SUMMARY OF EMPIRICAL STUDIES ON VOLATILITY TRANSMISSION (SPILL-OVER EFFECTS) AMONG WORLD FINANCIAL MARKETS

***Table A**: Summery of Studies with a Primary Focus on Mature Economies (Developed Markets)*

Study	Countries Covered	Period Covered and Frequency	Estimation Method	Methodological Issues	Summary of Findings
Au-Yeung and Gannon (2005)	2 countries, US and Hong Kong Spot and Futures markets	1994-2001, Daily	Bi-variate GARCH (BEKK) with multiple switching points in variance equation	Switch points capture changes in volatility structure due to regulatory events on HSI and HSIF	US SE found in the HSI and HSIF Evidence of structural changes in volatility found when US is excluded
Bodart and Reding (1999)	6 European Counties: EMS and non EMS.	1989-1994, Daily	Multivariate/Univariate GARCH models	Bivariate GARCH models that are used to analyse how exchange rate regime affects conditional correlations among countries	Unlike on the bond market, there is little significant evidence that stock correlations, among the countries reviewed, are affected by the degree of exchange rate variability.
Ciferelli and Paladino (2005)	3 Countries: US, UK and Germany	1992-2000, Daily	Symmetric and Asymmetric multivariate GARCH models	Model allows analysis of extent to which stock market volatility diffusion causes Stock market exuberance transmission	Volatility SE are largely accounted for by stock market exuberance Markets tend to be more interlinked during bouts of crises
Fratzscher (2002)	16 OECD countries	1986-2000, Daily	Multivariate volatility Model	Through a tri-variate GARCH specification regional and global shocks are distinguished and analysed.	European equity markets have become integrated with Euro area market experiencing an increasing dominant role in Europe, over that of the US.
In (2007)	3 countries, US, UK and Japan	1996-2001, Daily	Multivariate VAR-GARCH	Model enables testing asymmetry in the volatility SE	Unidirectional SE from the US to UK and Japan Significant reciprocal SE between UK and Japan
Isakov and Pérignon	5 countries, and Switzerland	1988-1998, Daily	Multivariate Volatility Model (GARCH-BEKK)	Inferences are made by modelling a series of bi-variate GARCH-BEKK with the 5 markets	Asymmetric volatility SE to Switzerland are mainly from European countries, and not significantly from the US
Kim *et al (2005)*	12 EMU countries, 3-no-EMU states, Japan and US	1989-2003, Daily	Multivariate volatility model (ARMA-EGARCH)	This model specification used, eliminates the assumption of constant correlation between stock returns. [1]	Time varying conditional correlations found with persistent effects among countries with similar industrial structures. Volatility SE among EMU States indicates increased integration
Koutmos and Booth (1995)	3 countries, US, UK and Japan	1986-1993, Daily	Multivariate Volatility Model (M-EGARCH) with constant correlations	Jointly examines the interdependencies, however fails to account for overlapping trading in UK and US	SE found from US to UK and Japanese markets SE found from Japan to UK SE are pronounced during periods of negative news
Savva (2008)	6 countries, US and European countries	1990-2005, Daily**	Multivariate volatility framework (EGADC)[2]	The framework nests several multivariate versions of GARCH models: VECH, CCC, BEKK and F-ARCH)	Bi-directional volatility SE between US and Europe Correlation between markets increases in after thee occurrence of negative news, and since introduction of Euro
Savva *et al* (2009)	4 countries, US, UK, France and Germany	1990-2004, Daily**	Asymmetric Dynamic Conditional Correlation (DCC) Model, VAR, M-EGARCH	The study employs daily pseudo-closing prices for all the markets to avoid the problem of non-synchronous trading	SE recorded among European markets which have intensified after introduction of the Euro SE from foreign markets are transmitted asymmetrically

NOTES: *SE* *Spill over Effect* *HSI* *Hang Seng Index* ** *Daily Closing Pseudo prices are used to avoid non-synchronous closing times*
EMU *European Monetary Union* *HSIF* *Hang Seng Futures*

***Table A:** (Continued)*

[1] See for instance Bollerslev (1990)
[2] Extended General Asymmetric Dynamic Covariance

Study	Countries Covered	Period Covered and Frequency	Estimation Method	Methodological Issues	Summary of Findings
Aragó and Fernández (2007)	5 countries: Europe	1995-2004, Daily	Multivariate GARCH-BEKK framework	SE are modelled using a series of Bi-variate GARCH-BEKK specifications of the local with the foreign stock market.	Indistinguishable asymmetric information SE are detected among all the countries EMU and non-EMU countries
Bae and Karolyi (1994)	2 Countries: US and Japan	1988-1992, Daily	Univariate GARCH, EGARCH Models	Day time and over night news transmission between the two markets is analysed.	Volatility SE are evident SE originating from the US to Japan are significantly understated in magnitude and persistence if asymmetry in their transmission is not taken into consideration.
Bartram and Wang (2005)	US and UK (Mimicking prices)	1978-1997, Daily (artificial)	Monte Carlo Simulations, GARCH	Time series of returns are simulated according to alternative stochastic processes: LRM, LRMH, GBM & GARCH	Simulation results show that market dependence is not generally conditional on volatility regimes, such that a bias in correlation measures only occurs for invariant conditionally hetroscedastic return generating processes.[3]
Christiansen (2007)	US, Europe, 6 EMU States and 3 non-EMU member states	1988-2002, Weekly	Univariate AR-GARCH Implemented as in Ng (2000)	Spill-over model allows volatility to be driven by local, regional and global factors	Stronger regional than global SE on EMU states, than on non-EMU. Weaker US SE than Aggregate European SE
Fernández and Lafuente (2004)	12 countries: Europe, Asia and America	1997-2001, Daily	Multivariate EGARCH models, Principal Analysis	Factor Analysis is used to analyse stock price volatility dynamics into 3 latent factors: Europe, Asia and America	Significant leverage effects are found. Volatility SE during this period (Asian crisis) were transmitted through contagion not by economic fundamentals
Hamao *et al* (1990)	3 countries: Japan, US, UK	1985-1988, Daily	Univariate GARCH-M models	Conditional variance in close-to-open and close to open returns of local market is approximated by a MA-GARCH-M process.	Unidirectional volatility SE from the US to UK (weaker) and Japan (stronger), UK to Japan (weak) after the 1987 crash. There is no significant SE prior to the 1987 crash

NOTES: *SE* *Spill over Effect* RM Linear Regression Model LRMH Linear Regression Model with Hetroscedasticity
EMU *European Monetary Union* GBM Geometric Brownian Motion

Table B: *Summery of Studies with a Primary Focus on Mature and/or Emerging Market Economies (Emerging Markets)*

Study	Countries Covered	Period Covered and Frequency	Estimation Method	Methodological Issues	Summary of Findings

[3] This finding contrasts that of Forbes and Rigobon (2002), who show that most correlation coefficients used in the vast literature to document inter-market linkages during turbulent times (usually referred to as contagion), are biased measures of dependence. When these biases are accounted for, there is no evidence of contagion in the 1987 US crisis, 1994 Mexican crisis and 1997 Asian crisis.

Alper and Yilmaz (2004)	3 developed markets and 4 emerging markets	1992-2001, Weekly	Univariate MA-GARCH models	Simple rolling regressions are employed to analyse volatility persistence before and after crises	Volatility contagion effects are found: mainly coming from the developed markets (US, Japan and UK) estimated on average to be four times that coming from emerging countries reviewed.
Beirne *et al* (2008)	41 EMEs , 6 Mature markets	1993,1996-2008, Weekly	Multivariate Volatility Models: Tri-variate GARCH-BEKK Models [Local, Regional, Global markets]	Changes in volatility transmission are examined during turbulent periods in mature markets	Volatility SE from mature markets are found most EME's, and from regional to local markets, with the spill over parameters changing during turbulent times (in mature markets)-contagion.
Bekaert *et al* (2005)	22 countries: Asia, Europe and Latin America	1980-1998,	Asymmetric GARCH with the mean equation implemented is a two-factor asset pricing model	As in Ng (2000), Spill-over model allows volatility to be driven by local, regional and global factors	No additional contagion documented after Mexican crisis, but increased integration in Asia during Asian crisis
Caporale *et al* (2005)	8 East Asian Countries	1990-1995, Weekly	Conditional Correlation Analysis, Univariate GARCH	This framework is adopted to analyse "contagion" which they define as increased cross-market linkages in response to a shock on another country	Contagion began in late 1997 at the time of the Hong Kong crash or onset of Korean crisis, with the source of crisis (Thailand) affecting the rest of the countries in the region.
Caporale *et al* (2006)	US, Japan, Europe(4), South East Asia (8) countries	1986-2000, Daily	Multivariate Volatility Models [GARCH-BEKK], Bootstrapping	A series of Bi-variate GARCH models are estimated to measure volatility SE before and after the 1997 Asian crisis.	Bi-directional volatility SE in the pre-crisis and whole sample. However, causality in variance links runs from country in turmoil (to others) following the onset of the crisis
Chiang *et al* (2007)	8 Asian Countries, US	1990-2003, Daily	Correlation Analysis, Multivariate GARCH [DCC-GARCH Model]	Hetroscedasticity-adjusted correlation and dynamic correlation analyses are used to investigate contagion during the 1996 Asian crisis	There was significant increase in cross-market co-movement during the crisis (contagion). However, the stability of the covariances is subject to structural changes (e.g. in response to news about foreign currency sovereign credit ratings).
Chuang *et al* (2007)	6 East Asian (Emerging) Markets	1992-2006, Weekly	Multivariate VAR-GARCH (BEKK) and VAR	Volatility transmission is examined through a VAR system of 6 conditional variances	SE are recorded, with a larger proportion coming from Japan to the rest of the East Asian states Volatilities have increased post Asian crisis period
Darrat and Benkato (2003)	5 countries: Turkey, US, UK, Japan and Germany	1986-2000, Monthly	Johansen Cointegration, Univariate GARCH Model	Volatility SE are analysed by expressing the conditional volatility of ISE, as a function of the lagged conditional variances of the other four markets	Volatility SE between the ISE and the other four matured markets, are found to have strengthened after liberalization, with the US and UK being the main drivers ISE volatility.
Ng (2000)	6 Pacific Basin States (emerging markets) , US and Japan	1980-1996, Weekly	Univariate and Multivatiate GARCH models	Spill-over model allows volatility to be driven by local, regional and global factors	Volatility SE effects from US and Japan found Global and regional factors account for less than 10% of Pacific basin volatility
Vrugt (2009)	4 countries: Japan, Hong Kong, S. Korea, Australia	1996-2007, Daily	Univariate GARCH Models	Analysis of how macroeconomic news announcements from the US and Japan affect conditional volatility in the 4 countries	US announcements are more important than Japanese (even in Japan) for all the markets reviewed.
Wei *et al (*1995)	3 Developed and 2 Emerging (markets)	1991-1992, Daily	Univariate GARCH models	Intra-day, open to close and close to open data are used in this study	Volatility SE are found from the US to the emerging countries over that exerted by Japan

NOTES: *SE* *Spill over Effects*
EME *Emerging Market Economy*

Table B: *(Continued)*

Study	Countries Covered	Period Covered and Frequency	Estimation Method	Methodological Issues	Summary of Findings
Apergis *et al* (1997)	Greece vis-à-vis USD, EC, ECU currencies	1992-1996, Daily	Univariate GARCH models	The GARCH variance equation for stock price conditional volatility includes lagged conditional volatilities of the 3	Volatility SE between Greek stock volatility and the USD volatility are found, but not with the other European currencies

				currencies.	
Bekaert and Harvey (1997)	20 Emerging Markets, US	1976-1992, Monthly	Univariate volatility models	EM volatility dynamics and what drives then are analysed by distinguishing world and local factors.	World factors drives less than 10% of volatility in 16 out of 20 EM surveyed, but increases after liberalization and crises for some Ems.
Li (2009)	US and 5 Emerging Market groups	1988-2007, Weekly	Multivariate Markov Switching ARCH, Multivariate GARCH Models	US-EM co-movements when both markets are in HV/LV states/regimes and the US-EM portfolio diversification implications are investigated.	The find that US-EME correlations vary depending on the volatility states of the two market groups Strongest US-EM correlations result when both US-EM markets are simultaneously characterised by high volatility
Miyakoshi (2003)	7 Asian countries, US and Japan	1998-2000, Daily	Multivariate EGARCH model	Spill-over model allows volatility to be driven by local (endogenous), regional and global (exogenous) factors.	Mean return SE from US (and not Japan) to the Asian markets Volatility SE from Japan (more than from the US) affect Asian market volatility
Niarchos *et at* (1999)	2 US and Greece	1993-1997, Daily	Multivariate Asymmetric volatility models, Cointegration tests	Study implements a Bi-variate EGARCH that allows for both mean and volatility SE between the two markets	No mean and volatility SE detected between US and Greece. Cointegration tests do not show a long run association between US and Greece
Pan *et al* (1999)	5 Asia Pacific countries and the US	1988-1994, Daily	Cointegration, Univariate GARCH Model	A modified cointegration test with ARCH effects is used to capture common time-varying volatility in these markets	There is no evidence of long run associations in mean returns. However, statistically significant long run common time-varying volatility is detected among the six Asia-Pacific markets
Tastan (2005)	6 countries: Turkey, EU and US	1990-2004, Daily	Multivariate Volatility Models [VAR-DCC-MVGARCH]	Turkey's integration into the EU and global market is analysed through time varying correlations and conditional covariances	Turkey exhibited a weak stale association with rest of the markets prior to the European customs union. After the customs union, there was a shift in the covariance structure of Turkey with other markets.
Tse *et al (2003)*	2 US and Poland	1994-2003, Daily	Multivariate Asymmetric Volatility models, Cointegration Tests	Study implements a Bi-variate EGARCH[4] that allows for both mean and volatility SE between the two markets	There's weak evidence of mean SE from the US, but no evidence of volatility SE. Cointegration tests reveal no evidence of a long run relationship between US and Polish Markets.

NOTES: *SE* *Spill over Effect* *HV* *High Volatility State* *EME* *Emerging Market Economies*
EMS *European Monetary System* *LV* *Low Volatility State*

Table C: *Summery of Studies with a Primary Focus on South African and/or African Markets*

Study	Countries Covered	Period Covered and Frequency	Estimation Method	Methodological Issues	Summary of Findings
Alhassan (2006)	9 counties: Ghana and Major world markets	1990-2003, Weekly	Cointegration and Error correction Analysis	First moment return associations are modelled using Cointegration and error correction analysis	Preliminary results show Ghana is not co-integrated with all the markets, except with Japan. However, an error correction model fails to validate this finding.
Hamavindu and Floros (2006)	2 countries RSA and Namibia	1999-2003, Daily	Unit root tests, Johansen Cointegration tests and	The returns are adjusted for thin trading to eliminate spurious serial correlation in	No evidence of volatility SE between Namibia and RSA. Returns exhibit low correlations and with weak evidence of long run

[4] Non-synchronous trading between the two markets is accounted for by introducing a first order moving average term in the mean return equations.

			Univariate GARCH models	index returns	relationship
Lamba and Otchere (2001)	9 developed countries, 7 African countries	1988-2000, Weekly	Vector Autoregressive (VAR) Model, Co integration	The study analyses South Africa's return co-movements with several developed markets prior to and after the apartheid regime.	With the exception of RSA and Namibia, they record weak evidence of co movement of African countries with overseas markets
Piesse and Hearn (2002)	3 Countries: RSA, Namibia and Botswana	1990-2000, Monthly	Cointegration and Autoregressive Distributed Lag (ADL) extension	First moment return co-movements are examined among the 3 markets to test the hypothesis of market integration.	There is significant evidence of a common stochastic trend driving the returns of Namibia and South Africa, which is stronger in Namibia, and '*spills over'* into the more open RSA.
Piesse and Hearn (2005)	10 Sub Saharan Countries	1993-2000, Daily	Univariate EGARCH spill over model	SE's are mapped by augmenting a single county's conditional volatility captured by EGARCH model, with another county's conditional volatility.	SE mainly between countries with strong trade links or sharing mechanisms for trade and settlement SE are mainly transmitted by RSA and Nigeria (largest markets) to other regional markets
Pretorius and De Beer (2004)	2 Countries: RSA and Zimbabwe	1996-1999, Daily	Univariate ARCH Models , Correlation Analysis	ARCH and correlation coefficients are used to examine contagion Rand and Zimbabwean dollar volatility	Significant volatility SE effects are detected in support of the contagion hypothesis through financial linkages, but not through bilateral trade linkages.
Samouilhan (2006)	2 Countries: RSA and UK	1996-2004, Daily	Univariate asymmetric volatility models [EGARCH]	First and second moment return associations are investigated between UK and RSA at broad and sector levels.	Significant volatility SE effects recorded with high/lower volatility in foreign markets associated with high/low domestic volatility. Causality in the SE was not addressed.
Samouilhan (2007)	2 countries: RSA and UK	1996-2004, Daily	Univariate volatility Models [GARCH]	An ICAPM that takes into account variance and covariance risk is used to determine the price of these two risks.	Significant volatility SE are detected such that increases in LSE volatility is associated with Increased JSE volatility. Domestic (RSA) risk is priced more than foreign risk

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