefficients. The GARCH-BEKK specification permits the estimation of spillover effects between equations. One drawback of [4], however, is it implies that only the magnitude of previous news is important in determining the current conditional variances and covariances. This is excessively restrictive because it does not allow for the very real possibility of asymmetric effects, defined as before. For a multivariate model, these can be specified as follows:

Let $k_{m,t-1}=1$ if $\varepsilon_{m,t-1}<0$ and $k_{m,t-1}=0$ if $\varepsilon_{m,t-1}\geq 0$ for m=1,... ,M.

Let K_{t-1} be an M×M diagonal matrix containing $k_{m,t-1}$ in the main diagonal elements, and 0's in the off-diagonal elements; and let $\xi_{t-1} = K_{t-1}\varepsilon_{t-1}$. As before, for ease of exposition we assume a GARCH(1,1) specification with p=q=1:

$$H_t = C'C + A'\varepsilon_{t-1}\varepsilon_{t-1}'A' + D\xi_{t-1}\xi_{t-1}'D' + BH_{t-1}B' \qquad [5]$$

In [5], D is the matrix of coefficients for the asymmetric effects. Since the symmetric and linear GARCH-BEKK model (i.e. [4] with p=q=1) is a restricted version of [5] in which D = 0, a likelihood ratio test can be used to determine the more appropriate model specification.

In the estimations that are reported below, the number of equations is M=3. We let $r_{m,t}$ denote the continuously compounded returns for the FX rate expressed in currency units per US dollar (m=1), the price return to the domestic stock market (m=2), and the price return to the international stock market (m=3), defined to be the returns on the Dow Jones Industrials Index. The model is estimated for each of the BRIC countries.

6. Data

We collect exchange rate indexes expressed as units of national currency per US dollar, domestic BRIC stock market indexes, and the US Dow Jones Industrials Index which we take as the international stock market. Followed by ABDV(2004), and Patton(2005), we intents to characterize the response of U.S, Brazil, Russia, Indian, and China(BRICs) stock markets to real-time U.S. macroeconomic news. The BRIC stock indexes are the BOVESPA (Brazil), Russian Federation Stock Exchange (Russia), Bombay Stock Exchange (India), and Shanghai Composite Index (China). The data were sourced from Datastream and cover the 10th October 1994 to 30th December 2005 giving a total of 2,929 observations for each series.

In addition, in order to have a robustness test on the effect of Financial episode in Brazil, Russia, and China(See page 12 footnotes), we

Figure 1 shows the evolution of exchange rate indexes, domestic stock market indexes, and the international stock market indexes and their returns over time. Returns are calculated as 100 x $ln(R_t / R_{t-1})$ where R is the asset price index at time *t*. From the left-hand side of the Figures, one can clearly observe the breaks in exchange rate regimes in Russia (1998) and Brazil (1999), respectively, and the subsequent adoption of a floating exchange rate regime and depreciation of the rouble and the real against the dollar. India has operated a managed float with the rupee depreciating against the dollar over time. In contrast, China employed a fixed exchange rate regime from 1993 until mid-2005. The Russian and Indian stock markets have been in a bull state since 1996 and 2001. Although the Brazilian stock market experienced more volatility in its evolution, it entered a sharp bull period in 2002. At the end of 2005, the stock market index was at its highest of the sample period for these three countries. By way of contrast, the Chinese stock market peaked in 2001 after a bull period that began in 1995 came to an end. Currently, the Chinese stockmarket is in a lengthy bear period (see Figure 1).

Figure 1 here

The literature reports that exchange rates and stock prices display similar features: volatility clustering, persistence, skewness, kurtosis, as well as spillovers or volatility transmission

between markets.[35] We concur with this finding for the BRICs. The evolution of FX and stock market indexes are shown on the left hand side of Figure 1 with returns on the right. The returns series display evidence of unpredictability and volatility clustering which is established through the autocorrelation of returns and squared returns. If returns are predictable, the autocorrelations should be significant, whilst volatility clustering will appear as significant autocorrelations in the squared returns. The Ljung-Box Q statistic is calculated at various lag lengths from 6 to 30 days for the return and squared return series, and the error and squared error series. For the return and error series, a significant Q statistic rejects the null hypothesis of no serial correlation, whilst a significant Q statistic for the squared return and squared error series rejects the null hypothesis that squared return and squared error are homoskedastic. In general, the Q statistics are significant for all stock markets and foreign exchange markets with the exception of the Chinese foreign exchange market. The data in Table 1 show return and error series are characterised by the presence of higher order serial correlation and non randomness, whereas the squared return and squared error series display non-linear dependency. The findings of autocorrelation and higher order serial correlation, and non-linear dependency support the decision to model volatility using GARCH methods.

Table 1 here

Table 2a shows descriptive statistics for stock market and FX returns. There is little difference in the magnitude of sample means in stock and FX markets although the latter are all significant whereas stock returns in Russia and India are significant. The only negative

[35] See Engle and Bollerslev, 1986; Boothe and Glassman, 1987; Hsieh, 1989; Baillie and Bollerslev, 1989, 1990; Bollerslev and Engle, 1993; Engle et al, 1990; and Ito et al, 1992. Generally, these studies examine volatility transmission between the US dollar and the currencies of other industrial nations.

return is found in the Chinese FX market. The distributional features of the returns series are as expected. The returns are clearly non-normal and with each series exhibiting skewness and kurtosis. The latter appears to be particularly marked in FX returns indicating that returns are fat tailed.

Table 2a here

For information, we re-express daily return and its standard deviation as annualised values. Annualised returns are greater in stock markets compared with FX markets. The highest annualised stockmarket return is offered in Russia (4.8%) followed in descending order by Brazil (2.7%), India and China (2.1%, respectively). However, there is higher risk associated with the Russian stock market (annualised standard deviation of 26.3%) and least in India (20%). The Russian FX offers the best return (4.5%) followed by Brazil (3%) and India (1.8%). In comparison with the variation of stock market returns, there is less volatility in FX returns.

We source the announcements dates for four series of US macroeconomic data for the period under review. The series (source) are the consumer price index (Bureau of Labour Statistics), index of industrial production, index of M2 (non M1), short-term interest rate on six month Eurodollar deposits (ED) (all Federal Reserve Board). The frequencies for the release and the (EST) times of announcements are as follows: CPI (monthly, 8.30am); IP (monthly, 9.15am); M2 (weekly, 4.30pm); ED (weekly, 9.30am). The data are announced on different days of the week and time of the month. We construct our variables as follows. First, we calculate the

percentage change in the data in logarithms between time *t* and time *t-1* for the period. Next, we standardise the data by subtracting the mean from each observation and dividing by the standard deviation. The use of standardised news is employed elsewhere in the literature as it has desirable properties such as facilitating comparisons of responses of different exchange rates to different items of news, and not affecting the statistical significance of response estimates (Andersen et al., 2003a). However, we recognise that our measure of standardised news is indicative of the magnitude of each evolution for the macroeconomic indicators, and not by design an indication of surprise.

Table 2b here

In Table 2b, we show the mean and standard deviation of returns on days when the standardised measure of announcements is negative and positive. The data are contemporaneous to take account of differences in time zones. Generally, the magnitude of average returns is much larger compared with the full sample with relatively larger returns in Brazilian and Russian markets, which arguably reflects the higher level of integration between the two countries and the US.

7. Empirical Results

The pricing of and dynamic interrelationships between exchange rates and stock markets have produced an extensive literature. In this section, we discuss the results from the asymmetric GARCH model of volatility. We define volatility as the conditional variance, covariance and correlation of returns. Price discovery, volatility transmission and the time-varying nature of volatility have implications for investors and portfolio managers who

assess such information and rebalance their portfolios continually to achieve efficient portfolio diversification. The information is also important for policymakers interested in financial stability.

7.1 Diagnostic Tests of GARCH Model

We estimate the GARCH models using the number of optimal lags suggested by the Schwartz Information Criterion. The BFGS (Broyden, Fletcher, Goldfarb, and Shanno) algorithm is used to maximise the log likelihood function. We adopt the quasi-maximum likelihood estimation (QML) of Bollerslev and Wooldridge (1992), which allows inference when the conditional distribution of the residuals is non-normal.

Initially, we estimate bi-variate BEKK GARCH models for each country which specify the FX market and domestic stock market. We test whether each model specification supports the specification of asymmetric news effects by estimating equations [3] and [4] and conducting the appropriate F-test that the joint significance of the asymmetric terms is equal to zero, that is, $\delta_{m,n} = 0$. The hypothesis is rejected by the data in every case which supports the specification of asymmetric effects and confirms that volatility is affected more by bad news compared with good news. Our next step is to extend each model to a multivariate setting by including the international stock market (Dow Jones Industrial). We test and reject $\delta_{m,n} = 0$ in each multivariate model. Using a likelihood ratio test, we evaluate whether the bi-variate or multivariate model is preferred. In short, the data overwhelmingly support the specification of a multivariate asymmetric model.[36] Our final step is to incorporate macroeconomic fundamentals in the conditional mean equation [1] and to employ likelihood

[36] In this paper, we report findings from the multivariate GARCH model. We did check the consistency of the estimated parameters from the multivariate model with those from the bi-variate model, and we confirm the interdependencies observed between foreign exchange markets and domestic stock markets are consistent across model specification. Further details are available from the authors upon request.

tests to establish a preferred model. The preferred model specifies macroeconomic fundamentals.

Since the asymmetric model is preferred, our presentation and discussion of results are based on the joint estimation of equations [1] and [5]. Table 3 shows the distributional features of the model residuals. Whereas the standardised residuals $(\varepsilon_1, \varepsilon_2, \varepsilon_3)$ are skewed and exhibit kurtosis, the levels are lower than those found in the raw data. The model specification in terms of adequately capturing the dynamics of the data is checked by testing the standardised residuals for the presence of serial correlation and heteroskedasticity. A correctly specified model implies the standardised residuals will be *iid* standard normal variables. Typically, univariate tests are applied independently to each series although multivariate tests have been developed but are less frequently employed (see, Kroner and Ng, 1998; Ding and Engle, 2001). We follow the former approach and carry out independent residual diagnostic tests using the Ljung-Box test.

Table 3 here

Ljung-Box Q statistics are calculated on the standardised residuals $(\varepsilon_1, \varepsilon_2, \varepsilon_3)$, standardised squared residuals $(\varepsilon_1^2, \varepsilon_2^2, \varepsilon_3^2)$, and cross-products of the standardised residuals $(\varepsilon_1\varepsilon_2, \varepsilon_1\varepsilon_3, \varepsilon_2\varepsilon_3)$ of each model. The Q statistics test for the presence of higher order serial correlation. Arguably, it is unreasonable to expect the models to completely account for serial correlation since the daily returns are highly leptokurtic. We are unable to accept the null hypothesis in the standardised residuals (except for ε_3 in each model and ε_1 in the China model). Whilst higher order serial correlation remains in the residuals, nevertheless, it has

been considerably lowered in comparison with the raw data presented in Table 1. In general, the null hypothesis is accepted for the standardised squared residuals and for the majority of the cross-products of standardised residuals. Thus, the models adequately capture the persistence in the variance of returns because the standardised squared residuals are serially uncorrelated. Finally, we employ a diagnostic test suggested by De Goeij and Marquering (2004). If the QML estimates are consistent then we should accept the following null hypotheses: $\varepsilon_i = 0$, $\varepsilon_i^2 = 1$, and $\varepsilon_i \varepsilon_j = 1$ where i,j = 1 ... 3. We accept the null in nearly every case. To summarise, our models either reduce or eliminate higher order serial correlation, and the QML estimates are consistent.

7.2 Price discovery

We consider the results of equation [1] for each of the BRICs. Conditional returns are modelled as a function of the optimal number of lagged returns and the four US macroeconomic fundamentals. The estimated coefficients and their standard errors are shown in Table 4. In panels A to B, the dependent variables are FX price returns and domestic stock market price returns, respectively.[37] According to Harvey (1995), EM returns are more predictable than returns in developed markets and local information has a more important role in predicting returns. Our results offer some support for this view but mostly in the pricing of FX. In each of the BRICs (except Russia), an appreciation of domestic currency significantly predicts domestic currency depreciation. Similarly, increasing domestic stock market price returns significantly predict an appreciation of domestic currency at time *t*, but the effect is considerably smaller compared with lagged FX returns. The relationship between currency movements and domestic stock market returns is longer lasting in Brazil, and Brazil

[37] We choose not to present the conditional mean equation for international stock market returns because we are interested in how international news affects the BRIC countries and not vice-versa.

is the only one of the BRICs where international stock market gains significantly depreciate the domestic currency. This is to be expected as a stronger US stock market will strengthen the dollar. We observe fewer significant relationships in the pricing of domestic stocks. Again Brazil appears to be relatively more integrated with the international market since a bullish US stock market predicts higher Brazilian returns. On the contrary, Russian stock prices are affected by local activity. Only in China does an appreciating domestic currency significantly lower domestic stock market price returns.

Table 4 here

One of our objectives is to examine whether macroeconomic announcements in the US have any affect on the price discovery process in EM markets. The empirical evidence suggests that price discovery is related to the degree of internationalisation between EM markets and global markets. Thus, we observe significant relationships between US macroeconomic fundamentals and FX returns in Brazil and Russia. Indian FX returns are related to one macroeconomic variable. On the contrary, stock market prices in Brazil and China are affected by one US variable each. For instance and in Brazil, larger rises in US consumer prices, industrial production, and money supply significantly depreciate the domestic currency which is expected since a faster growing US economy tends to appreciate the dollar. On the contrary, a US monetary expansion significantly lowers Brazilian stock market price returns.

7.3 Volatility transmission

The GARCH model enables us to estimate the persistence of volatility and the transmission of volatility across markets following innovations in returns. Following Engle and Ng (1993), innovations are treated as the continual arrival of news to which stock and FX markets respond by adjusting prices in line with prior expectations. Engle et al. (1990) suggest that

markets react to news originating in that market (the heat wave) and to news emanating from other markets (the meteor shower). Generally, our results are consistent with the previous literature since we find the heat wave effect to be larger in each of the BRICs. However, there is evidence of meteor shower effects or volatility transmission across markets.

The estimated coefficients from equation [5] are evidence of interdependencies between markets. Matrix A contains the coefficients on the lagged squared error terms which show the size and significance of innovations (news) affecting volatility. Innovations in individual asset markets are larger than cross-market and cross-border interdependencies. The magnitude of own-market coefficients ($\alpha_{11}, \alpha_{22}, \alpha_{33}$) is larger in FX markets (α_{11}) compared with domestic stock markets (α_{22}). There are more significant cross-market news shocks in Brazil compared with the other BRICs. For instance, there is a very large news shock from the domestic stock market to the FX market (α_{12}) which is observed also in India. News from the FX market significantly shocks the volatility of returns in domestic stock markets in Brazil and Russia (α_{21}), whilst international (US stock market) news impacts on domestic stock market volatility in Brazil and China (α_{23}).

The established literature suggests that returns are asymmetrically affected by the arrival of good and bad news. Following Glosten et al. (1993) we incorporate asymmetric effects in the conditional volatility model. Specifically, we model bad news as occurring on days when domestic currencies depreciated, domestic stock price returns decreased, and international stock price returns fell. The significance of bad news shocks can be identified from the coefficients in matrix D. The coefficients underline the fact that bad news from the

international stock market produces the largest shock on conditional volatility in the BRICs (δ_{33}). Domestic stock market bad news is significant but only in Brazil and India (δ_{22}) whereas bad news in the FX markets is insignificant (δ_{11}). The results suggest that the heat wave hypothesis is more appropriate in explaining news asymmetries since the number of cross-market and cross-border interdependencies is few – with the notable exception of India.

Table 5 here

The coefficients in matrix B indicate the persistence of news. Consistent with the heat wave hypothesis, news originating in an asset's own market takes longer to decay than news spilling over from other markets. This finding is common in the literature. Whereas the number of news shocks is greatest in Brazil (see matrix A) the shocks are not long lasting and have dissipated within one day. This finding can be generalised across the BRICs with some exceptions. In Brazil, the transmission of news from domestic stock markets significantly persists and increases the volatility of FX returns (β_{12}) whereas the volatility of domestic stock market returns is lowered by the persistence of news from the FX market in India (β_{21}). The volatility of FX returns in Russia (β_{13}), and domestic stock market returns in China (β_{23}) are lowered and increased, respectively, due to the persistence of international stock market news.

7.4 Volatility dynamics

As noted by Kearney and Patton (2000), amongst others, the coefficients from equation [5] by themselves have limited appeal. Thus, we use the coefficients to derive daily estimates of conditional variance, covariance, and correlation. Establishing the dynamics of returns and

their comovements are important for traders, international investors and other managers of international financial risks. We examine several issues raised in the existing literature. First, EML – and financial integration in general – is expected to facilitate an increase in the sensitivity of EM returns to international returns with the outcome that the covariance of returns is increasing over time (Karolyi and Stulz, 1996). Second, due to stronger linkages between countries, the covariance and correlation between returns will be particularly pronounced during episodes of financial crisis and global volatility (Bekaert and Harvey, 1997; Kaminsky and Reinhart, 2000; Longin and Solnik, 1995, 2001; Loretan and English, 2000).

7.4.1 Conditional Variance

The conditional variance is derived using the estimated coefficients from equation [5] which are presented in Table 5. Below we show how the variance for FX returns is derived noting that the variance is conditional upon news from the FX, domestic stock, and international stock markets.

$$h_{11} = \omega_{11} + \beta_{11}\sigma_{11}^2 + (\alpha_{11} + \gamma_{11})\varepsilon_1^2 + 2(\alpha_{12} + \gamma_{12})\varepsilon_1\varepsilon_2 + (\alpha_{22} + \gamma_{22})\varepsilon_2^2 + 2(\alpha_{13} + \gamma_{13})\varepsilon_1\varepsilon_3 + 2(\alpha_{23} + \gamma_{23})\varepsilon_2\varepsilon_3 + (\alpha_{33} + \gamma_{33})\varepsilon_3^2$$

The evolution of the estimated (annualised) conditional variances for FX and domestic stock markets in the BRICs are shown in Figure 2. *A priori* FX markets are expected to be more integrated than domestic stock markets and therefore the variance of FX returns should be lower. This feature is observed in the data. On average, the variance of FX returns is between two and three times lower than the variance of domestic stock market returns in Brazil, Russia and India, whereas it is around 5.7 times lower in China where a fixed exchange

regime was in place until July 2005. However, the variance of stock market returns in each of the domestic stock returns series appears to be falling over time which suggests that risk premiums are decreasing as markets become more integrated.

Figure 2 here

Unlike the stock market returns, the variance of FX returns – Brazil and Russia - are characterised by sharp spikes. The Figure clearly illustrates the Russian rouble crisis in August 1998 when the conditional variance jumped to over 77. The Russian flu triggered an exchange rate crisis in Brazil in the autumn of 1998 as investors in EM panicked. We note that the crisis sharply increased the variance of FX returns in Brazil to over 45, but the crisis had an even stronger impact on the variance of Brazilian stock market returns which rose rapidly to nearly 67. We carry out a t-test in order to determine whether the abandonment in exchange rate regime in Russia (17th August, 1998) and Brazil (13th January, 1999) significantly affected the conditional variance of returns. The test is performed on periods 260 days either side of the announcement. The tests show the change in exchange rate regimes led to an increase in the variance of FX returns at the 1% level of significance. We extend the period following the regime change to the end of December 2005 and observe the same result. Figure 2 also indicates that the variance of FX returns is lower under a fixed exchange rate regime (China).

7.4.2 Conditional Covariance

The conditional covariance of returns is also estimated using the coefficients from equation

$$h_{12} = \omega_{12} + \beta_{11}\sigma_{11}^2 + 2\beta_{12}\sigma_{12} + \beta_{22}\sigma_{22}^2 + (\alpha_{11} + \gamma_{11})\varepsilon_1^2 + 2(\alpha_{12} + \gamma_{12})\varepsilon_1\varepsilon_2 + (\alpha_{22} + \gamma_{22})\varepsilon_2^2 + 2(\alpha_{23} + \gamma_{23})\varepsilon_2\varepsilon_3 + (\alpha_{33} + \gamma_{33})\varepsilon_3^2 \quad [5].$$

The evolution of conditional covariances is displayed in Figure 3a and 3b.and TableA1 The Figures show that the covariances are time varying and they are characterised, in a number of instances, by very large spikes which are either positive or negative. For Brazil and Russia, the spikes are observed around the period of exchange rate crises in the autumn of 1998. We note that the covariance between domestic stock market returns and international stock market returns tends to be positive for each of the BRICs; the covariance is largest for Brazil which operates a relatively more developed stock market.

Figure 3 here

We find there are differences in covariance across the BRICs. In order to determine what causes these differences, we follow Kroner and Ng (1998), Brooks et al. (2002), and De Goeij and Marquering (2004) and plot news impact surfaces, which are a multivariate generalisation of the news impact curve introduced by Engle and Ng (1993). The surfaces show the effect of news shocks in the previous period on conditional covariance, holding the previous conditional variance and covariance constant at their unconditional sample levels.

Table A1 here

Table A1 shows the Average Conditional Covariance and Standard Deviations in BRICs by Year; 1994 – 2005, there are clear observable pattern lined up in BRICs. It tends there are substantial movements followed the evaluations in FX, domestic and stockmarkets returns in

all BRICs. Especially, the finding from Brazil and Russia of Conditional covariance are consistent to the expected rational, response to the financial episode in the year of 1998 and 1999 when in Brazil virus and Russian crisis duration. Particularly, the conditional Covariance returns in Brazil' domestic stockmarkets to FX markets appeared sharp movement from negative 4.9% in 1998 to negative 424% at 2002. The standard deviations outlines a clearer feature of volatility return from domestic stock markets to FX markets, within one year in different standard deviation of Brail markers rise from 13% in 1998 to 553% in 1999 while drop to 57% in 2000. The similar pattern studied from Russia three asset markets, suffered by Russian Government's default collapse in 1998, domestic stock market of Russia has significant decreased conditional covariance return deducted nearly 9 times through 1999 to 2000. While in India and China markets rather drew a relative steady returns. It is due to India in early 1995 has adopted managed floating exchange rate policy and China FX policy keeps the fixed exchange policy till Recent July, 2005.However, we still finding the pattern of co-movement during observed sample durations

Table A1b

Figure AI plots the graphs of Annualised Average Conditional Covariances for BRICs in Domestic & International Stockmarkets. It shows the evolutions of these four countries after experience different financial episode, In between Brail and US, the clear sharp spike are started from 1996, 1998, and 2002, it convergence on our expectations of Brazil responses to the domestic financial crisis and was contagion affected by Argentina crisis in 2002. Among the BRICs, Russia shows the least volume of both domestic and stock markets comovements,

through the spike occurs in the period of the 1997, 1999, and 2004, which it reflect to the volatility of conditional covariance varying time and it is followed the domestic crisis financial episode in 1999. Compare with India, China stock and has larger volume in covariance return, the most significant spike in China rather followed Russia in 1999 and Brazil in 2002. To sum up, Figure AI shows an overall strengthen relationship of each two different asset by the length of the observed years and it shows the evidence time-varying fundamental linkages between markets.

Figure AI

The news impact surfaces are shown in Figure 4. Generally speaking, the covariance between FX returns on local stock market returns is highest when there is either a positive or negative shock to both markets, and lowest when the shocks are oppositely signed. The exception is Brazil where a shock to local stock market returns realises the largest covariance providing there is not any shock to FX returns. The surfaces showing covariance between FX returns and international stock market returns illustrate the greatest difference in the shapes of the surfaces. For Brazil and Russia, the surfaces suggest that shocks to international stock market returns have little effect on the covariance with FX returns. For Russia, the covariance is greater when the shock to FX returns is large in either direction. The surfaces showing covariance between local and international stock markets returns show the same shape (except China). Covariance is at its peak when there are no shocks to either market.

7.4.3 Conditional Correlation

Previous studies suggest that correlations are time varying and have increased since the mid-1990s in reflection of wider financial integration (Bekaert and Harvey, 1997, 2002). Following De Goeij and Marquering (2004), we examine whether time variability in covariances is due to variation in variances. The conditional correlation coefficient ($\rho_{ij,t+1}$) between return *i* and *j* is estimated at time t +1 is estimated as shown below:

$$\rho_{ij,t+1} = \frac{\mathrm{cov}_t\left\{r_{i,t+1}, r_{j,t+1}\right\}}{\sqrt{\mathrm{var}_t\left\{r_{i,t+1}\right\}}\sqrt{\mathrm{var}_t\left\{r_{j,t+1}\right\}}}$$

If the correlation coefficient is constant over time, the variability in covariances is caused by the variation in variances. If we cannot accept constant correlations, then the modelling of time varying covariances is important. The evolution of correlations is shown in Figure 4 and the time varying nature of conditional correlations is clear.

Some observations can be made about the relationships between returns which apply across the BRICs. First, the correlation between FX returns and local stock market returns, on average, is negative. Second, correlations between FX returns and international stock market returns, on average, are very close to zero. Third, on average, the correlation between local and international stock market returns is positive. Generally speaking, the magnitude and patterns of the correlations suggest that portfolio risk can be reasonably predicted using conditional measures of association which account for heteroskedasticity in returns (Forbes and Rigobon, 2002; Longin and Solnik, 2001; Goetzmann et al., 2001; Boyer et al., 1999). This implies that conditional estimates may be useful information in deciding asset allocation and diversification strategies.

Consistence with Inghelbrecht(2006) discussion on the measure of how much of a portfolio is invested in stocks, bonds, and cash, will depend on how these three assets are correlated. Moreover, diversification is also important when one wants to construct portfolios consisting of only one type of asset, for instance stocks. The risk of a stock market portfolio can be highly reduced by diversifying over different countries and industries. The degree of risk reduction will in this case highly depend upon the correlations between international stock markets and global industry portfolios.

Clearly, optimal portfolios based on unconditional correlations will – especially in these periods of high uncertainty – be very different from those based on conditional correlations.(i.e from our one of empirical results suggests: correlation between FX returns and domestic stockmarkets returns is negative which it consistence recent evidence, Gagnon and Karolyi (2006)paper

Figure 4 here

The correlations show larger variation during episodes of financial crisis, for instance, in Russia and Brazil in autumn 1998. This supports the proposition that sharp movements in correlations make financial market a likely channel of contagion in EM (Kaminsky and Reinhart, 2000). The implementation of a floating exchange rate regime in Brazil in January 1999 appears to have shifted the average level of correlation between FX returns and local stock market returns, with correlations becoming larger and negative. A similar but much less pronounced pattern is observed for FX returns and international stock market returns. The correlations between local and international stock markets imply a varying degree of stock

market integration between the BRICs and the global market. The magnitude of the correlations indicates that the Brazilian stock market is more integrated with the international market with China the least integrated.

7.4.4 Robustness Tests

As noted in the previous session that Brazil and Russia operated a type of fixed exchange rate regime until the regimes collapsed in August 1998 and January 1999. In comparison, China operated a fixed exchange rate until July 2005. We re-estimate the preferred M-GARCH econometric model for Russia and Brazil after the new exchange rate regimes were implemented as a test of the robustness of our earlier results. Furthermore, we re-estimate a Bi-VARIATE GARCH model for China omitting the exchange rate returns in order to focus on the volatility dynamics between the Chinese and international stockmarkets.

Table Ia. and table Ib. outlines descriptive statistics for Brazil and Russia from Jan.1999 to Dec.2005 and China through Jan.1994- Dec.2005. In Table Ia, sample mean are both significantly different from zero on in Brazil and Russia. Compared with earlier results from 1994-2005, Brazil and Russian stock market returns are both increased as positive 5% significant and 1% from sample mean respectively, however, in the FX exchange markets returns. Russian remains the same level of significant sample mean return, as 5 percent.

As expected, although China Stock Market returns has significant, positive 10% different from mean return, but it is not in FX returns. In general, the distributional features of the returns series are as convinced from expected results, the null hypothesis of normally distributed returns is rejected by the Jarque-Bera statistics The returns are clearly non-

normal and with each series exhibiting skewness and kurtosis. The latter appears to be particularly marked in FX returns indicating that returns are all fat tailed in each BRIC courtiers.

Table Ia., table Ib.here

Table Ic. Ljung-Box Q statistics are re-calculated on according to standardised residuals ($\varepsilon_1, \varepsilon_2, \varepsilon_3$), standardised squared residuals ($\varepsilon_1^2, \varepsilon_2^2, \varepsilon_3^2$), and cross-products of the standardised residuals ($\varepsilon_1\varepsilon_2, \varepsilon_1\varepsilon_3, \varepsilon_2\varepsilon_3$) for Brazil and Russia whist the test results on $\varepsilon_1, \varepsilon_2$ (standardised residuals) , $\varepsilon_1^2, \varepsilon_2^2$ (squared residuals) and $\varepsilon_1\varepsilon_2$ cross-product only, committed to the hypothesis assumptions on capture and account for serial correlation, Both Brazil and Russia has clearly and cross-products of the standardised residuals ($\varepsilon_1\varepsilon_2, \varepsilon_1\varepsilon_3, \varepsilon_2\varepsilon_3$) Q test, especially, compared with earlier session result, we are unable to accept the null hypothesis in the standardised residuals from China test except ε_1, hence, the models more adequately capture the persistence in the variance of returns because the standardised squared residuals are serially uncorrelated. Finally, we employ a diagnostic test suggested by De Goeij and Marquering (2004). If the QML estimates are consistent then we should accept the following null hypotheses: $\varepsilon_i = 0$, $\varepsilon_i^2 = 1$, and $\varepsilon_i\varepsilon_j = 1$ where i,j = 1 … 3. We accept the null in every case. To sum up, our models either reduce or eliminate higher order serial correlation, and the QML estimates are consistent.

Table Ie. here

After re-estimate of equation [1], table Id aand table Ie shows conditional returns for both Brazil and Russia in one optimal lagged return and the four US macroeconomic fundamentals. The robustness test results offers better support for the view of Harvey (1995), EM returns are more predictable than returns in developed markets and local information has a more important role in predicting returns. In Particular, in Brazil, FX has increased in 10% significant but in negative conational returns, in contradicts, Russ FX conditional returns rise to 1% positive significant. Consistent from earlier results, Conditional mean return in Brazil follows a depreciation of FX currency lowers domestic and international stock markers return both in negative 1% and 5% respectively, one US macroeconomic series--short interest rate in 5% significant affect Brazil FX conditional returns but there has none US macroeconomic effect in Russia FX returns.

The comparison robustness results from domestic return from both Brazil and Russia are mainly reflect from increased the size of coefficient, especially, both Brazil and Russia domestic stock markets have 1% positive significant return, Brazil increase 10% significant at international stock market, and Money supplier news announcements from US has 5% negative return impact to Brazil domestic stock markets, Russia remains the same none impact by US news series announcements

Table If reports the results of Volatility Transmission for both Brazil and Russia FX, domestic & international stock markets from 199-2005, The robustness result remains the similar features of earlier empirical results reported from 1994-2005. Both Brazil and Russia

The magnitude of own-market coefficients ($\alpha_{11},\alpha_{22},\alpha_{33}$) is larger in FX markets (α_{11}) compared with domestic stock markets (α_{22}). There are more significant cross-market news

shocks in Brazil compared with Russia but mainly in unidirectional shocks, in addition, news from the FX market significantly shocks the volatility of returns in domestic stock markets in Brazil and Russia (α_{21}), in the Matrix of D from the equation [5], compare with earlier results, the current robustness test shows increased the significance level of bad news shocks mainly identified in home own markets of Brazil but Russia remains the same level and the coefficients underline the fact that bad news from the international stock market produces the largest shock on conditional volatility in the BRICs (δ_{33}). Domestic stock market bad news is significant but only in Brazil and India (δ_{22}) whereas bad news in the FX markets is insignificant (δ_{11}). The results consistent for the earlier indication of the heat wave hypothesis which has more appropriate in explaining news asymmetries since the number of cross-market and cross-border interdependencies

Table If. here

As stated in earlier model specification, the coefficients in matrix B implies the persistence of news. Remains to the heat wave hypothesis, news originating in an asset's own market takes longer to decay than news spilling over from other markets. This finding is common in the literature. Whereas the number of news shocks is greatest in Brazil (see matrix A) the shocks are not long lasting and have dissipated within one day. This finding can be generalised in both Brazil and Russia with few exceptions. In Brazil, the transmission of news from domestic stock markets significantly persists and increases the volatility of FX returns (β_{12}) whereas the volatility of domestic stock market returns is lowered by the persistence of news from the FX market in India (β_{21}). The volatility of FX returns in Russia (β_{13}), and domestic

stock market returns in China (β_{23}) are lowered and increased, respectively, due to the persistence of international stock market news.

Table IIa.,IIb., IIc reports China in II.BI-VARIATE session results, according to [1] estimation, as the results of conditional mean return in FX, domestic and international markes. Over all, the results quite consistent compared with the earlier sessions, however, followed the expectations, in the robustness test, we observed the clear weaken pattern in FX conditional mean return, there has none significant impact between FX and Domestic stock markets, and FX with international stock markers, this results has quite differs than earlier 1% and 5% negative significant return in FX mean equations, in contrast, one monetary news announcement of Industrial Productions has 1% significant negative return impact in China FX returns. Another important results feature has illustrated at China International stock market returns, it presented its substantially significant increase with the return relation with domestic, international markets at negative 10% 1 present positive significant level respectively. Interesting finding is from US news announcement; three out of four US monetary announcements has significant 1% in China international stock markets(only negative significant in Industrial Production series) It shows some indications on international stock markets has heavy affection towards US public news

Table IIa.,IIb., IIc

Equation [5] outlines the results of volatility transmission in China domestic and international stock markets. It contains one of the major estimation objectives. As it compared result from earlier Muti-Variate estimation, we find that Matrix A remains

consistent results except that coefficients on the lagged squared error terms enlarged the size and significance of innovations (news), affecting volatility in 1% level . Innovations in individual asset markets are larger than cross-market and cross-border interdependencies. The magnitude of own-market coefficients (α_{11}), is two times larger than international stock markets (α_{22}). In earlier session cited literature on modelling bad news occurring on days when domestic currencies depreciated[38] to domestic stock price returns decreased, and international stock price returns fell. The significance of bad news shocks can be identified from the coefficients in matrix D. Consistent with earlier Muti-GARCH, however, Bi-Variate test results shows the strengthen on the significant level of when bad news shocks from international stock markets there has 5% has negative significant returns results to domestic stockmarkets δ_{12} The results suggest that the heat wave hypothesis is more appropriate in explaining news asymmetries since the number of cross-market and cross-border interdependencies is few – with the notable exception of India. According to quoted heat wave and meteor shower hypothesis, The coefficients in matrix B indicate the persistence of news. news originating in an asset's own market takes longer to decay than news spilling over from other markets. Whereas the number of news shocks in international stock market has lasting the shocks to domestic stockmarkets with lagged one day. This finding can improved the earlier price discovery process in China domestic stock market that has significant impact with US news innovation to China In Brazil, the transmission of news from domestic stock markets significantly persists and increases the volatility of FX returns

[38] $R_t = \ln(s_t) - \ln(s_{t-1},)$ where S = the exchange rate index. $\ln(s_t) - \ln(s_{t-1})$ refers to the log return from the difference of today' exchange rate(s_t Information) to one day later(s_{t-1} Information) The exchange rate data are expressed as units of US dollars meaning $r_{t.} > 0$ refers to depreciation of local currency and $r_{t.} < 0$ appreciation of local currency

(β_{12}) whereas the volatility of domestic stock market returns is lowered by the persistence of news from international stock market.

Table IId.here

The evolution of conditional covariance is displayed in Figure Ia. , the estimation in equation [5] has re-estimated for both Brazil, Russia in conditional covariance and Conditional correlation. In general, the result has keep the same pattern in earlier test as time varying feature, although, the recent results shows number of severe spike shock patter, for instances, For Brazil and Russia there are few very large spikes which are either positive or negative. the spikes are observed around the period of exchange rate crises in the autumn of 1998. We note that the covariance between domestic stock market returns and international stock market returns tends to be positive for both Brazil and Russia; the covariance is largest for Brazil which operates a relatively more developed stock market.

Figure Ia. here

Figure II shows Chinese Conditional Correlations & Covariance from Jan. 1994-2005,this Bi-Variate GARCH test carried out the consistent result pattern on earlier results output, but has we observed the large negative spike in 1995, 1997, and 2001 both appears in Conditional Correlations & Covariance in duration, it indicate that Chinese stock markets has experienced the varies of financial episode during the time. The results of correlations between local and international stock markets in Chinese Stock markets implies a varying degree of stock market integrations with international stock markets

Figure II here

8. Conclusion

We have employed a multivariate GARCH model to investigate the price discovery and volatility transmission processes in the BRICs during a period when policymakers were aiming to increase the rate of integration between local financial markets and international markets. Of the BRICs, we find Brazil to be the most integrated with international markets followed (in rank order) by Russia, India and China.

We find that international (US) macroeconomic fundamentals impact on the price discovery process in EM, which is consistent with findings reported for several European countries (see Andersen and Bollerslev, 1998; Andersen et al., 2004). Thus, we suggest that EM asset prices can be predicted to a certain extent by public information which refutes the efficient markets hypothesis. Specifically, we observe that a currency depreciation is followed by a currency appreciation, and that lagged FX returns (for up to $t - 2$) are significant predictors of FX returns at time t. Consistent with findings reported elsewhere, local stock market increases appreciate the local currency.

The volatility of BRIC financial market returns is affected to a greater extent by news originating in each individual market (the heat wave) although there are some spillover effects (the meteor shower). Own market news does not decay as quickly as cross-market news. News shocks in FX markets tend to be larger than local stock markets and there is limited evidence of significant shocks from the international market affecting BRIC markets. However, we concur with other authors and confirm the importance of modelling asymmetries since BRIC markets are found to respond more to bad news.

In financial markets, the investor taking highly it consideration on the measure and interpret the time-variation in the asset return correlations, since it may have important consequences for the way (institutional) investors should construct optimal portfolios or perform risk management. I give some examples. Firstly, the traditionally low correlation between stock returns across countries induced investors to diversify their stock portfolios primarily on a geographical basis (see e.g. Heston and Rouwenhorst (1994); Griffin and Karolyi (1998)). however, according the most recent empirical evidence Inghelbrecht(2006) suggests that further globalization and (regional) integration have led to a significant increase in cross-country stock market correlations.

Hence, there is an emergence question on whether geographical diversification is still the best way to reduce the total risk of international portfolios, and whether other strategies, like industry diversification, may lead to superior results. Second, there is considerable evidence that international stock market correlations are asymmetric, i.e. correlations are substantially higher in (volatile) bear markets than during bull markets. If diversification benefits from international investing are not forthcoming at the time that investors need them the most (when their home market experiences a downturn), the strong case for international investing may have to be re-considered (see Ang and Chen (2002); Ang and Bekaert (2002)). Third, investors may want to exploit the negative correlations between stock and bond returns typically observed during periods of increased market uncertainty (see e.g. Connolly et al. (2005)).

The estimated variances clearly indicate the presence of financial crises like the autumn 1998 exchange rate problems in Russia and Brazil. We find that the variance of FX returns is significantly different following the change in exchange rate regime for both countries. As expected, the conditional covariances are found to be time-varying and highly responsive to episodes of financial distress. On average, we find negative correlations between FX returns and local stock market returns, very small correlations between FX returns and international stock market returns, and positive and larger average correlations between local and international stock market returns. The size and pattern of the conditional correlations suggests that EM assets still constitute an effective diversification strategy for investors.

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Table 1: Ljung-Box Q Statistics: Return and Squared Return; Error and Squared Error

Stock market	Return	Squared return	Error	Squared error	Exchange rate	Return	Squared return	Error	Squared error
Brazil					Real / $				
Q (6 lags)	44.58***	871.26***	321.87***	96.61***	Q (6 lags)	121.01***	1153.59***	36.37***	470.55***
Q (12 lags)	72.39***	1100.54***	406.25***	110.75***	Q (12 lags)	137.59***	1573.33***	204.18***	715.03***
Q (18 lags)	74.45***	1239.20***	466.93***	112.22***	Q (18 lags)	199.85***	1700.35***	239.17***	847.07***
Q (24 lags)	77.84***	1272.69***	479.83***	112.27***	Q (24 lags)	206.63***	1776.75***	272.68***	849.66***
Q (30 lags)	85.25***	1341.50***	511.71***	112.52***	Q (30 lags)	226.33***	1851.93***	281.49***	850.19***
Russia					Rouble / $				
Q (6 lags)	7.70	393.89***	20.46***	336.60***	Q (6 lags)	609.43***	1541.64***	286.96***	1736.98***
Q (12 lags)	23.51**	457.13***	50.19***	345.48***	Q (12 lags)	680.16***	1722.64***	457.82***	1992.19***
Q (18 lags)	39.71***	460.54***	54.52***	345.56***	Q (18 lags)	716.42***	1728.93***	466.71***	1997.55***
Q (24 lags)	46.33***	475.27***	59.98***	345.61***	Q (24 lags)	838.36***	1842.18***	632.85***	2104.15***
Q (30 lags)	53.54***	483.34***	63.02***	345.69***	Q (30 lags)	903.89***	1881.31***	800.31***	2475.73***
India					Rupee / $				
Q (6 lags)	55.13***	601.11***	66.31***	138.21***	Q (6 lags)	20.78***	196.63***	15.06**	56.57***
Q (12 lags)	77.52***	706.48***	96.75***	141.24***	Q (12 lags)	28.80***	241.58***	44.06***	57.26***
Q (18 lags)	84.89***	778.93***	135.73***	142.46***	Q (18 lags)	38.05***	272.43***	59.15***	57.47***
Q (24 lags)	89.37***	856.14***	167.33***	144.92***	Q (24 lags)	52.86***	306.76***	77.16***	58.04***
Q (30 lags)	97.01***	901.76***	198.54***	145.45***	Q (30 lags)	69.38***	330.67***	93.03***	62.73***
China					Renminbi / $				
Q (6 lags)	3.43	467.58***	467.58***	101.35***	Q (6 lags)	64.11***	0.58	0.06	0.00
Q (12 lags)	17.62	483.13***	483.13***	101.36***	Q (12 lags)	68.70***	0.60	0.08	0.00
Q (18 lags)	34.75**	493.55***	493.55***	101.36***	Q (18 lags)	86.49***	0.64	0.12	0.00
Q (24 lags)	52.22***	500.09***	500.09***	101.38***	Q (24 lags)	100.18***	0.67	0.15	0.00
Q (30 lags)	65.49***	501.19***	501.19***	101.39***	Q (30 lags)	117.99***	0.70	0.18	0.01

Note: The 95% critical values for Q(6), Q(12), Q(18), Q(24), and Q(30) are 12.6, 21.0, 28.9, 36.4 and 43.8, respectively. The 99% critical values for Q(6), Q(12), Q(18), Q(24), and Q(30) are 18.5, 28.3, 37.2, 45.6 and 53.7, respectively.

***, and ** Indicate statistical significance at the 1% and 5% levels, respectively.

Table 2a: Descriptive Statistics – Returns, October 1994 – December 2005 (%)

Stock Market Returns	**Brazil**	**Russia**	**India**	**China**
Sample Mean	0.0297	0.0919*	0.0173**	0.0173
Standard Deviation	2.6627	2.7470	1.5825	1.8344
Variance	7.0901	7.5460	2.5044	3.3652
Skewness	0.0450	0.3555	-0.3239	0.8335
Kurtosis (excess)	6.53	23.03	4.15	24.24
Jarque-Bera	5202.17	64818.15	2155.64	72029.5
FX Returns	**Real / $**	**Rouble / $**	**Rupee / $**	**RMB / $**
Sample Mean	0.0351**	0.0812**	0.0123**	-0.0020**
Standard Deviation	0.8522	1.7078	0.3070	0.0522
Variance	0.7262	2.9165	0.0942	0.0027
Skewness	0.4931	3.2051	0.9625	-19.8270
Kurtosis (excess)	26.46	220.09	28.85	784.91
Jarque-Bera	85564.65	5916899.40	102053.25	75379528.9
Observations	2,929	2,929	2,929	2,929

Table 2b: Descriptive Statistics – Returns on Announcement Days (%)

	DOW	BRUSD	BRA	RSUSD	RUS	IRUSD	IND	RMBUSD	CNY
Consumer price index when standardised measure is negative (n = 72)									
Average	-0.1040	0.0309	0.0275	0.3572	-0.0174	0.0638	0.0335	-0.0045*	-0.1118
std dev	1.2698	0.7060	2.4524	2.0319	3.2788	0.4403	1.6011	0.0197	2.4514
Consumer price index when standardised measure is positive (n = 61)									
Average	0.0802	0.0088	0.2037	0.3651	0.1460	0.0644	-0.2500	-0.0013	-0.0722
std dev	1.1929	0.6842	2.6280	2.9526	2.1352	0.3790	2.3484	0.0067	1.4568
Industrial production index when standardised measure is negative (n = 70)									
Average	0.1763	0.1768	0.3743	0.3974	0.2320	0.0448	0.3765*	-0.0016	0.0534
std dev	1.0730	1.4194	3.0681	3.0975	2.7854	0.3092	1.8147	0.0212	1.2898
Industrial production index when standardised measure is positive (n = 65)									
Average	0.0221	0.0923	0.2356	0.4086	0.0837	0.0315	-0.0610	-0.0021	-0.6897**
std dev	1.1762	0.4993	2.3476	2.8947	2.7977	0.3166	2.3152	0.0186	2.7057
Money supply index when standardised measure is negative (n = 341)									
Average	0.1039	0.0710	0.3027	-0.0065	-0.1307	0.0370	-0.0194	-0.0001	-0.0484
std dev	1.1062	0.9915	2.7261	1.5816	2.9398	0.3433	1.4258	0.0431	1.6585
Money supply index when standardised measure is positive (n = 241)									
Average	0.0195	0.0564	-0.2527	0.1335	0.1255	0.0188	-0.0386	0.0011	-0.1318
std dev	0.9715	0.6998	2.4366	0.8174	2.9943	0.2995	1.3801	0.0243	1.8507
Interest rates standardised measure is negative (n = 257)									
Average	0.0091	0.1183	0.1212	0.3042	0.1448	0.0375	-0.1003	-0.0045	0.0111
std dev	1.0958	1.0140	2.7964	2.5774	2.3892	0.3337	1.7286	0.0370	2.0521
Interest rates standardised measure is positive (n = 327)									
Average	0.0026	-0.0397	0.3945	0.0359	0.2344	-0.0044	0.2328	0.0028	-0.0112
std dev	1.0082	0.8966	2.5789	0.3448	3.3829	0.3026	2.0131	0.0565	1.9280

Note: ***, **, * statistically significant at 10%, 5% and 1%.

Table 3: Descriptive Statistics and Ljung-Box Q Statistics(a): Standardised, Standardised Squared, & Cross-Product of Standardised Residuals

Residual	ε_1	ε_2	ε_3	ε^2_1	ε^2_2	ε^2_3	$\varepsilon_1\varepsilon_2$	$\varepsilon_1\varepsilon_3$	$\varepsilon_2\varepsilon_3$
				Brazil					
Mean[(b)]	-0.0466**	-0.0127	-0.0068	0.9851	0.9602	0.9717	-4.022	-0.3303	1.0367
Std dev	0.99	0.98	0.99	7.35	1.83	1.82	246.85	270.24	4.03
Skewness	2.21	-0.39	-0.38	45.79	6.54	7.49	-42.67	-7.52	5.01
Kurtosis	54.41	1.60	1.51	2305.23	71.58	106.49	1954.77	443.01	77.44
Q (6)	25.39***	26.81***	4.19	0.34	43.05***	2.60	0.00	2.05	28.87***
Q (12)	34.59***	41.44***	9.70	0.54	46.82***	6.48	0.00	11.29	37.35***
Q (18)	50.74***	45.76***	19.36	1.01	52.52***	10.34	0.37	11.70	40.60***
Q (24)	58.67***	50.94***	23.42	1.18	56.38***	16.57	0.39	11.82	58.53***
Q (30)	61.84***	55.24***	35.91	1.94	58.43***	17.64	0.41	15.88	59.39***
				Russia					
Mean[(b)]	0.0169	0.0081	0.0008	0.9745***	0.9861	0.9895	-0.0798	-22.9139	0.8004
Std dev	0.99	0.99	0.99	5.89	5.14	1.81	130.22	948.29	17.48
Skewness	3.08	1.75	-0.36	25.82	6.64	-12.10	-53.92	2913.13	157.87
Kurtosis	34.36	25.10	1.36	800.71	82.57	476.99	2913.13	1035690.00	3038279.28
Q (6)	84.80***	14.68	3.50	41.90***	1.64	2.65	1.27	0.05	8.56
Q (12)	152.60***	26.84**	9.32	45.33***	2.15	6.08	2.29	0.06	11.54
Q (18)	203.28***	41.23***	21.04	46.32***	4.31	11.72	3.01	0.06	12.18
Q (24)	255.84***	47.88***	25.63	48.07***	11.48	19.26	3.31	0.06	13.68
Q (30)	286.47***	54.98***	40.27	49.07***	11.85	20.48	3.90	0.07	17.65
				India					
Mean[(b)]	0.0505***	-0.0102	0.0048	0.9653***	0.9498	0.9899	0.8709	-19.2806**	-3.3111**
Std dev	0.98	0.97	1.00	5.27	2.09	1.79	239.90	534.81	109.49
Skewness	2.47	0.00	-0.35	18.45	8.72	6.27	-10.05	-27.13	-23.29
Kurtosis	27.45	2.84	1.27	440.03	124.06	72.41	1330.06	901.96	751.10
Q (6)	30.22***	21.31***	3.91	1.42	4.68	1.83	0.02	0.18	1.64
Q (12)	41.51***	33.18***	9.21	2.36	9.06	5.63	0.06	10.57	4.97
Q (18)	49.94***	39.01***	18.93	4.14	16.75	11.63	0.07	10.75	10.81
Q (24)	66.02***	44.61**	23.23	4.64	30.30	19.08	0.23	11.12	13.43
Q (30)	75.02***	48.07**	35.84	6.47	43.96	20.16	0.25	11.16	14.38
				China					
Mean[(b)]	0.0008	0.0042	0.0031	0.9932	1.0075	0.9969	0.5660	-49.7352	16.2477*
Std dev	1.00	1.00	1.00	36.48	3.15	1.80	73.66	2371.13	757.00
Skewness	-31.88	0.67	-0.34	52.95	13.17	6.44	7.3677	-51.85	44.61
Kurtosis	1349.30	7.80	1.28	2839.99	242.97	78.91	699.87	2750.46	2207.71
Q (6)	8.27	10.39	3.71	0.00	3.96	1.87	7.25	74.94***	0.08
Q (12)	9.88	15.63	8.71	0.01	6.94	5.26	7.35	74.97***	2.15
Q (18)	18.49	31.20**	20.23	0.02	11.35	9.77	7.65	74.97***	2.17
Q (24)	22.15	46.49***	25.10	0.02	17.16	16.00	7.69	74.98***	2.27
Q (30)	33.48	62.23***	38.18	0.03	19.33	17.22	8.87	75.44***	2.29

Notes: (a) The 95% critical values for Q(6), Q(12), Q(18), Q(24), and Q(30) are 12.6, 21.0, 28.9, 36.4 and 43.8, respectively. The 99% critical values for Q(6), Q(12), Q(18), Q(24), and Q(30) are 18.5, 28.3, 37.2, 45.6 and 53.7, respectively. (b)test whether the sample mean of standardised residuals is equal to zero, sample means of standardised squared residuals and cross-products of the standard residuals are equal to 1. ***, and ** indicate significance.

Table 4a: Conditional Mean Equations – FX returns

	Brazil		Russia		India		China	
	Coefficient	**Std Err**	**Coefficient**	**Std Err**	**Coefficient**	**Std Err**	**Coefficient**	**Std Err**
Constant	0.0396***	0.0046	0.0218***	0.0038	0.0033	0.0023	-0.0030***	0.0010
Fx{1}	0.0161	0.0237	0.0548	0.0415	-0.1563***	0.0466	-0.3664***	0.0906
Fx{2}	-0.0340	0.0253	-0.0289	0.0308	-0.1198***	0.0393	-0.2505***	0.0961
Fx{3}	0.0001	0.0279	0.0473	0.0370	-0.0237	0.0331	-0.1266*	0.0774
Fx{4}	0.0320	0.0292	0.0537	0.0477			-0.0418	0.0404
Fx{5}							0.0116	0.0244
Do{1}	-0.0184***	0.0043	-0.0003	0.0005	-0.0087***	0.0020	-0.0005**	0.0002
Do{2}	-0.0068**	0.0033			-0.0015	0.0021		
Do{3}	-0.0047**	0.0020			0.0029	0.0023		
Do{4}	0.0029**	0.0012			0.0038	0.0025		
Do{5}	0.0033*	0.0017						
Int{1}	0.0107**	0.0047	-0.0013	0.0012	-0.0014	0.0028	-0.0003	0.0007
CPI	0.0467*	0.0269	-0.0003	0.0112	0.0061	0.0146	-0.0010	0.0009
IP	0.0276*	0.0143	-0.0291**	0.0118	0.0007	0.0156	0.0002	0.0018
MS	0.0413***	0.0153	0.0066*	0.0042	0.0298**	0.0135	0.0001	0.0005
IR	-0.0042	0.0154	0.0203**	0.0091	0.0007	0.0078	0.0003	0.0004

Table 4b: Conditional Mean Equations – Domestic stock market returns

	Brazil		Russia		India		China	
	Coefficient	Std Err	Coefficient	Std Err	Coefficient	Std Err	Coefficient	Std Err
Constant	0.0781***	0.0297	0.0983	0.1018	0.0338	0.0237	-0.0233	0.0241
Fx{1}	-0.0430	0.0664	0.0187	0.0585	0.0247	0.1030	-1.4251*	0.7545
Fx{2}	-0.0288	0.0692	0.0049	0.1547	0.0791	0.0936	-2.6654***	0.8308
Fx{3}	-0.0385	0.0754	0.0266	0.0560	0.0526	0.0961	-3.7914**	1.9043
Fx{4}	-0.0703	0.0623	-0.0220	0.1176			-1.9199	1.3371
Fx{5}							-1.7530	1.4729
Do{1}	0.0182	0.0217	0.1093***	0.0231	0.0373	0.0933	-0.0080	0.0198
Do{2}	-0.0130	0.0181			-0.0583	0.0916		
Do{3}	0.0003	0.0184			0.1374***	0.0210		
Do{4}	-0.0139	0.0185			0.0131	0.0152		
Do{5}	-0.0248*	0.0140						
Int{1}	0.0885**	0.0379	-0.0274	0.0691	0.0065	0.0152	0.0157	0.0226
CPI	-0.0787	0.1541	-0.0223	0.1761	-0.0648	0.1069	-0.0785	0.1184
IP	-0.1166	0.1390	-0.0488	0.2648	-0.0298	0.1158	-0.3839**	0.1480
MS	-0.1666***	0.0630	0.0221	0.0849	-0.0364	0.0493	0.0478	0.0530
IR	-0.0183	0.0764	-0.0003	0.1170	0.0757	0.0552	0.0300	0.0453

Table 4c: Conditional Mean Equations – International stock market returns

	Brazil		Russia		India		China	
	Coefficient	Std Err	Coefficient	Std Err	Coefficient	Std Err	Coefficient	Std Err
Constant	0.0350**	0.0160	0.0238	0.0231	0.0204	0.0156	0.0253	0.0156
Fx{1}	-0.0144	0.0219	-0.0106	0.0290	0.0009	0.0480	0.1494	0.3118
Fx{2}	0.0071	0.0226	-0.0312	0.0245	0.0213	0.0491	0.0354	0.3428
Fx{3}	-0.0134	0.0197	-0.0211	0.0226	-0.0217	0.0488	0.1123	0.2395
Fx{4}	-0.0128	0.0187	0.0174	0.0208			0.3021	0.2950
Fx{5}							-0.0146*	0.0085
Do{1}	0.0078	0.0059	0.0325***	0.0067	0.0480	0.0530	-0.0063	0.0081
Do{2}	0.0044	0.0067			0.0210**	0.0093		
Do{3}	-0.0027	0.0059			0.0033	0.0090		
Do{4}	-0.0051	0.0056			0.0063	0.0099		
Do{5}	-0.0115*	0.0062						
Int{1}	0.0114	0.0193	0.0054	0.0285	0.0077	0.0099	0.0166	0.0203
CPI	-0.0581	0.0593	0.0949	0.0757	0.0932	0.0773	0.0915	0.0754
IP	-0.0200	0.0667	-0.0189	0.0950	-0.0159	0.0803	-0.0260	0.0798
MS	-0.0334	0.0355	0.0565	0.0352	0.0703*	0.0379	0.0609*	0.0365
IR	-0.0228	0.0404	0.0621	0.0470	0.0615	0.0424	0.0650	0.0439

Table 5: Volatility Transmission: Forex, domestic & international stock markets

	Brazil		Russia		India		China	
	Coeff	Std Error	Coeff	Std Error	Coeff	Std Error	Coeff	Std Error
ω_{11}	0.0034	0.0028	-0.0004	0.0008	-0.0111**	0.0048	0.0399***	0.0137
ω_{12}	-0.3778***	0.0671	0.6079	0.6094	-0.3230***	0.0987	-0.0638	0.0659
ω_{13}	-0.0138	0.0100	-0.0811	0.0998	-0.0060	0.0288	0.0001	0.0167
ω_{22}	0.0623	0.0420	0.7604	1.1971	0.0199	0.1040	0.3789***	0.1066
ω_{23}	0.1035***	0.0130	0.0910	0.1126	0.1078***	0.0141	0.0041	0.0164
ω_{33}	-0.0007	0.1391	-0.0089	0.2051	-0.0001	0.1346	0.1056***	0.0181
α_{11}	0.6756***	0.0845	0.4686***	0.0506	0.6050***	0.0685	0.5629***	0.0616
α_{12}	-1.1994***	0.2346	0.2255	0.3648	-0.3133**	0.1381	1.0668	1.0674
α_{13}	-0.1048	0.0713	0.0390***	0.0144	-0.0120	0.0501	-0.3850	0.5240
α_{21}	0.0234***	0.0081	-0.0021**	0.0008	-0.0022	0.0041	0.0002	0.0002
α_{22}	-0.1853**	0.0910	0.4050*	0.2322	0.2730***	0.0318	0.3714***	0.0655
α_{23}	-0.0136*	0.0070	0.0027	0.0061	0.0151	0.0152	-0.0165***	0.0059
α_{31}	-0.0127***	0.0043	0.0014	0.0012	0.0054*	0.0031	0.0005	0.0006
α_{32}	0.1204	0.1780	-0.2132	0.5522	0.0035	0.0470	-0.0637**	0.0320
α_{33}	-0.0100	0.0405	-0.0280	0.1349	-0.0265	0.0319	0.0267	0.0631
β_{11}	0.8438***	0.0285	0.9332***	0.0108	0.8776***	0.0225	0.4778***	0.0797
β_{12}	0.1384**	0.0673	-0.0878	0.1441	0.0350	0.0399	2.1039	1.3745
β_{13}	0.0197	0.0293	-0.0065**	0.0032	-0.0025	0.0147	0.2183	0.4725
β_{21}	0.0001	0.0007	0.0005	0.0004	-0.0045*	0.0024	-0.0004	0.0004
β_{22}	0.9407***	0.0154	0.8061***	0.2501	0.9217***	0.0319	0.8990***	0.0419
β_{23}	-0.0018	0.0022	-0.0034	0.0031	-0.0062	0.0058	0.0049**	0.0025
β_{31}	0.0001	0.0008	-0.0001	0.0003	0.0011*	0.0006	0.0000	0.0010
β_{32}	0.0194	0.0153	0.0652	0.1751	0.0134	0.0149	0.0083	0.0060
β_{33}	0.9710***	0.0046	0.9633***	0.0102	0.9663***	0.0047	0.9633***	0.0057
δ_{11}	0.1591	0.1063	-0.0080	0.0151	0.0327	0.1593	0.1757	0.1110
δ_{12}	0.1713	0.2671	0.1903	0.1327	-0.0707	0.3034	-2.5100	2.0056
δ_{13}	-0.0257	0.0335	0.0443	0.0340	0.0007	0.0360	-0.1074	0.5551
δ_{21}	0.0245	0.0214	0.0017	0.0012	0.0273**	0.0125	0.0001	0.0002
δ_{22}	0.3223***	0.1130	0.3600	0.4218	0.2624**	0.1252	-0.0817	0.1792
δ_{23}	-0.0092	0.0131	0.0010	0.0077	-0.0300*	0.0179	-0.0225**	0.0112
δ_{31}	-0.0112	0.0114	-0.0029*	0.0017	-0.0074**	0.0035	0.0002	0.0002
δ_{32}	-0.0434	0.1042	-0.2619	1.1040	-0.0671	0.0817	-0.0087	0.0517
δ_{33}	0.3178***	0.0316	0.3423***	0.0721	0.3466***	0.0270	0.3522***	0.0267

Note: 1 = FX market, 2 = domestic stock market, 3 = international stock market

Figure 1: FX and stock market indexes and returns, 1994-2005

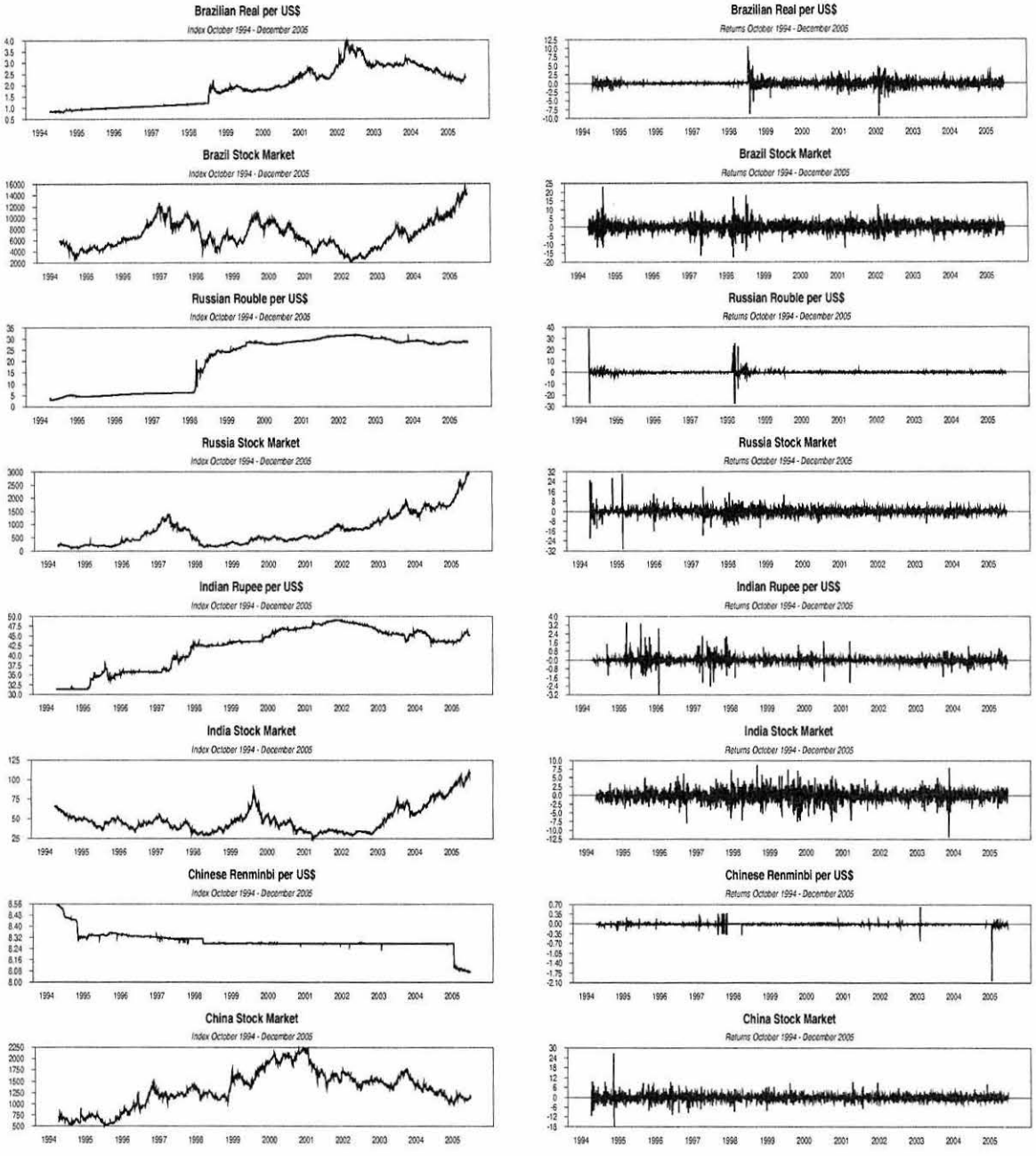


Figure 2 – Conditional Volatility (annualised): Stock Market & FX Market Returns

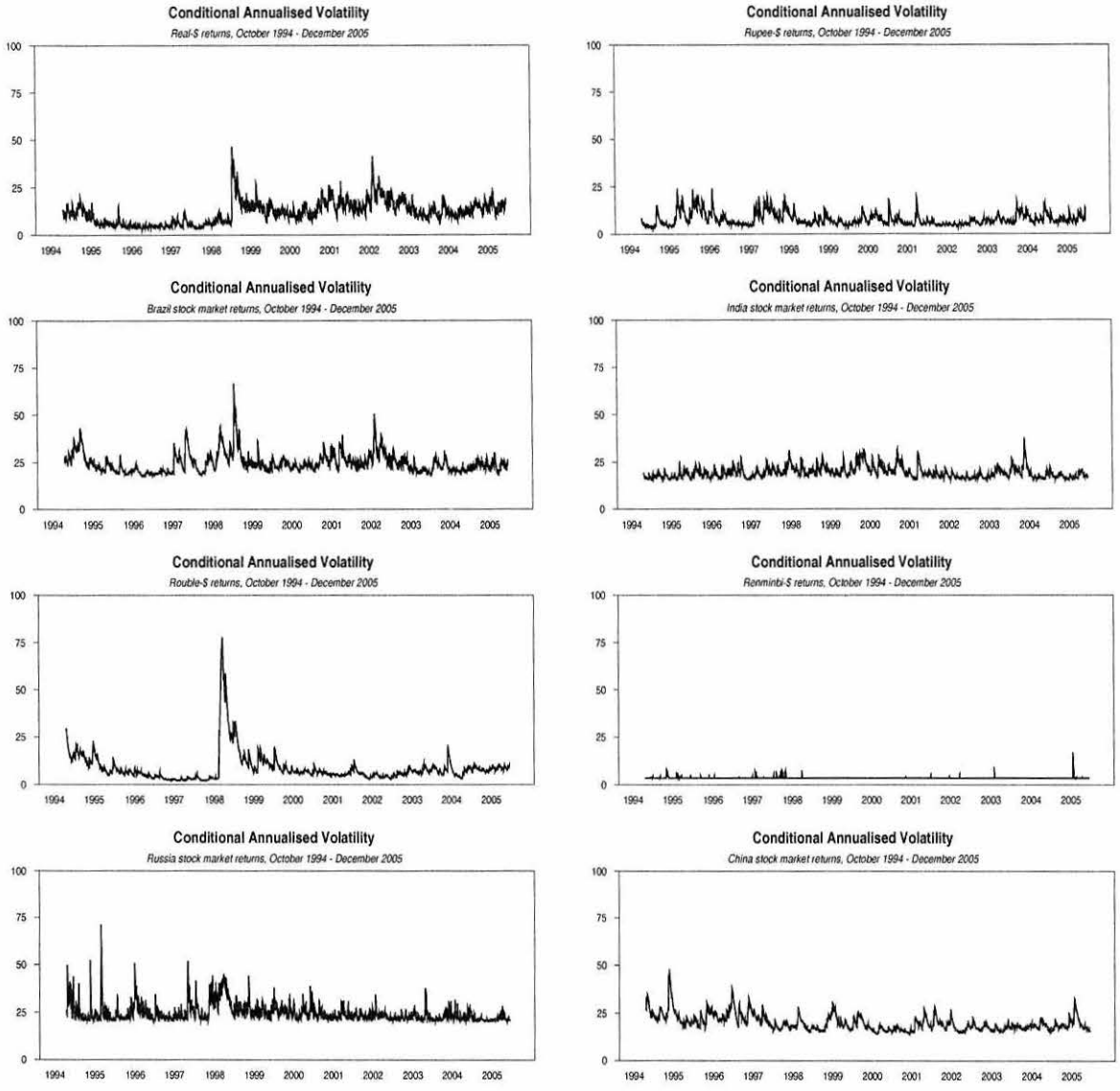


Figure 3a – Conditional Covariance: Stock Market & FX Market Returns

BRAZIL & RUSSIA

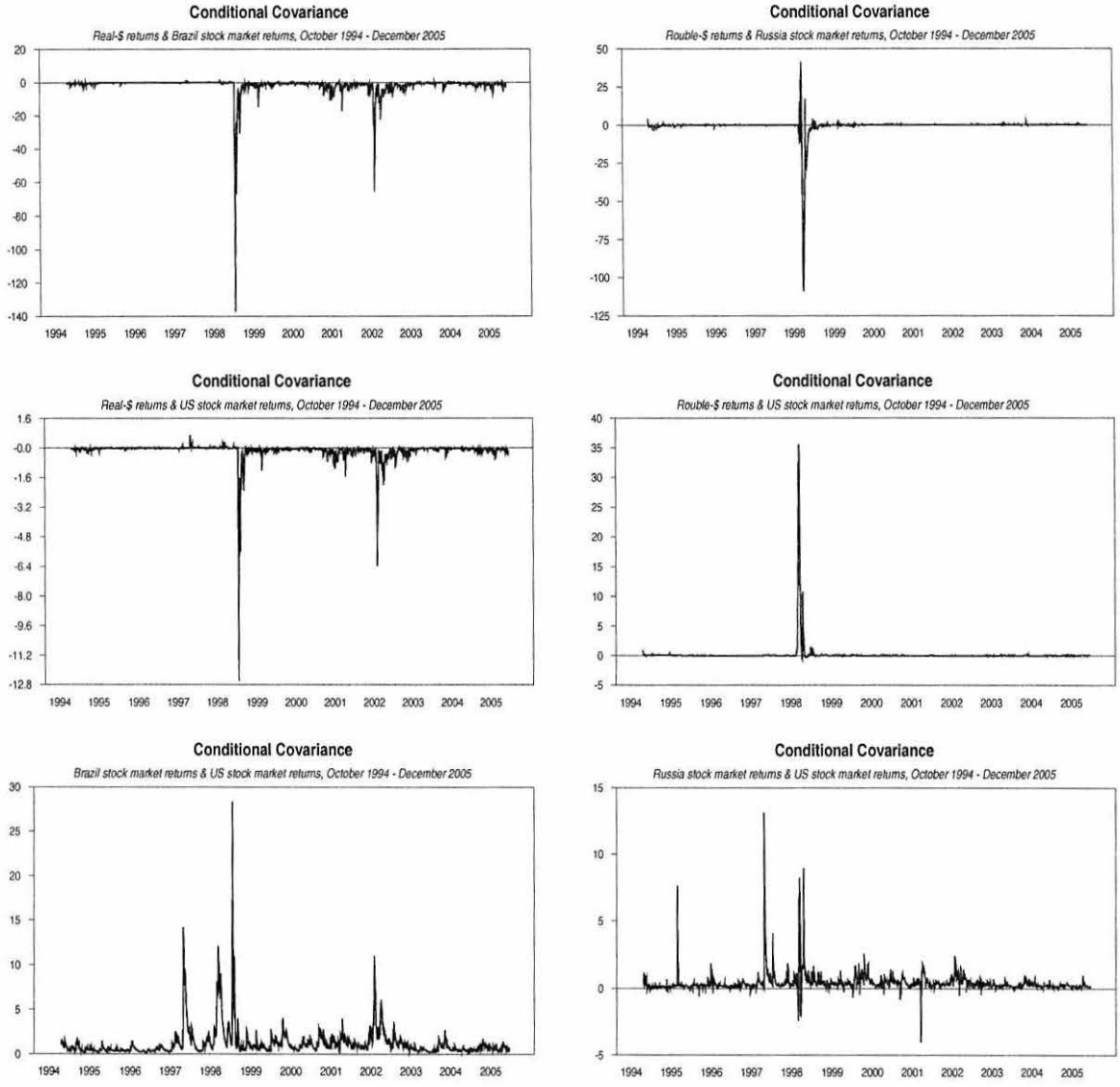


Figure 3b – Conditional Covariance: Stock Market & FX Market Returns

INDIA & CHINA

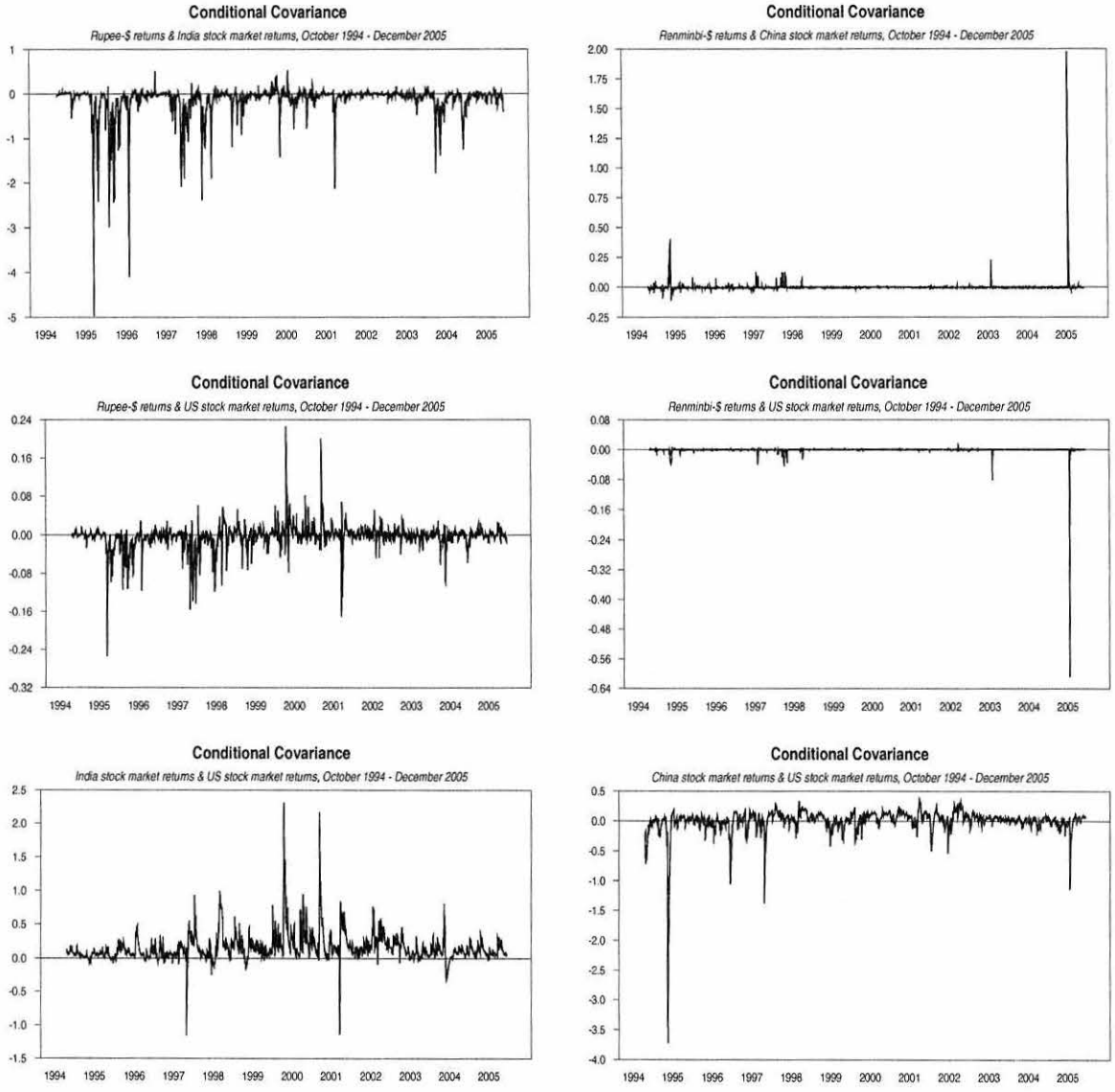
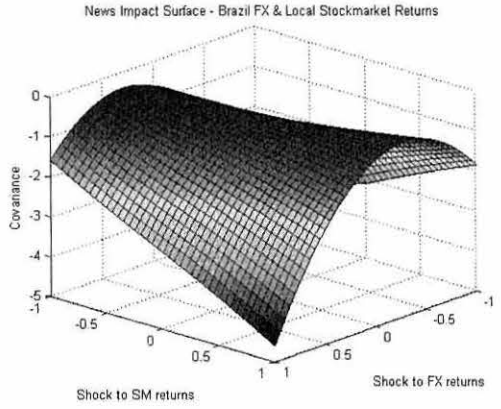
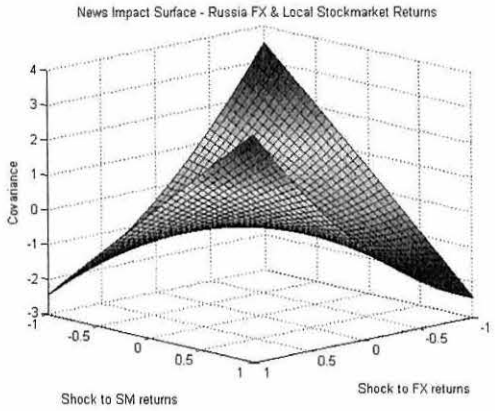
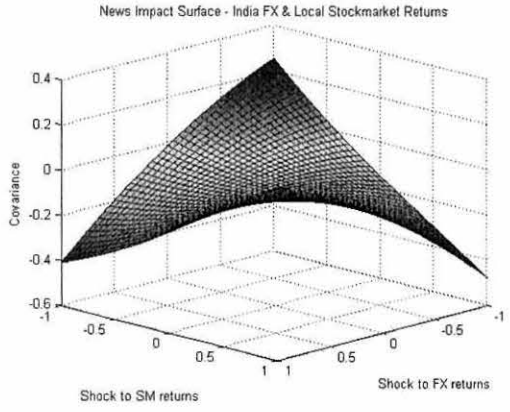


Figure 4: News impact surfaces for conditional covariance

4.1 FX and local Stock market returns: BRICs







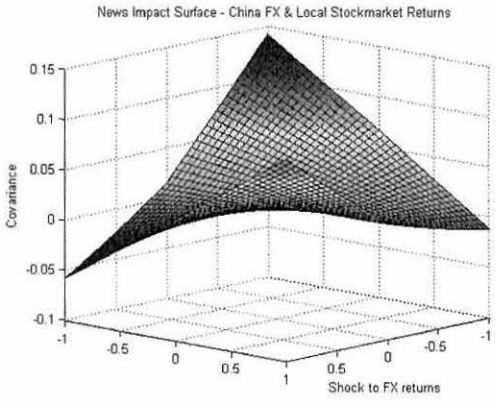
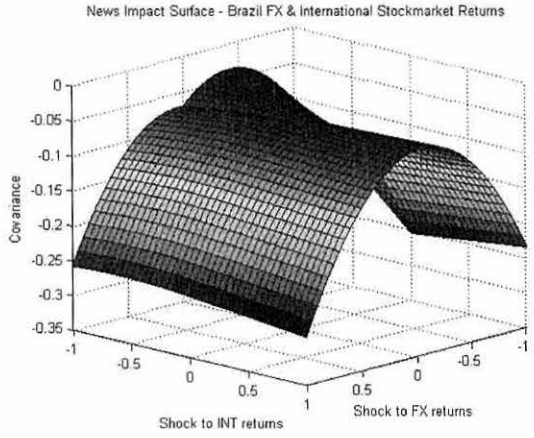
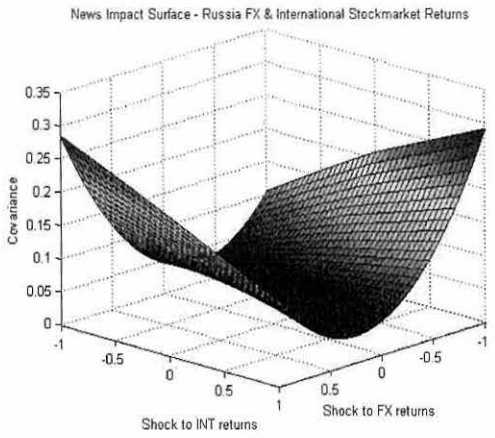
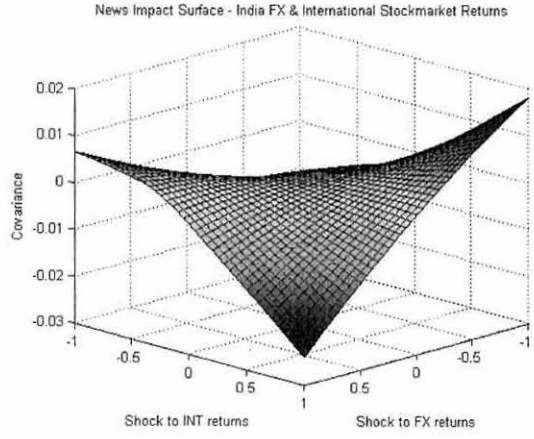


Figure 4: News impact surfaces for conditional covariance

4.2 FX and international Stock market returns: BRICs







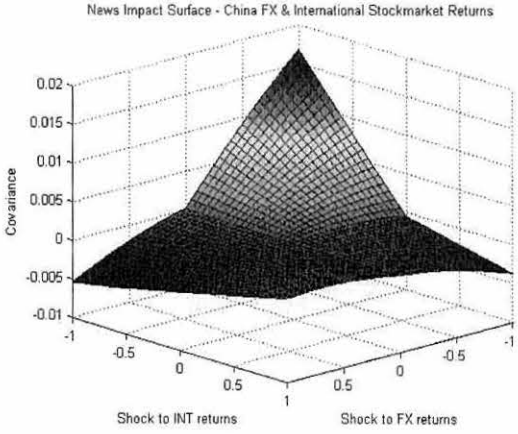
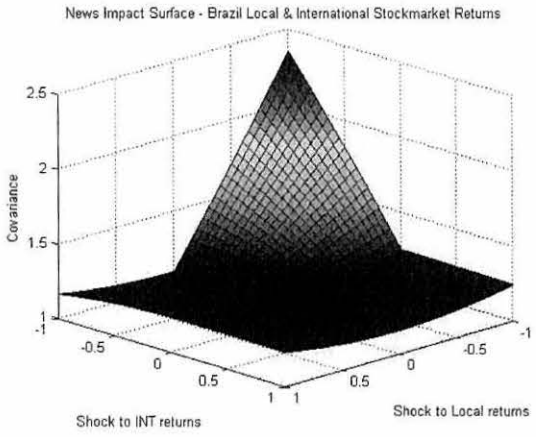
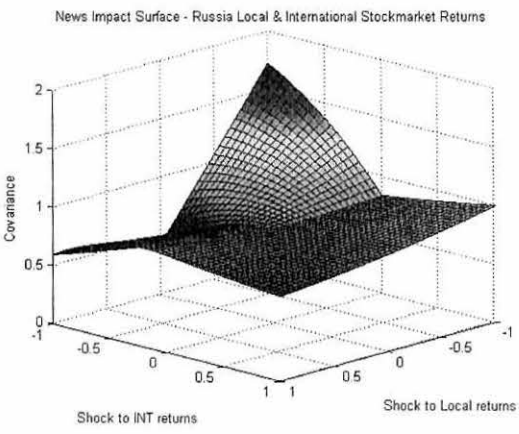
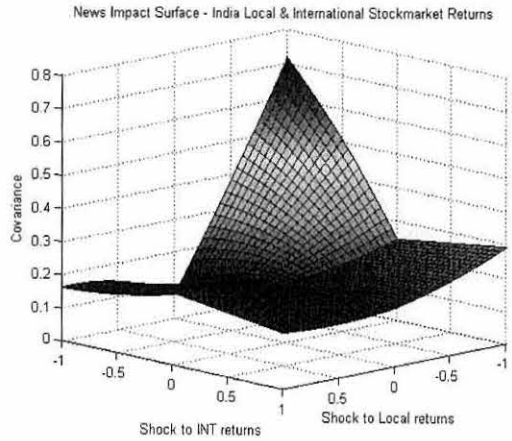


Figure 4: News impact surfaces for conditional covariance

4.3 Local and international Stock market returns: BRICs







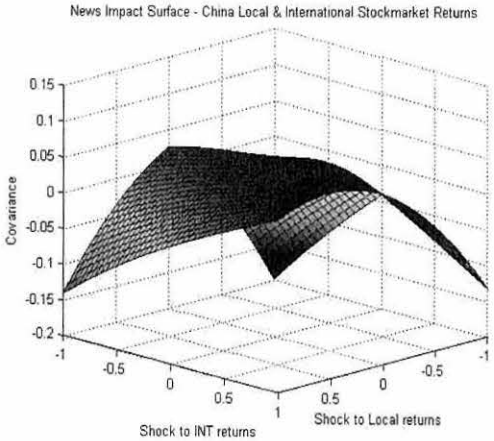


Figure 5a – Conditional Correlations: Stock Market & FX Market Returns

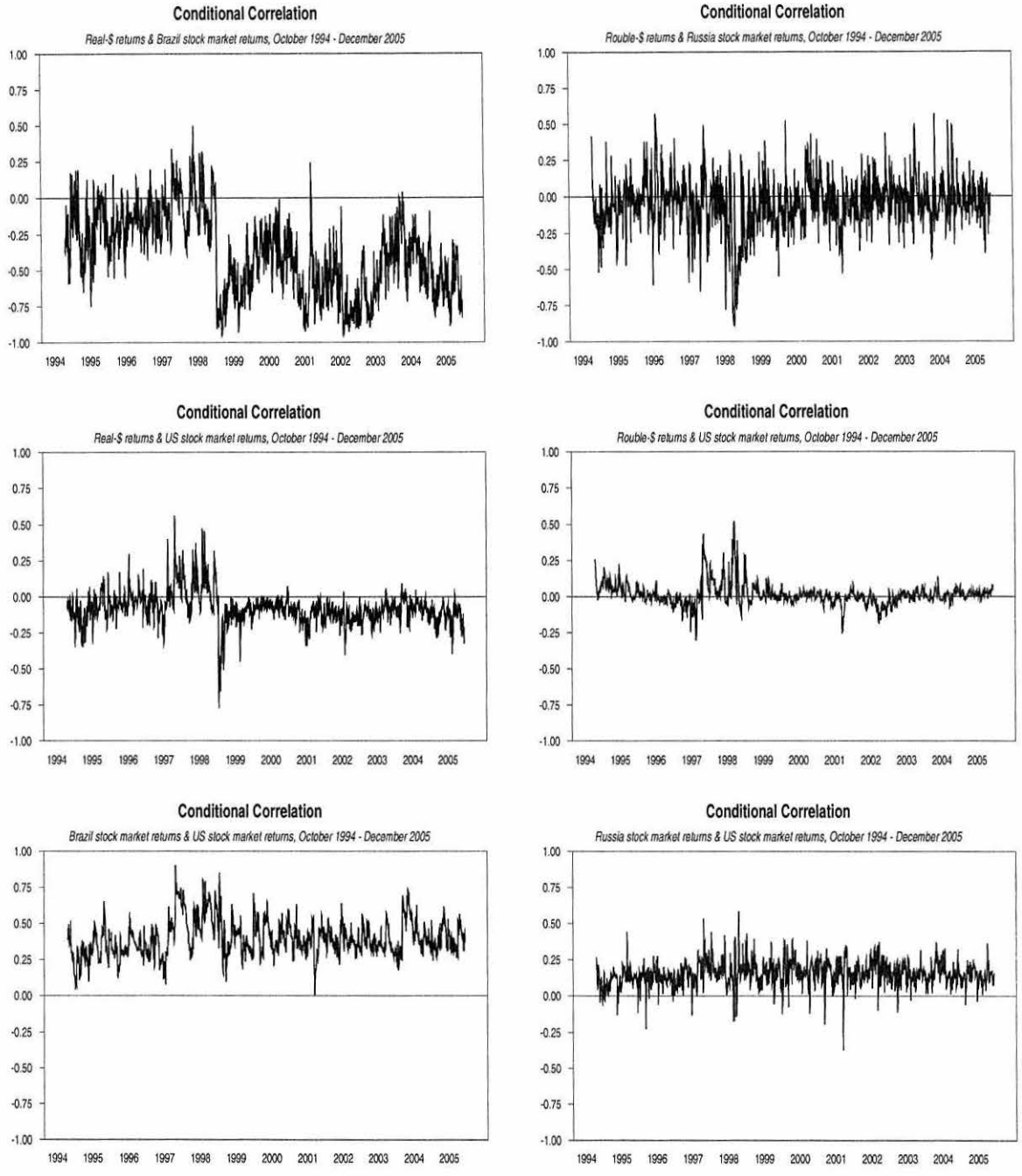


Figure 5b – Conditional Correlations: Stock Market & FX Market Returns

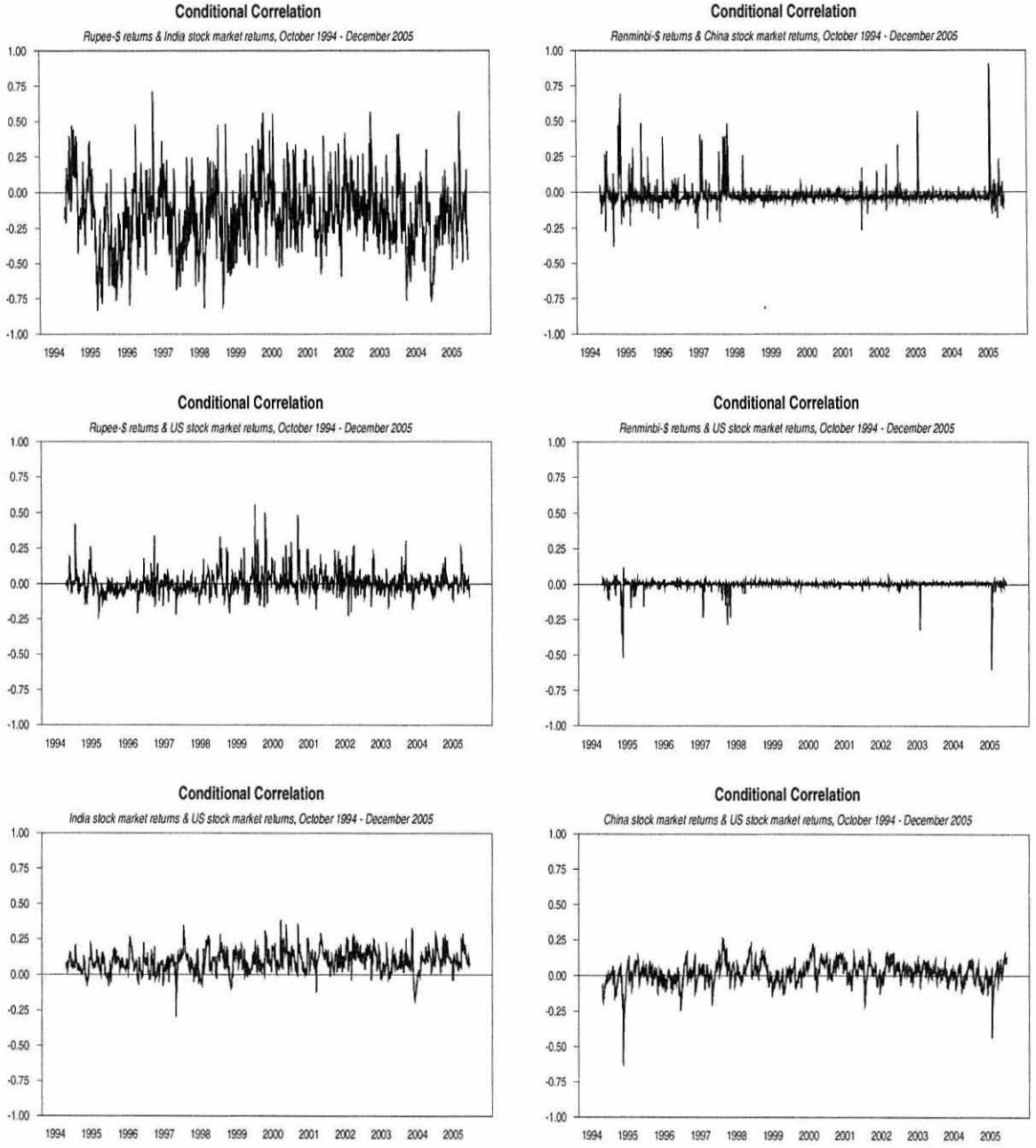


Table A1a: Average Annualised Conditional Variance and Standard Deviations by Year; 1994 - 2005

	Brazil			Russia			India			China		
Average	**H12**	**H13**	**H23**	**H12**	**H13**	**H23**	**H12**	**H13**	**H23**	**H12**	**H13**	**H23**
1994	-0.534	8.626	-0.062	-0.509	0.007	0.557	-0.002	0.001	0.107	-0.011	0.000	-0.138
1995	-0.537	12.290	-0.064	-0.183	0.005	0.239	-0.205	0.006	0.027	-0.005	-0.001	-0.110
1996	-0.033	2.778	-0.006	-0.015	-0.003	0.275	-0.338	-0.006	0.087	-0.005	0.000	-0.055
1997	-0.047	7.277	0.021	-0.005	-0.003	0.487	-0.150	-0.011	0.106	-0.005	0.000	-0.014
1998	-0.049	10.587	0.037	-9.641	1.389	0.455	-0.219	-0.010	0.192	0.004	-0.002	0.071
1999	-3.343	11.177	-0.314	-0.409	0.063	0.363	-0.088	-0.003	0.124	-0.002	0.000	0.018
2000	-0.619	5.385	-0.066	-0.041	0.002	0.611	-0.047	0.003	0.368	-0.001	0.001	0.086
2001	-1.876	7.866	-0.183	-0.012	-0.002	0.659	-0.077	-0.006	0.310	-0.001	0.001	0.097
2002	-4.246	10.756	-0.350	-0.011	-0.001	0.752	-0.007	0.003	0.236	-0.001	0.001	0.114
2003	-1.488	4.985	-0.134	-0.010	-0.001	0.361	-0.036	-0.004	0.133	0.001	-0.001	0.048
2004	-0.840	4.829	-0.071	-0.030	0.005	0.197	-0.176	-0.005	0.060	-0.001	0.000	0.009
2005	-1.220	4.728	-0.099	-0.025	-0.004	0.179	-0.061	-0.003	0.107	0.009	-0.005	-0.004
Standard deviations												
1994	0.381	0.040	0.189	1.304	0.109	0.481	0.027	0.008	0.029	0.010	0.001	0.143
1995	1.090	0.124	0.859	0.476	0.033	0.611	0.565	0.019	0.062	0.023	0.004	0.318
1996	0.084	0.017	0.171	0.164	0.011	0.260	0.557	0.031	0.110	0.007	0.002	0.133
1997	0.079	0.122	1.650	0.042	0.011	1.212	0.372	0.028	0.207	0.011	0.003	0.260
1998	0.134	0.076	1.873	29.885	3.348	1.139	0.349	0.033	0.235	0.021	0.009	0.173
1999	5.526	0.483	1.174	1.703	0.155	0.298	0.164	0.020	0.118	0.003	0.000	0.085
2000	0.570	0.070	0.536	0.293	0.020	0.496	0.237	0.044	0.328	0.002	0.001	0.136
2001	1.585	0.160	0.552	0.080	0.019	0.591	0.205	0.069	0.344	0.002	0.001	0.198
2002	7.723	0.539	1.291	0.057	0.008	0.537	0.036	0.018	0.151	0.003	0.002	0.214
2003	1.408	0.162	0.514	0.103	0.007	0.242	0.065	0.016	0.112	0.018	0.009	0.062
2004	0.922	0.085	0.354	0.160	0.022	0.159	0.289	0.023	0.138	0.001	0.000	0.057
2005	0.976	0.084	0.191	0.098	0.009	0.085	0.090	0.011	0.071	0.133	0.052	0.120

Note: 1 = foreign exchange rate, 2 = domestic stock market, 3 = international stock market

Figure AI: Annualised Average Conditional Covariances - Domestic & International Stockmarkets

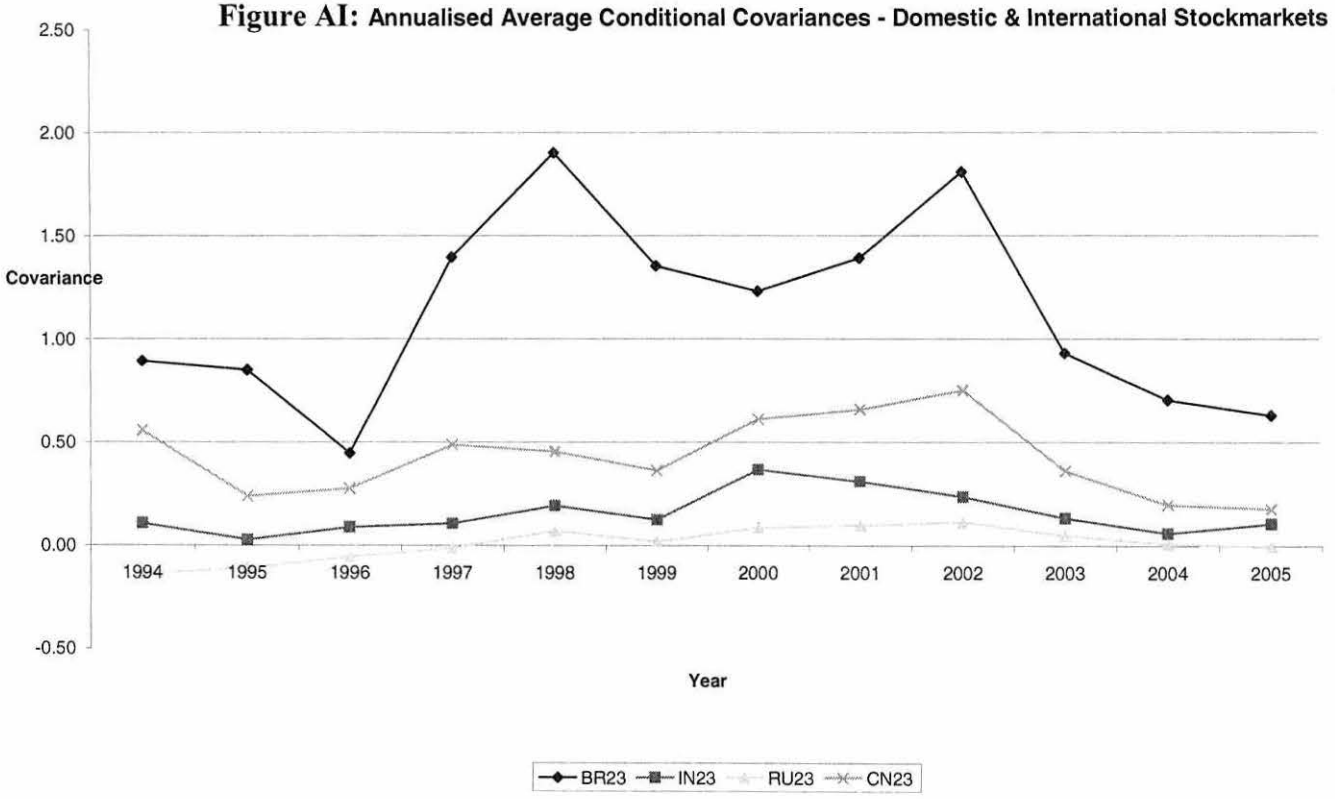


Table A2: Average Conditional Correlations and Standard Deviations by Year; 1994 – 2005

	Brazil			Russia			India			China		
Average	**COR12**	**COR13**	**COR23**	**COR12**	**COR13**	**COR23**	**COR12**	**COR13**	**COR23**	**COR12**	**COR13**	**COR23**
1994	-0.2900	-0.0779	0.3243	-0.1383	0.0654	0.0831	-0.0017	0.0244	0.0880	-0.0123	-0.0049	-0.0630
1995	-0.2002	-0.0962	0.3083	-0.0690	0.0614	0.1132	-0.1387	-0.0066	0.0572	0.0001	-0.0142	-0.0122
1996	-0.1907	-0.0293	0.3344	0.0053	0.0021	0.1277	-0.3008	-0.0260	0.0826	-0.0251	0.0069	-0.0206
1997	-0.0936	-0.0076	0.4134	-0.0315	-0.0041	0.1643	-0.1491	-0.0117	0.0583	-0.0222	0.0005	0.0119
1998	-0.0372	0.0689	0.5331	-0.2123	0.0925	0.1744	-0.2065	-0.0090	0.0913	0.0095	-0.0109	0.0680
1999	-0.6289	-0.1706	0.3833	-0.1208	0.0242	0.1660	-0.2070	0.0159	0.0920	-0.0321	0.0076	0.0126
2000	-0.3620	-0.0621	0.4299	-0.0465	0.0060	0.1786	-0.0489	0.0449	0.1243	-0.0267	0.0042	0.0556
2001	-0.5607	-0.1241	0.3760	-0.0537	-0.0207	0.1696	-0.1215	0.0327	0.1189	-0.0277	0.0034	0.0564
2002	-0.6574	-0.1337	0.3841	-0.0311	-0.0375	0.1817	-0.0812	0.0251	0.1221	-0.0278	0.0043	0.0384
2003	-0.5709	-0.1054	0.3760	0.0074	-0.0006	0.1496	-0.1492	-0.0021	0.0969	-0.0160	0.0014	0.0383
2004	-0.3652	-0.0748	0.4294	-0.0228	0.0093	0.1603	-0.2376	-0.0006	0.0764	-0.0282	0.0086	0.0127
2005	-0.5870	-0.1415	0.3925	-0.0281	0.0219	0.1408	-0.1783	0.0110	0.1257	-0.0059	-0.0025	0.0025
Standard deviations												
1994	0.1565	0.0448	0.0994	0.1663	0.0579	0.0762	0.1596	0.0593	0.0322	0.1034	0.0297	0.0540
1995	0.1953	0.1052	0.1145	0.1497	0.0520	0.0659	0.2961	0.0821	0.0575	0.1352	0.0762	0.1074
1996	0.1347	0.0687	0.0756	0.1846	0.0352	0.0610	0.2433	0.0448	0.0618	0.0524	0.0097	0.0578
1997	0.1616	0.1378	0.1759	0.1896	0.1364	0.0857	0.2289	0.0617	0.0660	0.0672	0.0257	0.0647
1998	0.1781	0.1302	0.1250	0.3002	0.1287	0.1063	0.2094	0.0559	0.0856	0.1083	0.0466	0.0735
1999	0.2002	0.1480	0.1260	0.1636	0.0556	0.0759	0.2233	0.0892	0.0706	0.0175	0.0052	0.0697
2000	0.1396	0.0394	0.1075	0.1552	0.0254	0.0913	0.2345	0.1162	0.0789	0.0193	0.0049	0.0702
2001	0.2101	0.0682	0.1002	0.1553	0.0571	0.0977	0.1971	0.0867	0.0748	0.0162	0.0065	0.0575
2002	0.1788	0.0614	0.0723	0.1169	0.0515	0.0730	0.1683	0.0744	0.0545	0.0379	0.0078	0.0734
2003	0.1941	0.0571	0.0735	0.1509	0.0369	0.0592	0.1807	0.0559	0.0664	0.0776	0.0331	0.0373
2004	0.1661	0.0593	0.1305	0.1650	0.0313	0.0655	0.2618	0.0569	0.0850	0.0133	0.0032	0.0475
2005	0.1577	0.0739	0.0806	0.1037	0.0193	0.0566	0.1890	0.0477	0.0628	0.1322	0.0630	0.0844

Note: 1 = FX market, 2 = domestic stock market, 3 = international stock market

I: Muti-VARIATE ASYMMETRIC BEKK GARCH Test: Brazil, Russia

Table Ia. Descriptive Statistics – Returns, October 1999 – December 2005 (%)

Stock Market Returns	**Brazil**	**Russia**
Sample Mean	0.0667**	0.1579***
Standard Deviation	5.8246	2.0712
Variance	2.413	4.289
Skewness	0.097	-0.271
Kurtosis (excess)	3.866	3.853
Jarque-Bera	1134.4	1151.3
FX Returns	**Real / $**	**Rouble / $**
Sample Mean	0.0316	0.0183**
Standard Deviation	1.0461	0.3711
Variance	1.0944	0.1377
Skewness	0.1357	6.944
Kurtosis (excess)	15.48	145.76
Jarque-Bera	18167.13	1630410.54
Observations	1825	1825

Table Ib. Descriptive Statistics – Returns, October 1994 – December 2005 (%)

Stock Market Returns	**China**
Sample Mean	0.035*
Standard Deviation	1.06
Variance	1.12
Skewness	-0.24
Kurtosis (excess)	4.55
Jarque-Bera	2553.86
FX Returns	**RMB**
Sample Mean	0.017
Standard Deviation	1.83
Variance	3.37
Skewness	0.83
Kurtosis (excess)	24.23
Jarque-Bera	72029.5
Observations	2929

Note: ***, **, * statistically significant at 1%, 5% and 10%.

Table Ic. Descriptive Statistics and Ljung-Box Q Statistics(a): Standardised, Standardised Squared, & Cross-Product of Standardise Residuals

Residual	ε_1	ε_2	ε_3	ε^2_1	ε^2_2	ε^2_3	$\varepsilon_1\varepsilon_2$	$\varepsilon_1\varepsilon_3$	$\varepsilon_2\varepsilon_3$
				Brazil					
Mean[(b)]	0.037	-0.007	0.005	1.07***	1.03***	0.98***	0.95***	-2.596	-1.12
Std dev	1.04	1.017	0.99	2.98	2.32	5.73	4.05	82.29	92.19
Skewness	0.566	-0.30	-0.20	19.02	14.65	6.89	-18.21	-14.93	-42.52
Kurtosis	5.68	3.073	0.90	519.39	363.67	63.04	632.92	352.28	1811.17
Q (6)	24.1934***	4.89	2.49	290.71***	50.24***	3.86	94.67***	2.14	0.0955
Q (12)	37.9503***	13.38	7.26.	295.70***	57.48***	7.32	98.793***	12.71	0.1067
Q (18)	61.0477***	23.89	14.89.	298.24***	61.65***	11.01	100.51***	13.79	0.1087
Q (24)	65.2568***	28.02	22.47	301.16***	65.08***	16.33	103.74***	15.96	0.1157
Q (30)	69.3858***	32.03	32.06	305.30***	67.16***	17.81	113.64***	16.54	0.1205
				Russia					
Mean[(b)]	0.0093	-0.010	0.013	1.28***	0.98***	0.99***	-0.97	33.69	2.71**
Std dev	1.13	0.99	0.99	14.35	1.96	1.82	166.43	1228.02	48.31
Skewness	6.90	-0.30	-0.23	34.19	5.99	6.89	12.49	29.27	25.30
Kurtosis	123.26	2.00	1.08	1288.98	58.50	96.12	449.99	894.47	874.00
Q (6)	84.80***	14.68	3.50	41.90***	1.64	2.65	1.27	0.05	8.56
Q (12)	152.60***	26.84**	9.32	45.33***	2.15	6.08	2.29	0.06	11.54
Q (18)	203.28***	41.23***	21.04	46.32***	4.31	11.72	3.01	0.06	12.18
Q (24)	255.84***	47.88***	25.63	48.07***	11.48	19.26	3.31	0.06	13.68
Q (30)	286.47***	54.98***	40.27	49.07***	11.85	20.48	3.90	0.07	17.65

China

	ε_1	ε_2	ε^2_1	ε^2_2	$\varepsilon_1\varepsilon_2$
Mean[(b)]	0.01	0.0000	1.01	1.00***	-30.67
Std dev	1.01	0.99	4.38	1.80	1084.90
Skewness	1.08	-0.35	-0.34	6.64	-28.39
Kurtosis	16.7	11.48	31.07	85.83	901.10
Q (6)	6.56	3.68	5.70	2.81	1.64
Q (12)	12.31	8.78	6.66	6.05	2.15
Q (18)	20.32	20.59	8.76	11.35	4.31
Q (24)	32.63	25.51	10.00	18.42	11.48
Q (30)	46.47*	38.63	11.36	19.66	11.85

Notes: (a) The 95% critical values for Q(6), Q(12), Q(18), Q(24), and Q(30) are 12.6, 21.0, 28.9, 36.4 and 43.8, respectively. The 99% critical values for Q(6), Q(12), Q(18), Q(24), and Q(30) are 18.5, 28.3, 37.2, 45.6 and 53.7, respectively. (b)test whether the sample mean of standardised residuals is equal to zero, sample means of standardised squared residuals and cross-products of the standard residuals are equal to 1. ***, and ** indicate significance

Table Id. Conditional Mean Equations – FX returns, 1999-2005

	Brazil		Russia	
	Coefficient	**Std Err**	**Coefficient**	**Std Err**
Constant	-0.0042	0.0115	0.0109	0.0033***
Fx{1}	-0.0442*	0.0247	0.1312	0.0298***
Do{1}	-0.0943***	0.0077	0.2019	0.0000
Int{1}	-0.0293**	0.0135	-0.0020	0.0019
CPI	0.0671	0.0496	-0.0011	0.0155
IP	0.0584	0.0655	0.0086	0.0170
MS	0.0075	0.0194	0.0115	0.0074
IR	0.0493**	0.0249	0.0115	0.0072

Table Ie. Conditional Mean Equations – Domestic stock market returns

	Brazil		Russia	
	Coefficient	**Std Err**	**Coefficient**	**Std Err**
Constant	0.0771**	0.0347	0.1474***	0.0402
Fx{1}	0.0509	0.0595	0.0118	0.0431
Do{1}	0.0947***	0.0226	0.1043	0.0223
Int{1}	0.0879*	0.0455*	-0.0382***	0.0401
CPI	-0.1295	0.1506	-0.0150	0.1212
IP	-0.1531	0.2044	-0.1557	0.2087
MS	-0.1563**	0.0681**	-0.0339	0.0664
IR	-0.0788	0.0780	-0.0443	0.0666

Table If. Volatility Transmission: Forex, domestic & international stock markets

	Brazil		Russia	
	Coeff	**Std Error**	**Coeff**	**Std Error**
ω_{11}	0.1282***	0.0168	-0.0177**	0.0085
ω_{12}	-0.5802***	0.0733	-0.1609	0.2030
ω_{13}	-0.0199	0.0224	0.0750	0.0578
ω_{22}	0.0728	0.0997	-0.1975**	0.0859
ω_{23}	0.0802***	0.0210	-0.0317	0.0668
ω_{33}	0.0001	0.1101	0.0654	0.0703
α_{11}	0.3281***	0.0393	0.3165***	0.0548
α_{12}	-0.5880***	0.1664	-0.0254	0.0362
α_{13}	0.0220	0.0223	0.0049	0.0094
α_{21}	0.0156	0.0155	-0.0091	0.0093
α_{22}	-0.1875***	0.0572	0.2315***	0.0729
α_{23}	-0.0107	0.0107	-0.0218**	0.0094
α_{31}	-0.0156	0.0253	0.0019	0.0023
α_{32}	0.3183***	0.0828	0.0336	0.0453
α_{33}	-0.0498	0.0317	-0.0760*	0.0405
β_{11}	0.9414***	0.0116	0.9412***	0.0173
β_{12}	-0.0182	0.0320	-0.0030	0.0152
β_{13}	-0.0132	0.0095	0.0029	0.0025
β_{21}	0.0221***	0.0053	-0.0005	0.0032
β_{22}	0.9052***	0.0227	0.9525***	0.0247
β_{23}	0.0016	0.0072	0.0089*	0.0045
β_{31}	-0.0221***	0.0045	0.0004	0.0009
β_{32}	0.0543**	0.0223	0.0133	0.0136
β_{33}	0.9680***	0.0066	0.9573***	0.0031
δ_{11}	0.3155***	0.0744	-0.2055***	0.0794
δ_{12}	-0.1889	0.2031	0.0338	0.0806
δ_{13}	-0.0196	0.0361	-0.0133	0.0166
δ_{21}	-0.0264	0.0190	0.0156*	0.0083
δ_{22}	0.2489***	0.0628	0.2187***	0.0736
δ_{23}	-0.0341	0.0266	-0.0171	0.0174
δ_{31}	0.0799***	0.0230	-0.0101**	0.0051
δ_{32}	-0.0537	0.1046	-0.0648	0.0627
δ_{33}	0.3381***	0.0346	0.3574***	0.0165

Note: 1 = FX market, 2 = domestic stock market, 3 = international stock market

II.BI-VARIATE ASYMMETRIC BEKK GARCH China

Table IIa. Conditional Mean Equations – FX returns, 1994-2005

	China	
	Coeff	**Std Err**
Constant	-0.0224	0.0259
Do{1}	0.0055	0.0197
Int{1}	0.0172	0.0238
CPI	-0.0674	0.0923
IP	-0.2522***	0.0871
MS	0.0294	0.0559
IR	0.0145	0.0492

Table IIb. Conditional Mean Equations – Domestic stock market returns

	China	
	Coeff	**Std Err**
Constant	0.0267*	0.0155
Do{1}	-0.0149**	0.0070
Int{1}	0.0209	0.0203
CPI	0.0796	0.0739
IP	-0.0266	0.0773
MS	0.0566	0.0373
IR	0.0536	0.0412

Table IIc. Conditional Mean Equations – International stock market returns

	China	
	Coeff	**Std Err**
Constant	-0.1242**	0.0504
Do{1}	-0.0448*	0.0249
Int{1}	0.0997***	0.0190
CPI	0.2005***	0.0318
IP	-0.0133***	0.0036
MS	-0.0072	0.0113
IR	0.1035***	0.0246

Table IId. Volatility Transmission: domestic & international stock markets

	China	
	Coeff	**Std Error**
ω_{11}	-0.1242**	0.0504
ω_{12}	-0.0448*	0.0249
ω_{22}	0.0997***	0.0190
α_{11}	0.2005***	0.0318
α_{12}	-0.0133***	0.0036
α_{21}	-0.0072	0.0113
α_{22}	0.1035***	0.0246
β_{11}	0.9689***	0.0079
β_{12}	0.0003	0.0010
β_{21}	0.0043	0.0028
β_{22}	0.9606***	0.0060
δ_{11}	-0.2167***	0.0397
δ_{12}	-0.0171**	0.0074
δ_{21}	0.0353*	0.0202
δ_{22}	0.3381***	0.0318

Note: 1 = domestic stock market, 2 = international stock market

Figure Ia. Conditional Correlation, from Jan.1999-Dec.2005: Brazil

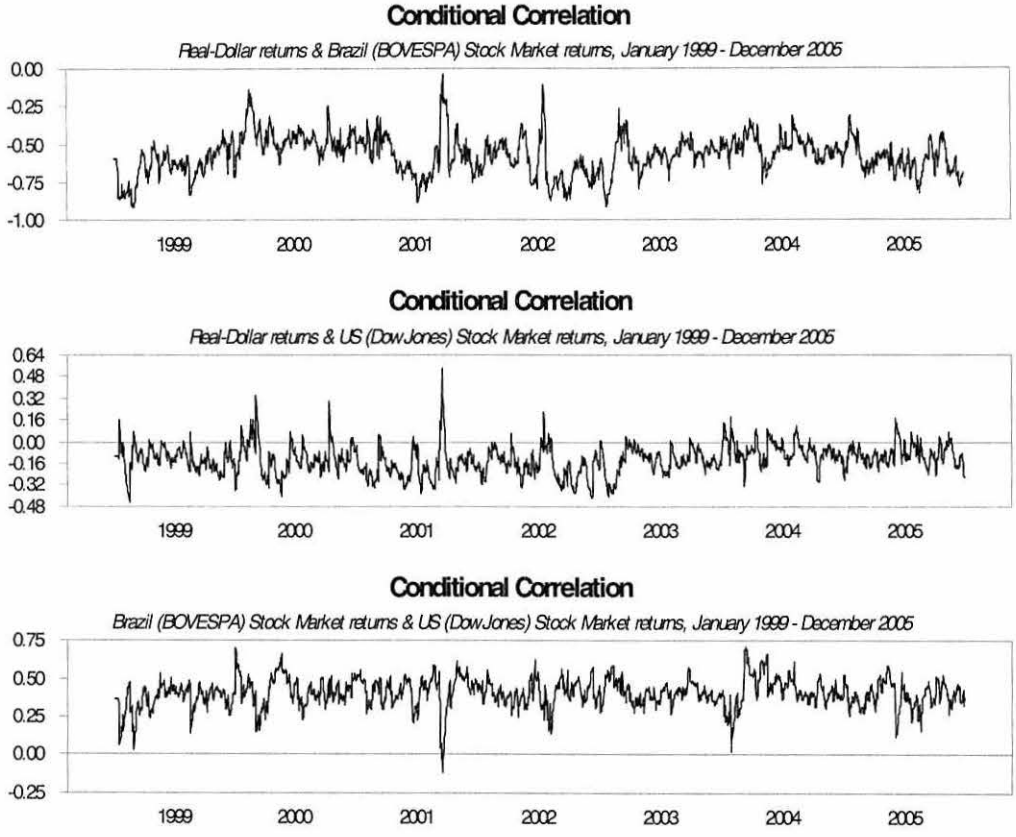


Figure Ib. Conditional covariance from 1999-2005: Brazil

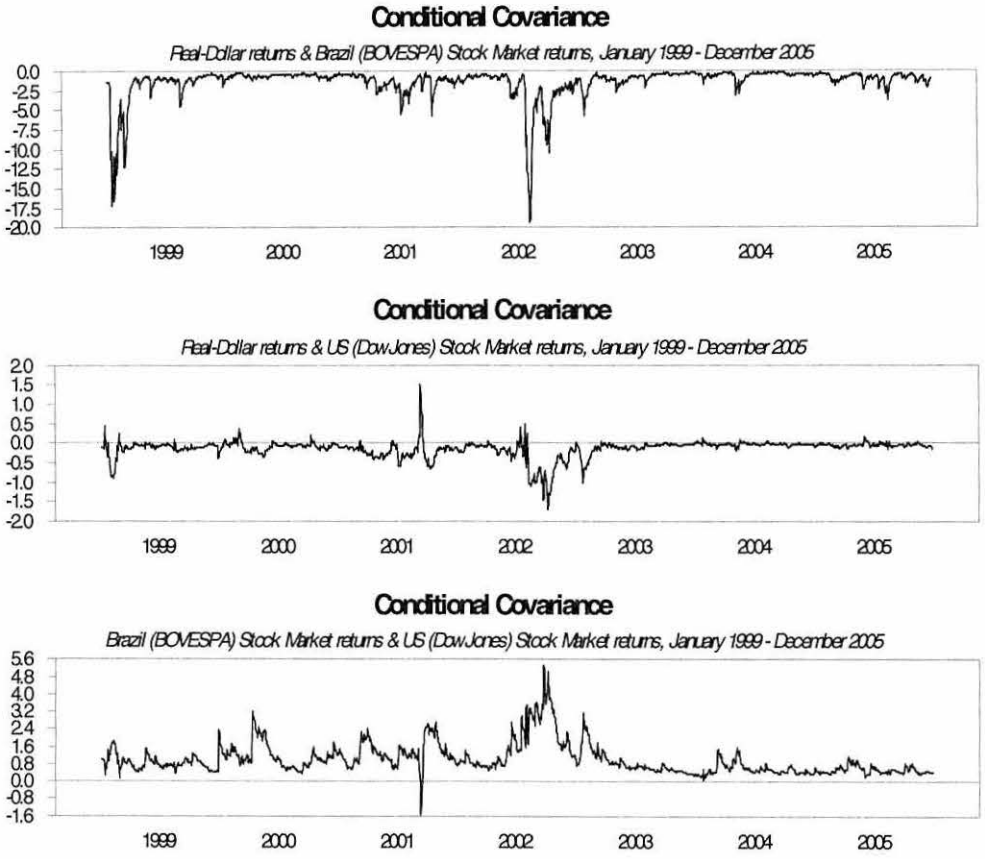


Figure Ic. Conditional Correlations from Jan.1999-Dec.2005: Russia

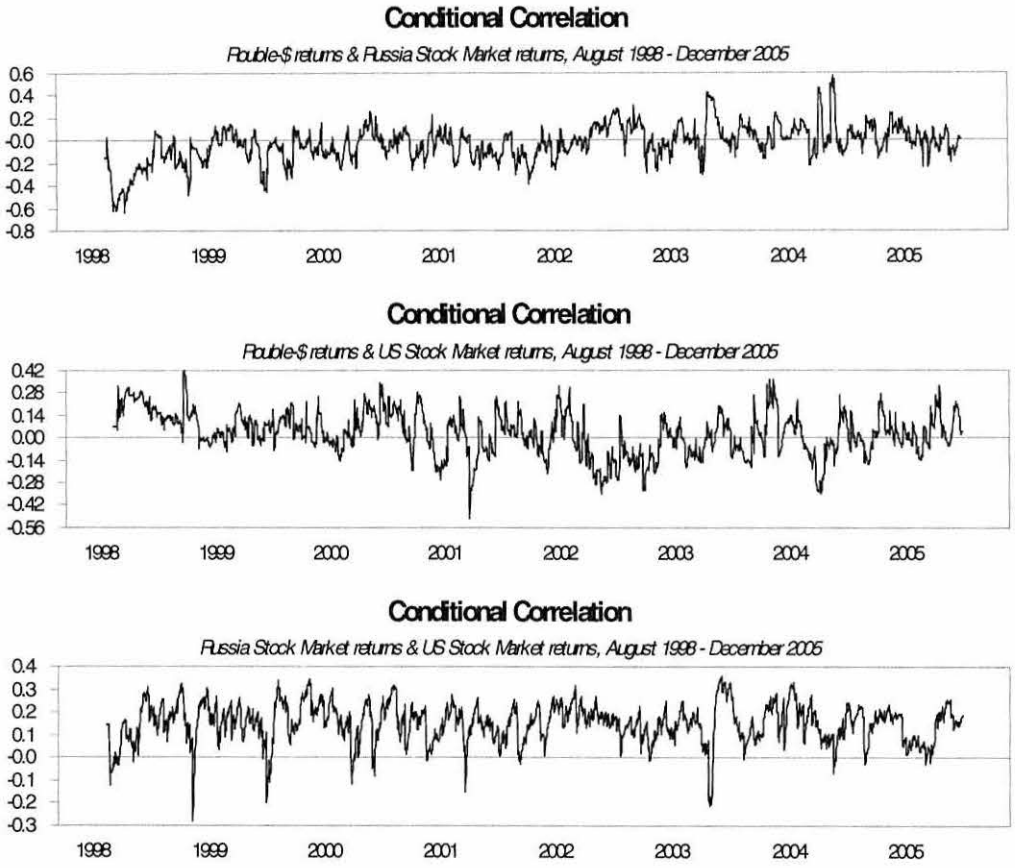


Figure Id. Conditional Covariance from Jan.1999-Dec.2005: Russia

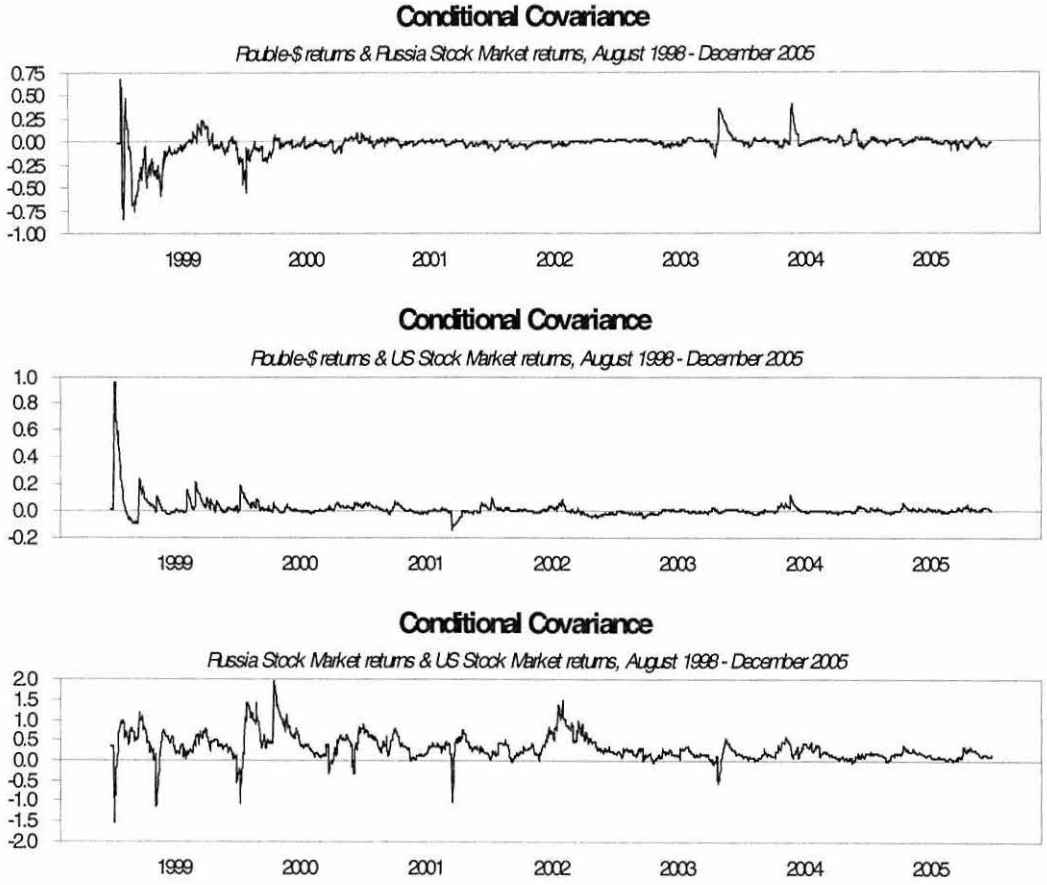
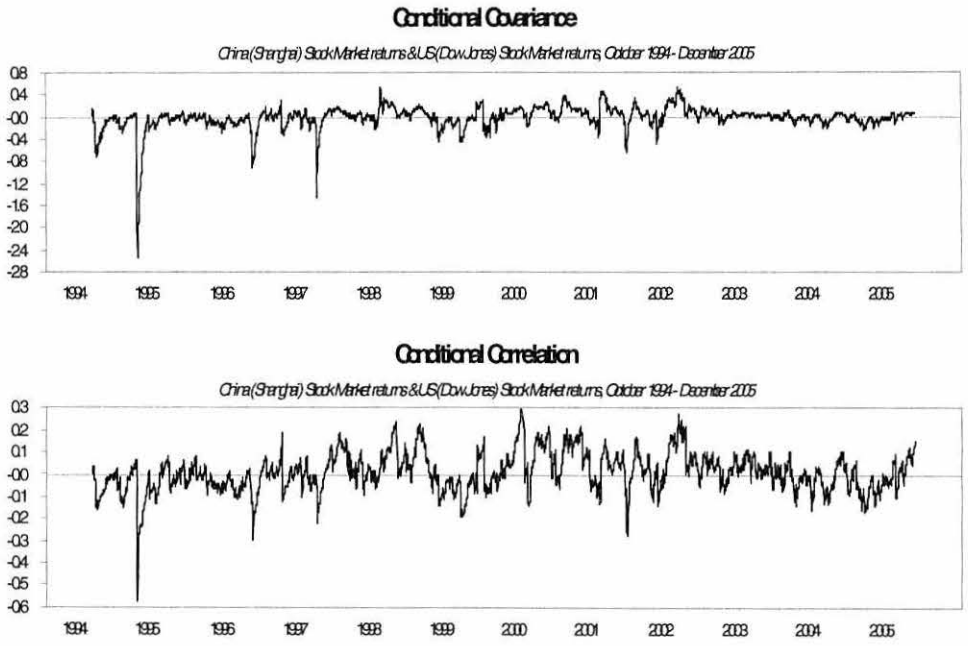


Figure II Conditional Correlations & Covariance from Jan. 1994-2005:



PART III: CONCLUSIONS, CONTRIBUTIONS, POLICY IMPLICATIONS & FUTURE RESEACH

PART III

Conclusions, Contributions, Policy implications, Future Research

III.1 Summary and Conclusions

The underlying theme of this research is international financial integration. Particular emphasis has been given to integration between financial markets in emerging markets and international markets. Three segments of the financial market have been studied: the banking system, stock market, and foreign exchange market. The broad research questions were summarised at the beginning of this thesis in a Chart-Map (see page 14).

Policy makers in emerging markets have implemented extensive financial liberalisation programmes involving banking sector deregulation, equity market liberalisation, and capital account liberalisation. Policy-wise, such reforms are expected to raise rates of economic growth as emerging markets become more integrated with international markets. As a caveat, the speed of financial reform and, consequently the level of financial integration, vary across emerging markets. The research carried out in this thesis employed daily financial market data and sophisticated econometric techniques to investigate microeconomic aspects of the integration process. The results presented in this research are amongst the earliest pieces of empirical evidence concerning the integration of specific financial markets in emerging markets with international markets.

The first working paper examined stockmarket reaction to the announcement of M&A involving an acquiring international bank and an emerging markets target bank. The period of the research is from 1998 to 2005 and the M&A announcements pertain to three geographic areas – Latin America, Central and Eastern Europe, and Asia. Due to increasingly competitive conditions in industrialised banking markets, and the opening up of emerging markets retail banking sectors to foreign investors we have identified 74 transactions involving the acquisition of ownership stakes in 46 target banks. An event study methodology was used to calculate cumulative abnormal returns to bank shareholders. The research aims of this research was to determine whether cross-border bank M&A generates significant value gains (returns) to bank shareholders, and how value gains are distributed between target bank shareholders and acquiring bank shareholders. Cumulative returns were subsequently regressed against variables that quantify the level of foreign ownership plus control variables that proxy for bank size and the state of stockmarkets in the six months prior to the M&A announcement.

The research analysed joint return to combined banks, abnormal return to international banks, and market-adjusted return to target banks. As expected, and consistent with previous studies, market-adjusted returns to target banks are positive and relatively large. This is true irrespective of the type of ownership stake acquired. However, market-adjusted returns are sensitive to the method of acquisition: tender offers and stock swaps yield the greatest returns. However, abnormal returns to international banks are negative although there are some exceptions: when North American banks acquire CEE targets, the increase of an existing majority stake, open market purchases of Asian and CEE targets, tender offers and

privately negotiated purchases of Latin targets. Joint returns to combined banks are driven by abnormal returns to international banks because the latter are considerably larger than their targets. Hence, the number of win-win outcomes is limited and the returns tend not to be statistically robust.

Interestingly, the acquisition of majority control of emerging market target banks significantly lowers joint returns. This finding contravenes European evidence but is consistent with some US research. Furthermore, it contradicts evidence from the non-financial sector which finds acquisition of majority control significantly raises returns. Thus, we establish a difference in the value creating effects of cross-border M&A transactions between banking and non-financial sectors in emerging markets.

There is evidence that acquiring minority stakes significantly increases joint return. Increasing a minority stake and increasing an existing majority stake are positively, yet insignificantly, related to joint return and abnormal return to international banks. A statistically significant and inverse relationship between joint return and the assets size of target banks is observed which is irrespective of the type of ownership stake acquired. There is not a robust statistical relationship between market-adjusted returns to target banks and any of five ownership control types which suggest returns to target banks are driven by other factors. Certainly, market-adjusted returns are significantly lowered when there is a bear period in industrialised countries' stockmarkets.

There is no evidence suggesting a transfer of wealth from emerging market target shareholders to international bank shareholders. The implication is that industrialised countries' stockmarkets do not expect cross-border M&A transactions to create value. This finding is consistent with some US evidence yet inconsistent with the non-financial sector in emerging markets.

The second working paper investigated the price discovery and volatility transmission processes in leading foreign exchange markets from 1975 to 2005 yielding 8,086 daily observations. The currencies used in the research were the Japanese yen, Swiss franc, and British pound *vis-à-vis* the US dollar. The data are the H.10 Foreign Exchange Rate series produced by the Board of Governors of the Federal Reserve System in the US and they are noon spot rates. A multivariate asymmetric BEKK GARCH model was employed to jointly estimate the conditional mean and conditional variance equations. The estimated coefficients from the conditional variance equation were used to derive estimates of volatility dynamics, that is, estimates of conditional volatility, covariance and correlation.

The research aims were to investigate whether US macroeconomic news announcements are important in the price discovery process. The dates and times of announcement of four major macroeconomic series were constructed: consumer price index, industrial production index, money supply, and short-term interest rate. A second aim was to analyse the volatility transmission process and see which type of news is more important in explaining the variance of spot returns: home news or cross-border news (so-called spillover effects). The asymmetric specification of the model means that it is possible to quantify the effect that

currency depreciation (in markets for the yen, franc and pound) has on the variance of spot returns. Volatility dynamics are examined for time varying behaviour. If there are patterns in the conditional covariances and correlations, this information could be used for the purposes of international portfolio and risk management. Finally, the model is re-estimated across periods when the US economy was in recession in order to determine whether relationships are sensitive to different stages of the business cycle.

In terms of price discovery in FX markets, the estimated coefficients in the conditional mean equation show that US news announcements on consumer prices and short-term interest rates are significantly and positively related to spot returns. Larger rises in US consumer prices raise yen-dollar and franc-dollar returns. Pound-dollar returns significantly increase following relatively large increases in short-term interest rates which also significantly raise franc-dollar returns. The results imply that the effect of news announcements of US macroeconomic fundamentals lasts for 3.5 hours which is a longer than the time suggested by Andersen et al (2003).

Consistent with the existing literature, FX markets are found to be more responsive to news originating in "home" markets. However, currency movements do transmit cross borders. Currency depreciation of the yen and pound significantly affects the variance of returns in the two markets but the direction of the effects is different. Yen depreciation lowers the variance of yen returns whereas pound depreciation increases the variance of returns. Yen (franc) depreciation spills over to significantly increase the variance of franc (yen) returns whilst franc (pound) deprecation significantly lowers the variance of returns to the pound (franc).

The arrival of news has a persistent effect lasting for at least one day. The magnitude of persistence is considerably larger for "home" news compared with cross-border news.

The conditional volatility, covariance, and correlation of exchange rate returns are time-varying. Generally speaking, there is a sharp upward trend in conditional volatility and correlation from 1975 to the mid-to-late 1980s which probably reflects increasing integration in financial markets. Although there is variability in the 1990s, the trend is slightly downwards. It is increasing, however, in the early-to-mid 2000s though the patterns show far less dispersion compared with the 1970s and 1980s.

Finally, during recessionary periods, news announcements of US macroeconomic fundamentals are insignificant in predicting FX returns. However, currency depreciation (home *and* cross border) becomes more important in influencing the variance of FX returns. Mean conditional variances of FX returns are much larger during recessionary periods and there are sharper movements in conditional covariances and correlations. The observation of clear patterns in conditional mean and volatility suggests this information could be useful for international portfolio and risk management purposes.

The third working paper applied the multivariate asymmetric BEKK GARCH model to examine the price discovery and volatility transmission processes in the BRIC countries (Brazil, Russia, India and China) between 1994 and 2005 for a total of 2,929 daily observations. For each of the BRICs, the preferred model jointly estimates the conditional mean and conditional variance for three asset markets: FX market (all currencies *vis-à-vis* the

US dollar), the domestic stockmarket, and the international stockmarket (the US Dow Jones index is used as the proxy). Estimating country specific models meant that differences in the degree of international financial integration could be observed. Similarly, to the best of our knowledge, this research is one of the earliest studies to investigate the role that US macroeconomic news announcements has on the price discovery process in emerging markets financial markets.

The research aims were to quantify whether US macroeconomic fundamentals significantly affect financial returns in emerging markets' FX and equity markets. Also examined was the volatility transmission process between FX returns, local and international stock market returns. The asymmetric model specification lets the researcher identify how currency depreciation affects the volatility of stockmarket returns and vice-versa. As the rate of integration quickens, one would expect that "international" news will become a more important piece of information. The estimated interdependencies between the variance and covariance of US returns and emerging markets returns are taken as an indication of the degree of integration. Finally, the research aimed to determine if conditional volatility is time varying. Volatility dynamics suggest that the variance of returns will decline and the covariance of returns increase as integration progresses (because of changes in diversification opportunities). Likewise, it is important to establish the degree of correlation and how it is evolving because of its implications for international portfolio diversification.

An interesting and original finding is role that international (US) macroeconomic fundamentals have on the price discovery process in emerging markets. The evidence

reported in this research is consistent with findings reported for European markets (Andersen and Bollerslev, 1998; Andersen et al., 2004). Tentatively, this implies that the release of public information can be used to predict emerging market asset price returns, which refutes the efficient markets hypothesis. Currency depreciation tends to be followed by currency appreciation, and lagged FX returns are significant predictors of FX returns at time *t*. Consistent with findings elsewhere in the literature, local stock market increases appreciate the local currency.

The volatility of BRIC asset price returns is influenced more by "home" news although spillover effects between different asset and geographic markets do exist. Home news is found to be more persistent in explaining volatility since the spillover effects tend to decay at a faster pace. The magnitude of news shocks in FX markets tends to be greater than in local stock markets whilst there is only limited evidence of significant shocks from the international market affecting BRIC markets. The findings concur with the established literature and confirm the importance of modelling asymmetries since BRIC markets are more responsive to bad news.

The variance of asset price returns is expected to be lower the greater the degree of integration with international markets. In the BRICs, the variance of FX returns is lower than local stock market returns, which implies that emerging market currency markets are relatively more integrated with international markets. The estimated variances and covariances are time-varying and clearly indicate the timing of financial crises like the autumn 1998 exchange rate problems in Russia and Brazil. Furthermore, the variances clearly show a significant shift following the change in exchange rate regime in both

countries. On average, there are negative correlations between FX returns and local stock market returns, very small correlations between FX returns and international stock market returns, and positive and larger correlations between local and international stock market returns. The size and pattern of correlations suggests that emerging market assets remain an effective diversification strategy for investors.

III.2 Policy implications & contributions

This research makes several significant policy implications to the existing literature on banking sector M&A, and price discovery and volatility transmission across financial asset markets.

a) Broadly speaking, the empirical evidence presented in Working Paper No. 1 suggests it is difficult to discover a win-win situation from cross-border M&A transactions in banking. Whereas stockmarkets may favourably react to M&A announcements in the target banks' markets, stockmarkets in industrialised markets tend not to react in the same manner. And it is the latter which are driving joint returns to the combined bank. However, if investors are vigilant enough to consider factors such as the type of ownership stake acquired, method of acquisition, geography of international and target banks, and recent stockmarket trends, then a limited number of win-win cases can be observed. However, the returns tend not to be statistically robust. Indeed, the overall lack of robust statistical evidence points to problems associated with small samples. We suggest stockmarket perceptions regarding cross-border M&A transactions in emerging markets reflect information asymmetries associated with

valuing opaque bank assets, and uncertainties associated with investing in banks in financial systems that have been under severe distress in recent times. In a small number of transactions, the acquisition of ownership rights is limited by regulations. Nevertheless, we expect the consolidation of global banking to continue as current regulations pertaining to foreign ownership of domestic banks are eliminated over time. Similarly, more industrialised country banks facing increasingly competitive domestic markets, may seek out shareholder value in emerging markets that offer potential for expansion and diversification.

b) One contribution of Working Paper No. 2 is that it investigates price discovery and volatility transmission in spot markets over a thirty year period which tends to be considerably longer than other studies. Arguably, this research is one of the earliest pieces of empirical evidence on how US macroeconomic news announcements impacts on spot returns. That a significant relationship is found between FX returns and publicly available information runs contrary to the efficient markets hypothesis which claims that asset prices incorporate all publicly available information. (This finding is applicable to the research carried out in Working Paper No. 3.) However, the observed relationships are sensitive to the stage of the business cycle in the US: during episodes of recession in the US the formerly observed price discovery relationships disappear. Statistical tests confirm the appropriateness of the asymmetric model. The results suggest that the volatility of FX returns is more responsive to currency depreciation. This affect is stronger when the US economy in is recession. That there are observable patterns in conditional covariance and

correlations between FX returns has implications for international portfolio and risk management, as well as asset allocation strategies. The time varying volatility dynamics could be used to weight assets in investors' portfolios.

c) Several implications may be drawn from Working Paper No. 3. This research is amongst the earliest attempts to include the effect of US macroeconomic news announcements in the price discovery process for emerging market financial assets. That there are significant relationships between FX returns and domestic stock market returns and US macroeconomic fundamentals is an indication of international financial integration. However, and as expected, the observed relationships are not common to each of the BRICs, and that they apply mainly to Brazil and Russia is an indication of the variation in international financial integration across emerging markets. Therefore, one might expect that as the process of financial liberalisation goes further in emerging markets, news regarding the state of the US economy will have a significant impact on emerging market asset prices. The study also provides evidence on how currency depreciation and news from international stock markets affects asset price returns in emerging markets. Similarly, the finding of time varying volatility dynamics and the direction of correlations between asset price returns is of importance for international and domestic investors alike.

III.3 Limitations and suggestions for future research

There are inevitable limitations concerning research. Notwithstanding, limitations pertaining to data availability, some suggestions for future research provide an indication of some of the difficulties associated with the current research.

There are a number of potential anomalies associated with event studies. For instance, the selection of the period used to derive estimates of alpha and beta which are used to construct predicted returns. The majority of studies employ OLS regression techniques to estimate alpha and beta. However, the two coefficients may be time varying. Therefore, an extension to the present research would involve using GARCH methods to estimate time varying alpha and beta. The computed abnormal returns from OLS and GARCH models could be compared. The selection of the length of the event window is also contentious especially when researchers use emerging markets price data that may suffer from thin trading and illiquidity. The choice of market index could be different with the banking sector index being used in place of national stockmarket indexes. There is the issue of leakage of information prior to M&A announcements. The empirical evidence presented in this research is short term and a future development would be to calculate long run returns. The results represent stockmarkets' *expectation* of whether M&A transactions will be value creating. Firmer evidence concerning the post M&A performance of target banks would be a stronger guide as to the success of each M&A deal. Other comparisons of pre-and-post M&A performance could be carried out.

Whereas the multivariate asymmetric BEKK GARCH model has many appealing qualities, the number of assets or markets that may be included in the model is limited. Many studies

specify bi-directional GARCH models with a very small number of studies specifying four or five markets. As a future development, more recent GARCH family models like dynamic conditional correlation and its asymmetric variant offer researchers greater flexibility in the number of markets that may be included.

As noted in this research, several authors are investigating the price discovery process using ultra high frequency data, especially in relation to FX markets. The use of such data allows researchers to quantify the duration of shocks to periods of minutes or hours. By definition, the GARCH(1,1) model estimates whether persistence lasts for one day.

Another interesting exercise would involve using the estimated conditional covariances and correlations as weights or guides in an asset allocation framework. One could create hypothetical portfolios using the conditional information and evaluate their performance. This exercise could be carried out across asset classes within an industrialised or emerging market, or between industrialised and emerging markets. The results would be further evidence of the degree of international financial integration.