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STOCK AND CURRENCY MARKET LINKAGES: AN EMPIRICAL ANALYSIS FROM EMERGING ECONOMIES

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ABSTRACT

Purpose: The Causality relationship between forex and stock market in any economy is dependent on its economic fundamentals. This study examines return and volatility linkages between stock and currency markets for 28 emerging economies weekly MSCI stock index values (in local currency) and foreign exchange rates (indirect quotes) from 1988 to 2019.

Theoretical Framework: The understanding of the relationship between forex and stock markets through return and volatility spillover will help in predicting behavior of one market on account of the knowledge of movements in another market. Impact of global financial crisis (GFC) on this relationship is another dimension of research. This study finds the causal relationship between forex and stock markets through return and volatility spillover for all emerging economies along with the effect of GFC on the relationship.

Design/Methodology/Approach: The empirical analysis is conducted for the total period and three sub-periods namely pre-global financial crisis, crisis, and post-crisis periods by using the Granger Causality test (Granger 1969) followed by Vector Auto Regression (VAR) model and finally the Dynamic Conditional Correlations (DCC), a multivariate model proposed by Engle (2002). The volatility linkages are studied by employing BEKK-GARCH (Baba, Engle, Kraft, & Kroner, 1990)

Findings: It is found that return spillovers are predominantly from Stock to forex markets during the pre-crisis and crisis period but from forex to stock market in the post-crisis period. The increasing presence of return relationships from 10 countries in the pre-crisis period to 19 countries during the crisis period, implying a contagion effect. The BEKK-GARCH result confirm that volatility spillovers are observed throughout from forex to stock markets.

Research, practical & social implications: More extensive return and volatility associations between stock and forex market after the global financial crisis confirm the increasing importance of economic fundamentals. Return linkages exhibit contagion against the decoupling effect observed in volatility spillovers during the crisis period.

Originality/Value: Based on empirical observations, the study attempts to provide important policy implications for Policy makers, global investors, and academic community.

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LIGAÇÕES ENTRE OS MERCADOS CAMBIAL E DE AÇÕES: UMA ANÁLISE EMPÍRICA DAS ECONOMIAS EMERGENTES

RESUMO

Propósito: A relação de causalidade entre forex e mercado de ações em qualquer economia é dependente de seus fundamentos econômicos. Este estudo examina as ligações de retorno e volatilidade entre os mercados bolsistas e cambiais para 28 economias emergentes valores semanais do índice de ações do MSCI (em moeda local) e taxas de câmbio (cotações indiretas) de 1988 a 2019.

Estrutura teórica: A compreensão da relação entre os mercados cambiais e bolsistas através do retorno e da volatilidade contribuirá para prever o comportamento de um mercado devido ao conhecimento dos movimentos em outro mercado. O impacto da crise financeira global (CFG) nesta relação é outra dimensão da investigação. Este estudo encontra a relação causal entre os mercados cambial e de ações através do retorno e da volatilidade para todas as economias emergentes, juntamente com o efeito do GFC sobre a relação.

Design/Metodologia/Abordagem: A análise empírica é realizada para o período total e três subperíodos, ou seja, pré-crise financeira global, crise e pós-crise, usando o teste de causalidade de Granger (Granger 1969), seguido pelo modelo de Regressão Automática Vetorial (VAR) e, finalmente, as Correlações Condicionais Dinâmicas (DCC), um modelo multivariado proposto por Engle (2002). Os vínculos de volatilidade são estudados empregando-se BEKK-GARCH (Baba, Engle, Kraft, & Kroner, 1990)

Constatações: Constatou-se que as repercussões do retorno são predominantemente de Stock para mercados forex durante o período pré-crise e crise, mas de forex para mercado de ações no período pós-crise. A presença crescente de relações de regresso de 10 países no período anterior à crise para 19 países durante o período de crise, o que implica um efeito de contágio. O resultado BEKK-GARCH confirma que as repercussões da volatilidade são observadas ao longo de todo o mercado cambial para os mercados bolsistas.

Pesquisa, implicações práticas e sociais: Mais extensas associações de retorno e volatilidade entre o mercado de ações e forex após a crise financeira global confirmam a crescente importância dos fundamentos econômicos. As ligações de retorno exibem contágio contra o efeito de dissociação observado nas repercussões da volatilidade durante o período de crise.

Originalidade/Valor: Com base em observações empíricas, o estudo tenta fornecer implicações políticas importantes para os formuladores de políticas, investidores globais e comunidade acadêmica.

Palavras-chave: Mercados Emergentes, Contágio, Dissociação, Ligações de Retorno, Repercussão da Volatilidade, VAR, Modelo BEKK-GARCH, Modelo DCC.

VÍNCULOS BURSÁTILES Y DE MERCADO DE DIVISAS: UN ANÁLISIS EMPÍRICO DESDE LAS ECONOMÍAS EMERGENTES

RESUMEN

Propósito: La relación causal entre el mercado de divisas y el mercado de valores en cualquier economía depende de sus fundamentos económicos. Este estudio examina los vínculos entre el rendimiento y la volatilidad entre los mercados bursátiles y de divisas para los valores semanales del índice bursátil MSCI de 28 economías emergentes (en moneda local) y los tipos de cambio (cotizaciones indirectas) de 1988 a 2019.

Marco teórico: La comprensión de la relación entre el mercado de divisas y los mercados bursátiles a través del retorno y la volatilidad de derrame ayudará en la predicción del comportamiento de un mercado a causa del conocimiento de los movimientos en otro mercado. El impacto de la crisis financiera global (CFM) en esta relación es otra dimensión de la investigación. Este estudio encuentra la relación causal entre el mercado de divisas y los mercados bursátiles a través del retorno y la volatilidad de derrame para todas las economías emergentes, junto con el efecto de la GFC en la relación.

Diseño/Metodología/Enfoque: El análisis empírico se realiza para el período total y tres subperíodos, a saber, los períodos pre-crisis financiera global, crisis y post-crisis, utilizando la prueba de causalidad de Granger (Granger 1969) seguido por el modelo de regresión automática vectorial (VAR) y finalmente el modelo de correlaciones condicionales dinámicas (DCC), un modelo multivariado propuesto por Engle (2002). Los vínculos de volatilidad se estudian mediante el empleo de BEKK-GARCH (Baba, Engle, Kraft, & Kroner, 1990)

Hallazgos: Se encuentra que los derrames de retorno son predominantemente de los mercados bursátiles a los mercados de divisas durante el período previo a la crisis y la crisis, pero de divisas a mercado de valores en el período posterior a la crisis. La creciente presencia de relaciones de retorno de 10 países en el período previo a la crisis a 19 países durante el período de crisis, lo que implica un efecto de contagio. Los resultados de BEKK-GARCH confirman que los derrames de volatilidad se observan a lo largo de todo, desde el mercado de divisas a los mercados de valores.

Investigación, implicaciones prácticas y sociales: Asociaciones más extensas de rentabilidad y volatilidad entre el mercado bursátil y el mercado de divisas después de la crisis financiera mundial confirman la creciente importancia de los fundamentos económicos. Los vínculos de retorno muestran un contagio contra el efecto de disociación observado en los efectos indirectos de la volatilidad durante el período de crisis.
Originalidad/Valor: Basado en observaciones empíricas, el estudio intenta proporcionar importantes implicaciones políticas para los responsables de las políticas, los inversores globales y la comunidad académica.

Palabras clave: Mercados Emergentes, Contagio, Desacoplamiento, Vínculos de Retorno, Derrame de Volatilidad, VAR, Modelo BEKK-GARCH, Modelo DCC.

INTRODUCTION

The collapse of Bretton Wood System (1946 -1971) followed by opening of the currency market in 1973 invited the attention of market players and researchers towards the return and volatility linkages between the stock and forex market. **Dornbusch and Fisher (1980)** hypothesized **'flow oriented**' model which believes that exchange rate movements cause movements in stock prices. Contrary to this **Branson (1981)** suggested **'portfolio balance'** model highlighting the influence of stock price on currency market movements through capital account transactions. **Aggarwal (1981); Soenen and Hennigar** (1988); **Bahmani - Oskooee and Sohrabian (1992)** in their respective observed only a short-run relationship between stock and currency movements in advanced economies whereas **Otmar Issing (2000); Massa & Schumacher (2019);** and **Bekaert, Harvey, and Lumsdaine (2002)** tried to find the cause-effect relationship between Stock and currency market movements for both short and long run. Further, **Tsagkanos & Siriopoulos (2013)** confirmed this short-run relationship in USA but observed long-run relationship between stock and forex market in European Union (EU). The wave of globalization among the emerging economies and subsequent currency crisis of 1990s[1] attracted researchers to observe the relationship between stock and currency markets of emerging market economies.

Granger et al. (2000) studied the relationship between the stock and forex returns for nine East-Asian countries and found mixed results. They observed that changes in forex rate cause changes in stock price for South Korea; vice versa for the Philippines; bidirectional relationships between the two variables for Hong Kong, Malaysia, Singapore, Thailand, and Taiwan; and no relationship for Indonesia and Japan. **Smyth and Nandha (2003**) in their study for four South-Asian countries namely Bangladesh, India, Pakistan, and Sri Lanka using daily data from 1995 to 2001 did not find any long-run relationship between stock prices and exchange rates. **Phylaktis and Ravazzolo (2005)** by applying multivariate Granger causality test on the monthly data from 1980 to 1998 for pacific basin countries namely Hong Kong,

Indonesia, Malaysia, the Philippines, Singapore, and Thailand observed a positive relationship between exchange rates and stock prices. **Pan, Fok & Liu (2007)** by applying Granger causality test, a variance decomposition analysis and an impulse response analysis found that Hong Kong exhibited bidirectional relationship whereas Japan, Malaysia, and Thailand witnessed significant causal relationship from forex to stock market and from stock to forex markets for Korea, and Singapore during pre- currency crisis period (i.e. before 1997). Taiwan failed to witness any relationship during the pre-crisis period. During the crisis period, this relationship was from forex to stock price for all sample countries except for Malaysia. Study on six Asian emerging markets (India, Korea, Malaysia, Philippines, Taiwan, and Thailand) by **Tai (2007)** witnessed the presence of portfolio balance model i.e. stock market returns influences the forex movements. **Yau & Nieh (2009)** observed a long-run equilibrium relationship between NTD/JPY and the stock prices of Japan and Taiwan on the monthly data from January 1991 to March 2008 by employing the threshold error-correction model (TECM). They further confirmed that exchange rates affect stock price of Taiwan in the long run. **Zhao (2010)** studied for Chinese market on monthly data from January 1991 to June 2009 using VAR and MGARCH models and found the bidirectional volatility spillover but failed to evidence the return spillover between two markets.

Chkili et al. (2011) by applying a two regime Markov-Switching EGARCH model on four emerging countries found a regime switching behavior in volatility of stock markets and found a significant role of forex rate changes on this switching behavior. **Lin (2012)** examined the six Asian emerging markets namely India, Indonesia, Korea, the Philippines, Taiwan and Thailand using the autoregressive distributed lag (ARDL) model and observed stronger co-movement between exchange rates and stock prices during crisis periods compared to tranquil period and these spillovers during crisis periods are from stock prices to exchange rates. **Tsai (2012)** for the study in Six Asian markets namely Singapore, Thailand, Malaysia, the Philippines, South Korea, and Taiwan found the negative relationship very prominent when exchange rates were extremely high or low. **Liang, Lin, and Hsu (2013)**, in their study on ASEAN-5 countries (Indonesia, Malaysia, Philippines, Singapore and Thailand) using the panel Granger causality and panel Dynamic Ordinary Least Square (DOLS) methodologies, found that changes in stock price affect the forex movements. The similar results were found by **Chkili and Nguyen (2014)** in their study on the BRICS nations by using a regime-switching model and Markov switching VAR models. They witnessed significant impact from stock

market returns to exchange rates for all countries, except South Africa. However, this result was more pronounced during high volatility compared to the low volatility period.

Moore & Wang (2014) in their study for six Asian emerging markets: Indonesia, Malaysia, South Korea, the Philippines, Singapore and Thailand, and four developed markets: Australia, Canada, Japan and the UK on monthly data by using bivariate DCC–GARCH model witnessed the negative relationship between the two variables. **Ho and Huang (2015)** found a mixed result of causality relationship between Stock and Forex return for BRIC nations. They noticed Forex to Stock causal relationship in Brazil, India and China but stock to forex for Russia. **Akdogu & Birkan (2016)**, using a series of causality tests on 21 emerging market economies, recorded a mixed result. Eight countries exhibited stock to forex, two countries bidirectional and only one country from forex to stock causal relationships. Remaining 10 economies failed to reflect any significant relationship. In the study to find the relationship between stock and forex markets for nine advanced and twelve emerging economies **Cho et al. (2016)** found that the relationship is the function of the global equity market conditions. During the bearish market outward capital movement from emerging to advanced economy takes place leading to depreciation of emerging economies' currencies against advanced economies' currency. They also observed that currency returns are positively correlated with stock returns in emerging markets implying the appreciation of emerging country's currency during the bullish stock market. **Sui and Sun (2016)** in their study on the daily data of BRICS nations from their respective beginning of the floating exchange rates till August 2014, examined the long run and short run dynamic relationship between stock returns and foreign exchange rates by applying VAR and VECM model. The results found the spillover effect from forex to stock for all the BRICS nations in the short run but no significant relationship for any BRICS country in long run. They also observed a coupling effect during the 2007–2009 financial crisis. **Han and Zhou (2017)** in their study for BRICS nations applied mixed c-vine copula models and witnessed negative correlations for most stock/exchange rate pairs. **Wong (2017)** studied a mix of emerging and advanced economies namely: Malaysia, the Philippines, Singapore, Korea, Japan, the United Kingdom (UK), and Germany using both constant and dynamic conditional correlation (CCC and DCC- MGARCH) models and observed a significant negative relationship for Malaysia, Singapore, Korea, and the UK. The relationship was found insignificant for the Philippines, Japan, and Germany.

Bahmani-Oskooee and Saha (2018) by applying non-linear ARDL method on monthly time-series data from 24 emerging and advanced countries, found the short-run bilateral

asymmetric cointegration between exchange rates and stock prices for most of the sample countries whereas long-run asymmetric relationship was present in only few countries with dominance from stock to forex. **Nesrine et al. (2019)** in their study for Tunisia and Turkey by applying the GARCH model found a significant volatility spillover from forex to the stock market. **Cuestas and Tang** (2021) did not find any long-run relationship between forex and stock returns in China by using Markov switching SVAR model on monthly data for January 1994 to January 2018. However, its contemporaneous spillover effects on stock returns are found to be statistically significant which got intensified during Asian and Global financial crisis periods.

Previous studies have shown contrasting empirical evidence and **are limited to specific geopolitical/economic zones or blocks**. Most studies are **for a shorter period**. Some studies concentrated on the relationships between the two variables with limited perspectives like the effect of the global financial crisis on the relationship. Further, very little work is available for a large cross-section of emerging markets. Thus, it has become necessary to study the relationship between Exchange Rates and Stock returns, taking a comprehensive set of the emerging market economies. Both prices and volatility linkages should be studied to get a more comprehensive view of the information transmission processes. The impact of the global financial crisis on the return and volatility linkages between the Stock and the currency markets may also be examined.

The present study is a step in this direction. **The prime motivation** of the proposed study is to re-examine the relationship between exchange rates and stock prices for all emerging economies and for an extended study period that also covers more recent observations. The study intends to examine how such a relationship varies for geographically distributed emerging markets and draw necessary policy implications for economic planners & regulators and investment implications for the global investment community. The critical research challenges explored by the study are: What is the relationship between stock market returns and currency rate changes in EMEs? Do these relationships have any change in the pattern during the pre-crisis vs. post-crisis period? How does the volatility spillover process operate for EMEs? Thus, the study has the **following objectives**: 1. To evaluate the relationship between exchange rate changes and Stock returns 2. To examine the volatility linkages between exchange rates and stock markets, 3. To observe the change in the behavior of both return and volatility linkages during Pre-crisis, Crisis, and Post-crisis periods.

THEORETICAL FRAMEWORK

The review of all prominent published study on the subject indicates the absence of any conclusive result with respect to return and volatility linkages between stock and currency market**.** Neither **'flow oriented**' nor **'portfolio balance'** models have been accepted exclusively for any economy. Further, these linkages may behave differently for both short and long run during the global financial crisis including pre- and post-crisis periods. Globalization wave among developing countries transformed them as emerging market economies (EMEs) and brought them closure to each other leading to increased possibilities of contagion effect. Thus, it became necessary to have an elaborate study on the return and volatility linkages between forex and stock markets for all EMEs. The basic macroeconomic concepts support the 'flow oriented model' for short-run and 'Portfolio balance model' in long run for return and volatility linkages between forex and stock markets of emerging economies. This study empirically re-examined the relationship for return and volatility for all EMEs using high-end econometric tools as explained below.

METHODOLOGY

Data

Thirty emerging market economies are considered for the study after referring to the lists published by the International Monetary Fund (IMF) and Morgan Stanley Capital International (MSCI) World Index in June 2019, subject to the availability of required data. Out of the selected 30 emerging economies, Greece is excluded because of its Currency being Euro. Greece is part of the European Monetary Union (EMU); hence it has a common currency with other EMU members. Hence, the value of the euro is not determined exclusively by the performance of the Greek economy. In addition, Venezuela is dropped because of extreme volatility in its Currency (Venezuelan Bolívar) and very high inflation value owing to continued political and economic uncertainty. The study is based on weekly MSCI stock index values (in local currency) and foreign exchange rates (indirect quotes) for twenty-eight (28) emerging economies. Daily data has been avoided due to estimations problems encountered owing to minimal to negligible currency rate changes over higher frequency. No changes in the exchange rate, i.e., zero value of forex returns, are ignored for all the countries and their corresponding values for stock market returns. The data for the sample countries is taken till July 4th, 2019, whereas the starting dates differ for each country depending upon their availability, as shown in **table 1.** The data source is Bloomberg Terminals.

Table 1: Stock Index and Currency Information for Sample Countries

Country	Starting Date	Stock Index	Currency name
Argentina	June 1, 1992	MERVAL	Argentine Peso
Bangladesh	December 1, 2009	Dhaka Stock Exchange Broad Index (DSEX)	Bangladeshi Taka
Brazil	January 16, 1992	IBOVESPA	Brazilian Real
Bulgaria	June 1, 2005	SOFIX	Bulgarian Lev
Chile	January 1, 1988	IGPA	Chilean Peso
China	January 1, 1993	Shanghai Composite	Renminbi
Colombia	January 1, 1993	COLCAP	Colombian Peso
Czech Republic	January 3, 1995	SE PX	Czech Koruna
Egypt	January 3, 1995	EGX 30	Egyptian Pound
Hungary	January 3, 1995	BUX	Hungarian Forint
India	January 1, 1993	SENSEX	Indian Rupee
Indonesia	November 6, 1991	IDX Composite	Indonesian Rupiah
Malaysia	January 1, 1988	FTSE KLCI	Malaysian Ringgit
Mexico	January 1, 1988	MEXBOL	Mexican Peso
Pakistan	January 1, 1993	KSE 100	Pakistani Rupee
Peru	January 1, 1993	IGBVL	Sol
Philippines	November 6, 1991	PCOMP	Philippine Peso
Poland	June 21, 1993	WIG	Polish złoty
Qatar	June 2, 2005	QE General	Qatari riyal
Romania	December 1, 2005	BET	Romanian leu
Russia	January 2, 1995	MOEX	Russian Ruble
South Africa	January 1, 1993	JALSH All	South African rand
S. Korea	January 1, 1988	KOSPI	South Korean won
Taiwan	January 1, 1988	TWSE	New Taiwan dollar
Thailand	January 1, 1988	SET 50	Thai Baht
Turkey	January 1, 1988	BIST 100	Turkish lira
UAE	June 2, 2005	ADX General	UAE Dirham
Ukraine	June 1, 2006	PFTS	Ukrainian hryvnia

Note: The last date for each country data is July 4th 2019
Source: Bloomberg Terminals

Methodology

The relationship between Stock and forex returns for sample markets are verified using the Granger Causality test (Granger 1969) as indicated in the following bivariate regression equations:

$$y_t = \alpha_0 + \alpha_1 y_{t-1} + \ldots + \alpha_l y_{t-l} + \beta_1 x_{t-1} + \ldots + \beta_l x_{t-l} + e_t$$

$$x_t = \alpha_0 + \alpha_1 x_{t-1} + \ldots + \alpha_l x_{t-l} + \beta_1 y_{t-1} + \ldots + \beta_l y_{t-l} + u_t$$

For all possible pairs of (x, y) series in the group. The reported F-statistics are the Wald statistics for the joint hypothesis: $\beta_1 = \beta_2 = \ldots = \beta_l = 0$ for each equation. The null hypothesis is that x does not Granger cause y in the first regression and y does not Granger cause in the second regression at the appropriate lag length (l) decided through VAR lag length

determination criteria for the minimum value of Schwarz information criterion (SIC) at a 5% significance level.

All the pairs showing the causality relationship are further confirmed through Vector Auto Regression (VAR) model expressed as $y_t = \alpha_1 y_{t-1} + \ldots + \alpha_p y_{t-p} + \beta x_t + e_t$ where y_t is a k vector endogenous variables, x_t is a d vector exogenous variables, $\alpha_1, \ldots, \alpha_p$ and β are matrices of coefficients to be estimated, and e_t is a vector of innovations which may be contemporaneously correlated but are uncorrelated with their own lagged values as well as with the variables present on the right-hand side of the equation.

To overcome the limitations of conventional methods the paired relationships between stock and forex returns for all the sample countries are tested by using Dynamic Conditional Correlations (DCC), a multivariate model proposed by Engle (2002) as an extension of Bollerslev's (1990) constant conditional correlation estimator expressed as $H_t = D_t R D_t$ where $D_t = \text{diag}\{\sqrt{h_{i,t}}\}$ where R is a correlation matrix containing the conditional correlations. A simple estimate of R is the unconditional correlation matrix of the standardized residuals. In the DCC model, R in the above equation changes to R_t (time varying) and re-written as $H_t = D_t R_t D_t$ the diagonal elements of Dt are modeled as univariate GARCH models, that is $h_{i,t} = h_i(\theta_i; y_{i,t-1}, y_{i,t-2}, \ldots)$, where $h_i(\bullet ; \bullet , \bullet, ...)$ is a known function, and θ_i is a vector of parameters, i = 1 , 2, . . . , N. The conditional correlation matrix is then modeled as a function of the past standardized returns, namely, $R_t = Q_t^{*-1/2} Q_t Q_t^{*-1/2}$ Where: $Q_t = (1 - \alpha - ß) S + \alpha \varepsilon_{t-1} \acute{\varepsilon}_{t-1} + \beta Q_{t-1}$. It relaxes the assumption of constant correlation and provides flexibility by reducing the number of parameters to estimate (Kim and Sun, 2017).

To measure the variance of returns we employed BEKK-GARCH model of (1, 1) as used by (**Li, 2015**). H_t is a time-varying variance–covariance matrix represented by the equation:

$H_t = C'C + A' \varepsilon_{t-1} \varepsilon_{t-1}'A + B' H_{t-1} B$, where C is a (2*2) symmetric matrix representing the constant components and A & B are (2*2) unrestricted matrices. The noise and volatility spillovers are measured by the diagonal elements of matrix A and B, respectively. In the analysis, we focus on the off-diagonal elements of the matrix.

Findings

The relationship between stock returns and currency rate changes

In this section, we begin by providing descriptive statistics for the sample stock indices and currency rates. First, the price series for both stock index and foreign exchange rates for all

28 countries are converted into their percentage returns. Then, these return series are tested for stationarity using the Augmented Dickey-Fuller test (ADF). It is found that all 28 pairs of forex and stock market return series are stationary at the level.

Table 2 records descriptive statistics for both stock and currency market series. These figures may not be fully comparable across countries due to differences in data period, as shown in table 1. Panel A in Table 2 deals with stock returns, whereas Panel B is for forex data. From Panel A, it is evident that annualized[3] stock returns have ranged from -17.89% for UAE to 38.67% for Turkey. The average annual stock return for these 28 emerging market economies is 9.16%. Only three countries, namely Bulgaria, UAE, and Ukraine, exhibit negative mean stock returns among the sample countries. The annual volatility, measured by Standard deviation, has varied from 19.51% (South Africa) to 52.66% (Russia), with an average of 30.37% for all countries.

The values from Panel B for Forex rate change range between -5.30% for Romania to 37.94% for Brazil, with an overall average value of 6.90% pa. The positive (negative) sign implies currency depreciation (appreciation). Interestingly, all EMEs have experienced currency depreciation viz a viz USD except two countries (namely the Czech Republic and Romania) over the study period. The annual volatility in forex return varies from 0.11% for UAE to 33.80% for Russia, with an average of 13.47%.

Stock returns of 15 out of 28 sample countries are negatively skewed, whereas only three are negatively skewed in the currency market return. The kurtosis values are very high, ranging from 5.29 (South Africa) to 173.31 (Romania) for Stock returns, whereas it ranges from 5.73 (UAE) to 858.30 (China) for Forex returns. High Jarque-Bera values imply that weekly stock and forex return series are generally not distributed. Ljung Box statistics (up to three lags) confirm no significant serial correlation in most of the sample series.

To start with, first, we divided the total period of the study into three sub-periods based on the global financial crisis, which is mainly documented from August 9th, 2007, to October 18th, 2009 [Trichet, J.-C. (2010)] [Angelini, P., Nobili, A. and Picillo, C. (2011)]. The empirical findings and analysis are made for four different time frames: total, pre-crisis, crisis, and post-crisis periods. Due to the non-availability of data, Bangladesh values are shown only for the post-crisis period.

Table 2 Descriptive Statistics

Panel A: Stock market Return								
Country	**Weekly Return Mean %**	**Std. Dev. %**	**Skewness**	**Kurtosis**	**Jarque-Bera**	**Ljung Box AC Val at lag1**	**Ljung Box AC Val at lag2**	**Ljung Box AC Val at lag3**
Argentina	0.1977	5.1998	0.298231	6.862453	682.889	0.053 (0.082)	0.029 (0.138)	0.045 (0.106)
Bangladesh	0.0482	3.0437	0.220005	8.055984	389.5683	0.041 (0.436)	0.015 (0.707)	-0.018 (0.845)
Brazil	0.2625	5.2973	-0.502808	6.826864	880.6584	-0.067 (0.014)	0.028 (0.028)	0.055 (0.01)
Bulgaria	-0.147	3.4809	-1.617629	20.32404	8709.442	0.104 (0.007)	0.128 (0.00)	0.155 (0.00)
Chile	0.2059	3.2002	-0.246251	8.689082	1945.623	0.047 (0.074)	0.058 (0.019)	0.081 (0.001)
China	0.0479	4.1693	-0.012018	5.970286	335.6484	0.023 (0.481)	-0.006 (0.768)	0.057 (0.318)
Colombia	0.2435	3.9854	0.044532	6.784088	785.6112	0.059 (0.031)	0.051 (0.018)	0.095 (0.00)
Czech Republic	0.1245	3.1691	-0.290157	5.937941	454.7656	-0.035 (0.219)	0.035 (0.218)	0.072 (0.024)
Egypt	0.3461	4.0137	-0.069153	6.15949	457.9856	0.065 (0.032)	0.024 (0.074)	0.038 (0.079)
Hungary	0.3029	4.0678	-0.05041	7.401088	984.3295	-0.006 (0.829)	0.044 (0.305)	0.076 (0.024)
India	0.2575	3.5329	-0.092618	5.307078	287.0416	0.014 (0.614)	0.055 (0.126)	0.028 (0.161)
Indonesia	0.2806	3.9766	0.248999	7.736914	1270.436	0.04 (0.137)	0.024 (0.227)	0.089 (0.003)
Malaysia	0.1414	3.0979	0.934916	17.60742	11973.2	-0.034 (0.216)	-0.072 (0.015)	0.082 (0.001)
Mexico	0.2919	4.0763	-0.262213	7.835322	1455.79	0.011 (0.677)	0.014 (0.788)	0.089 (0.006)
Pakistan	0.2395	4.1069	-0.488726	8.072295	1255.241	0.11 (0.00)	0.056 (0.00)	0.012 (0.001)
Peru	0.3354	4.1971	0.099665	6.09809	525.2651	-0.034 (0.222)	0.013 (0.423)	0.057 (0.111)
Philippines	0.16	3.3836	0.198366	5.449423	343.2567	0.019 (0.49)	0.074 (0.019)	0.054 (0.008)
Poland	0.2109	4.2296	0.355327	7.413097	1076.447	0.04 (0.154)	0.047 (0.088)	0.029 (0.114)
Qatar	0.1852	3.5682	-0.809104	11.00411	1200.318	-0.049 (0.307)	0.082 (0.139)	-0.074 (0.097)
Romania	0.0177	5.4724	-9.519179	173.3088	799041.9	0.011 (0.784)	0.047 (0.463)	0.101 (0.04)
Russia	0.2539	7.3028	-1.789694	36.09513	55820.52	-0.002 (0.949)	-0.001 (0.997)	0.101 (0.006)
S Africa	0.2391	2.7059	-0.235577	5.285204	300.562	-0.068 (0.013)	0.013 (0.04)	0.023 (0.068)
S Korea	0.1845	3.8221	0.303337	6.264464	722.5825	-0.039 (0.121)	0.003 (0.299)	0.1 (0.00)
Taiwan	0.1227	4.0225	0.101213	6.560844	821.008	0.014 (0.585)	0.05 (0.121)	0.01 (0.223)
Thailand	0.1751	4.1789	0.4971	7.732074	1491.51	0.026 (0.316)	0.082 (0.004)	0.013 (0.009)
Turkey	0.7436	5.9839	0.571352	6.935257	994.9273	0.036 (0.179)	0.044 (0.104)	0.047 (0.054)

UAE	-0.344	5.4359	-1.298081	7.242912	152.5779	0.093 (0.255)	0.163 (0.069)	0.197 (0.01)
Ukraine	-0.1938	5.1922	0.623837	9.02568	954.5265	-0.018 (0.66)	0.061 (0.288)	0.019 (0.44)
Panel B: Descriptive Statistics -Forex market Return								
Country	**Weekly Return Mean %**	**Std. Dev. %**	**Skewness**	**Kurtosis**	**Jarque-Bera**	**Ljung Box AC Val at lag1**	**Ljung Box AC Val at lag2**	**Ljung Box AC Val at lag3**
Argentina	0.339	2.5396	11.39784	172.9625	1314734	0.252 (0.00)	0.066 (0.00)	0.055 (0.00)
Bangladesh	0.0529	0.5056	2.482996	30.08432	11468.1	-0.117 (0.025)	0.126 (0.004)	0.14 (0.00)
Brazil	0.7296	3.1228	1.983334	12.66416	6138.59	0.419 (0.00)	0.457 (0.00)	0.433 (0.00)
Bulgaria	0.0116	1.344	-0.16929	6.923697	434.9275	0.024 (0.537)	0.001 (0.826)	0.021 (0.875)
Chile	0.0782	1.2859	0.437438	7.086341	1041.994	0.079 (0.003)	0.016 (0.01)	0.05 (0.005)
China	0.026	1.6719	28.84967	858.2986	27955487	0.004 (0.897)	0.007 (0.971)	-0.001 (0.996)
Colombia	0.1132	1.501	0.467883	7.132495	984.4322	0.026 (0.348)	0.054 (0.092)	0.075 (0.007)
Czech Repub	-0.00217	1.6841	0.206779	6.379097	587.6754	0.02 (0.484)	0.001 (0.783)	0.037 (0.54)
egypt	0.1831	3.0945	27.53148	849.2995	32935876	-0.09 (0.003)	0.112 (0.00)	0.008 (0.00)
Hungary	0.0941	1.8707	0.407378	6.43677	633.637	-0.02 (0.484)	-0.024 (0.557)	0.035 (0.447)
India	0.0688	0.904	0.462092	13.04448	5451.873	0.061 (0.028)	0.022 (0.066)	0.059 (0.02)
Indonesia	0.1966	3.4105	6.725956	121.2616	793338.9	-0.01 (0.717)	0.094 (0.002)	0.002 (0.007)
Malaysia	0.0422	1.1882	2.093338	52.59292	136750.3	-0.057 (0.039)	0.005 (0.117)	0.134 (0.00)
Mexico	0.1622	1.7571	3.81239	43.89304	106490.4	0.129 (0.00)	0.081 (0.00)	0.005 (0.00)
Pakistan	0.1426	1.013	2.091911	36.02624	52133.32	-0.174 (0.00)	0.051 (0.00)	0.055 (0.00)
Peru	0.0539	0.7053	0.595065	13.72834	6349.994	-0.058 (0.036)	0.052 (0.019)	0.063 (0.004)
Philippines	0.0607	1.2392	1.767717	33.65507	53086.97	-0.115 (0.00)	0.055 (0.00)	0.086 (0.00)
Poland	0.074	1.791	0.899117	7.831329	1431.749	-0.038 (0.166)	0.008 (0.37)	0.101 (0.002)
Qatar	0.00128	0.278	2.18208	60.13294	59097.94	-0.145 (0.002)	0.142 (0.00)	0.078 (0.00)
Romania	-0.102	4.2372	-20.071	474.7444	6098861	0.01 (0.794)	-0.001 (0.967)	-0.01 (0.988)
Russia	0.2112	4.687	-1.657	302.7776	4527583	-0.121 (0.00)	0.247 (0.00)	-0.003 (0.00)
S Africa	0.1363	2.1732	0.914097	10.43923	3239.873	-0.006 (0.825)	-0.017 (0.814)	-0.06 (0.156)
S Korea	0.0359	1.7467	5.635428	104.2652	680431.5	-0.113 (0.00)	0.302 (0.00)	-0.033 (0.00)
Taiwan	0.00605	0.6154	0.650388	14.36558	8446.467	0.116 (0.00)	0.045 (0.00)	0.074 (0.00)
Thailand	0.0248	1.1556	1.989912	53.84148	165902.7	-0.006 (0.826)	0.107 (0.00)	0.098 (0.00)

Turkey	0.6431	3.2445	6.334795	102.5429	596606.1	-0.107 (0.00)	0.067 (0.00)	0.093 (0.00)
UAE	9.32E-05	0.0155	0.035853	5.734733	46.15077	-0.425 (0.00)	-0.078 (0.00)	-0.009 (0.00)
Ukraine	0.3308	3.5373	6.401949	103.0344	256389.5	-0.019 (0.642)	-0.011 (0.864)	-0.082 (0.223)

Source: Authors' own work

The pair-wise **Granger Causality tests** are run for all 28 countries at their optimal lags determined by the Schwarz information criterion (SIC). The results are reported in **table 3**. The results for the total period show the causality relationships for ten countries. Four of these countries, namely, Czech Republic, Peru, S Korea, and S Africa, exhibit stock to forex, and Bulgaria, Egypt, Mexico, and Turkey, have forex to Stock spillovers. Only two emerging markets China and India, exhibit bidirectional relationships, which is stronger from forex to Stock. This mixed result is on the same line as found by **Granger et al. (2000**). This relationship is absent in the remaining eighteen countries.

Performing sub-periods analysis, we find causal relationships in ten countries during the pre-crisis period. Five of these ten countries are the same who have exhibited relationships during the total period, and Argentina, Colombia, Philippines, Russia, and UAE are the additional five countries here. This relationship is mostly from Stock to forex, as shown by eight out of ten countries supporting the "Stock oriented" model and findings of previous research (**Liang, Lin, and Hsu (2013)).** Only two countries, Argentina, and China exhibit forex to stock relationships during this period. During the Crisis period, this relationship is confirmed for nineteen countries implying the contagion effect. These relationships are also predominantly from Stock to forex like that witnessed during the pre-crisis period. These associations are observed only for nine countries during the post-crisis period. Four countries, i.e., China, Egypt, India, and the Philippines, are the same as the pre-crisis period. It is important to note that the relationships during the post-crisis period are predominantly from forex to Stock as against Stock to forex in the pre-crisis period supporting the "Flow oriented" model in confirmation with the findings of **Pan, Fok & Liu (2007)**. This forex to Stock spillovers may be because the market participants started focusing more on fundamentals after the global financial crisis. Forex market is closely related to economic fundamentals, and hence its performance impacted the sentiments in the stock market. Chile is the only country for which the stock and forex market relationship is not observed for any period.

The **VAR model** of the same lag length as used during the Granger Causality test for each sample EMEs is applied in the next step for determining these relationships. Results (along

with t-statistics) are shown in **table 4**. The findings of VAR are found consistent with that of Granger Causality results for the total and three sub-periods. These significant VAR relationships are primarily at the one-week lag.

Table 3: Pairwise Granger Causality Test between stock indices and currency market values. Stock index to Forex rate (St to Fx) and Forex rate to Stock index (Fx to St) causality test is at 5% level of significance at specified lag length decided by minimization of Schwarz Info Criteria. Probability is reported in '( )' and F-Statistics in '[ ]'. Values for Bangladesh is not reported for Pre-crisis and Crisis periods.

		Granger Causes at 5% level of Significance.										
	Total Series			**Pre- Crisis Series**				**Crisis Series**		**Post Crisis Series**		
Country	**Lag length**	**St to Fx**	**Fx to St**	**Lag length**	**St to Fx**	**Fx to St**	**Lag length**	**St to Fx**	**Fx to St**	**Lag length**	**St to Fx**	**Fx to St**
Argentina	1	(0.0680) [3.33672]	(0.3121) [1.0226]	1	(0.1804) [1.7977]	(0.0298) * [4.7352]	1	(2.E-06)* [25.1024]	(0.0128)* [6.3988]	1	(0.2942) [1.1030]	(0.7461) [0.1049]
Bangladesh	1	(0.3174) [1.0017]	(0.1093) [2.5751]	1			1			1	(0.3174) [1.0017]	(0.1093) [2.5751]
Brazil	1	(0.9851) [0.0003]	(0.4223) [0.6442]	1	(0.2222) [1.4923]	(0.4817) [0.4956]	1	(0.0049)* [8.2421]	(0.1985) [1.6738]	1	(0.9912) [0.0001]	(0.1377) [2.2114]
Bulgaria	1	(0.0616) [3.5051]	(0.0197)* [5.4603]	1	(0.0076)* [7.3998]	(0.2389) [1.4027]	1	(0.1586) [2.0143]	(0.9631) [0.0021]	1	(0.5896) [0.2913]	(0.9260) [0.0086]
Chile	1	(0.8321) [0.0449]	(0.1645) [1.9343]	1	(0.1873) [1.7408]	(0.5221) [0.4101]	1	(0.6869) [0.1633]	(0.1181) [2.4812]	1	(0.2051) [1.6103]	(0.7594) [0.0939]
China	1	(0.0175)* [5.6587]	(0.0012)* [10.5038]	1	(0.0560) [3.6646]	(8.E-05)* [15.7122]	1	(0.1586) [2.0147]	(0.0015)* [10.5647]	2	(0.0387) * [3.2752]	(0.1862) [1.6872]
Columbia	1	(0.9116) [0.0123]	(0.3121) [1.0227]	1	(0.0097)* [6.7275]	(0.1495) [2.0813]	1	(0.1838) [1.7894]	(0.4046) [0.7001]	1	(0.2517) [1.3170]	(0.1951) [1.6838]
Czech	1	(0.0312)* [4.65072]	(0.5184) [0.4173]	1	(0.1425) [2.1561]	(0.1833) [1.7744]	1	(0.0899) [2.9270]	(0.9532) [0.0035]	1	(0.6197) [0.2466]	(0.2422) [1.3714]
Egypt	2	(0.6222) [0.4746]	(0.0072)* [4.9567]	1	(0.0090)* [6.8609]	(0.0225) * [5.2352]	1	(0.0025)* [9.5587]	(0.0020)* [10.0068]	1	(0.0798) [3.0819]	(0.0181) * [5.6321]
Hungary	1	(0.7148) [0.1336]	(0.1973) [1.6642]	1	(0.3539) [0.8607]	(0.1342) [2.2483]	1	(0.0825) [3.0706]	(0.8307) [0.0459]	1	(0.7912) [0.0702]	(0.0041) * [8.3305]
India	1	(0.0474)* [3.9402]	(0.0244)* [5.0774]	1	(0.0252)* [5.0334]	(0.7340) [0.1155]	1	(0.3141) [1.0225]	(0.9820) [0.0005]	1	(0.2871) [1.1358]	(0.0115) * [6.4347]
Indonesia	1	(0.1287) [2.3113]	(0.1599) [1.9772]	1	(0.8795) [0.0229]	(0.3037) [1.0592]	1	(0.0026)* [9.4817]	(0.6562) [0.1993]	2	(0.0012) * [6.7969]	(0.0332) * [3.4314]

Malaysia	1	(0.5085) [0.4373]	(0.5162) [0.4216]	1	(0.9868) [0.0003]	(0.7740) [0.0825]	1	(0.0034)* [8.9601]	(0.0347)* [4.5718]	1	(0.1585) [1.9955]	(0.7896) [0.0713]
Mexico	2	(0.0764) [2.5765]	(0.0064)* [5.0729]	1	(0.9636) [0.0021]	(0.4077) [0.6862]	1	(0.0064)* [7.7361]	(0.0759) [3.2119]	1	(0.2264) [1.4671]	(0.1224) [2.3959]
Pakistan	1	(0.7791) [0.0787]	(0.1494) [2.0804]	3	(0.6945) [0.4826]	(0.4282) [0.9249]	1	(0.6698) [0.1828]	(0.0389)* [4.3710]	1	(0.0917) [2.8559]	(0.3316) [0.9448]
Peru	1	(0.0325)* [4.5799]	(0.2433) [1.3627]	1	(0.0314)* [4.6465]	(0,7869) [0.0732]	1	(0.0144)* [6.1888]	(0.2982) [1.0924]	1	(0.3463) [0.8889]	(0.3328) [0.9404]
Philipines	1	(0.9905) [0.00014]	(0.7537) [0.0984]	1	(0.0285)* [4.8156]	(0.4462) [0.5809]	1	(0.0171)* [5.8681]	(0.1231) [2.4141]	1	(0.0021)* [9.5284]	(0.8214) [0.0510]
Poland	1	(0.2081) [1.5864]	(0.8537) [0.0340]	1	(0.2274) [1.4596]	(0.3310) [0.9462]	1	(0.0418)* [4.2414]	(0.4191) [0.6579]	1	(0.2576) [1.2849]	(0.3306) [0.9485]
Qatar	5	(0.4680) [0.9189]	(0.9681) [0.1854]	1	(0.4515) [0.5711]	(0.6508) [0.2061]	1	(0.4730) [0.5186]	(0.0406)* [4.2924]	1	(0.2121) [1.5613]	(0.6798) [0.1706]
Romania	1	(0.9604) [0.0025]	(0.1339) [2.2525]	1	(0.7720) [0.0845]	(0.1475) [2.1388]	1	(0.0201)* [5.5639]	(0.7286) [0.1210]	1	(0.1106) [2.5563]	(0.0855) [2.9699]
Russia	4	(0.5446) [0.7702]	(0.4248) [0.9666]	2	(0.0191)* [3.9840]	(0.5305) [0.6345]	1	(0.0007)* [12.0388]	(0.0901) [2.92335]	1	(0.0641) [3.4460]	(0.1826) [1.7822]
S Africa	1	(0.0078)* [7.0931]	(0.2049) [1.6085]	3	(0.9540) [0.1104]	(0.3597) [1.0731]	1	(0.2687) [1.2357]	(0.0599) [3.61325]	1	(0.0138)* [6.1108]	(0.0048)* [8.0380]
S Korea	3	(8.E-06)* [8.8994]	(0.1303) [1.8842]	3	(0.0753) [2.3048]	(0.3505) [1.0944]	1	(0.0988) [2.7722]	(0.9969) [1.5E-05]	1	(0.1921) [1.7067]	(0.0089)* [6.8998]
Taiwan	2	(0.1755) [1.7419]	(0.6202) [0.4779]	1	(0.3356) [0.9281]	(0.5538) [0.3507]	1	(0.0149)* [6.1219]	(0.0461)* [4.0700]	1	(0.8565) [0.0327]	(0.0982) [2.7463]
Thailand	1	(0.1901) [1.7182]	(0.6430) [0.2148]	1	(0.1043) [2.6437]	(0.3467) [0.8862]	1	(0.0350)* [4.5548]	(0.6323) [0.2303]	1	(0.0653) [3.4145]	(0.7845) [0.0748]
Turkey	1	(0.3489) [0.8781]	(0.0040)* [8.3018]	1	(0.5525) [0.3531]	(0.1429) [2.1502]	1	(0.0373)* [4.4459]	(0.0899) [2.9268]	1	(0.1520) [2.0588]	(0.0189)* [5.5462]
UAE	1	(0.4154) [0.6640]	(0.2753) [1.1919]	1	(0.0028) [9.3365]	(0.3558) [0.8601]	1	(0.0230)* [5.3163]	(0.0542)* [3.7872]	1	(0.1769) [1.8288]	(0.5359) [0.3838]
Ukraine	1	(0.1522) [2.0553]	(0.6866) [0.1629]	1	(0.3544) [0.8722]	(0.3098) [1.0509]	1	(0.0053)* 8.1090]	(0.0021)* [9.8861]	1	(0.2483) [1.3364]	(0.8982) [0.0164]

Source: Authors' own work

Table 4: Vector Auto Regression (VAR)

	Total Series			Pre- Crisis Series				Crisis Series		Post Crisis Series		
Country	**Lag length**	**St to Fx**	**Fx to St**	**Lag length**	**St to Fx**	**Fx to St**	**Lag length**	**St to Fx**	**Fx to St**	**Lag length**	**St to Fx**	**Fx to St**
Argentina	1	-1.05E-05 (5.8E-06) [-1.82667]	0.699983 (0.69222) [1.01122]	1	-3.60E-06 (2.7E-06) [-1.34078]	5.13768* (2.36100) [2.17606]	1	-1.91E-05* (3.8E-06) [-5.01023]	188.323* (74.4481) [2.52959]	1	-1.92E-05 (1.8E-05) [-1.05024]	0.416159 (1.28433) [0.32403]
Bangladesh	1	0.000109 (0.00011) [1.00085]	-0.598636 (0.37305) [-1.60472]	1			1			1	0.000109 (0.00011) [1.00085]	-0.598636 (0.37305) [-1.60472]
Brazil	1	-2.64E-08 (1.4E-06) [-0.01862]	1.946102 (2.42468) [0.80262]	1	-4.35E-06 (3.6E-06) [-1.22160]	1.141609 (1.62168) [0.70397]	1	-6.07E-05* (2.1E-05) [-2.87090]	269.7237 (208.481) [1.29376]	1	9.50E-08 (8.6E-06) [0.01105]	-22.11485 (14.8713) [-1.48709]
Bulgaria	1	-5.68E-06 (3.0E-06) [-1.87219]	8.92755** (3.82052) [2.33673]	1	-7.04E-05* (2.6E-05) [-2.72025]	-56.95602 (48.0895) [-1.18438]	1	-1.34E-05 (9.4E-06) [-1.41927]	-1.642245 (35.4545) [-0.04632]	1	-1.37E-05 (2.5E-05) [-0.53976]	0.151383 (1.62979) [0.09289]
Chile	1	5.35E-05 (0.00025) [0.21204]	0.012164 (0.00875) [1.39079]	1	-0.000662 (0.00050) [-1.31942]	0.003550 (0.00554) [0.64036]	1	0.004079 (0.01010) [0.40410]	-0.464792 (0.29507) [-1.57518]	1	-0.002321 (0.00183) [-1.26900]	-0.023222 (0.07577) [-0.30649]
China	1	0.00025* (0.00011) [2.37881]	-0.26991* (0.08328) [-3.24095]	1	0.000291 (0.00015) [1.91432]	-0.6085* (0.15352) [-3.96386]	1	-0.000195 (0.00014) [-1.41939]	6.79601* (2.09086) [3.25034]	2	0.0014* (0.00055) [2.54387]	5.482665 (4.11535) [1.33225]
Columbia	1	0.000276 (0.00248) [0.11109]	0.000798 (0.00079) [1.01130]	1	-0.0145* (0.00559) [-2.59374]	0.000735 (0.00051) [1.44269]	1	-0.119449 (0.08930) [-1.33768]	0.016465 (0.01968) [0.83671]	1	-0.025458 (0.02218) [-1.14761]	-0.008880 (0.00684) [-1.29763]
Czech	1	-0.00036* (0.00017) [-2.15655]	-0.038500 (0.05960) [-0.64600]	1	-0.000327 (0.00022) [-1.46836]	-0.078442 (0.05889) [-1.33207]	1	-0.001197 (0.00070) [-1.71085]	0.066550 (1.13040) [0.05887]	1	-0.000219 (0.00044) [-0.49657]	-0.190308 (0.16251) [-1.17109]

Egypt	2	-9.25E-05 (0.00017) [-0.54748]	-11.4285* (5.22523) [-2.18717]	1	-1.10E-05* (4.2E-06) [-2.61934]	2.23118* (0.97514) [2.28805]	1	-1.63E-05* (5.3E-06) [-3.09171]	264.827* (83.7174) [3.16334]	1	0.000161 (9.2E-05) [1.75553]	4.92296* (2.07438) [2.37321]
Hungary	1	-9.25E-05 (0.00025) [-0.36551]	0.031794 (0.02465) [1.29005]	1	-0.000269 (0.00029) [-0.92772]	-0.038168 (0.02546) [-1.49942]	1	-0.003764 (0.00215) [-1.75231]	0.082708 (0.38601) [0.21426]	1	-0.000188 (0.00071) [-0.26493]	0.15396* (0.05334) [2.88626]
India	1	0.00012* (5.9E-05) [1.98500]	0.16342* (0.07252) [2.25330]	1	-0.00018* (8.1E-05) [-2.24352]	0.018760 (0.05519) [0.33991]	1	-0.000724 (0.00072) [-1.01123]	-0.029271 (1.29229) [-0.02265]	1	0.000254 (0.00024) [1.06576]	0.4335* (0.17089) [2.53668]
Indonesia	1	0.006932 (0.00456) [1.52030]	0.001260 (0.00090) [1.40612]	1	0.003657 (0.02412) [0.15160]	0.000390 (0.00038) [1.02920]	1	-0.16394* (0.05324) [-3.07924]	0.012965 (0.02904) [0.44638]	2	0.09677* (0.04317) [2.24128]	0.12351* (0.06273) [1.96876]
Malaysia	1	4.25E-06 (6.4E-06) [0.66131]	0.276224 (0.42539) [0.64934]	1	2.37E-07 (1.4E-05) [0.01654]	0.142380 (0.49579) [0.28718]	1	-0.00017* (5.7E-05) [-2.99334]	22.9733* (10.7443) [2.13818]	1	5.07E-05 (3.6E-05) [1.41261]	0.208115 (0.77961) [0.26695]
Mexico	2	8.42E-05 (4.6E-05) [1.83721]	57.1719* (22.9771) [2.48821]	1	1.61E-07 (3.5E-06) [0.04567]	0.733449 (0.88541) [0.82837]	1	-0.00015* (5.4E-05) [-2.78137]	70.43375 (39.3003) [1.79219]	1	2.41E-05 (2.0E-05) [1.21123]	-5.429853 (3.50798) [-1.54786]
Pakistan	1	4.62E-05 (0.00016) [0.28056]	0.027413 (0.01901) [1.44235]	3	-0.000249 (0.00232) [-0.10739]	0.655866 (0.56502) [1.16078]	1	0.000536 (0.00125) [0.42752]	-0.97083* (0.46436) [-2.09070]	1	-0.000855 (0.00051) [-1.68995]	0.107570 (0.11067) [0.97201]
Peru	1	-2.13E-06* (1.0E-06) [-2.14007]	2.44623 (2.09556) [1.16734]	1	-7.22E-06* (3.3E-06) [-2.15558]	-0.226007 (0.83560) [-0.27047]	1	-4.51E-05* (1.8E-05) [-2.48774]	66.18653 (63.3259) [1.04517]	1	-3.33E-06 (3.5E-06) [-0.94284]	7.852724 (8.09930) [0.96956]
Philippines	1	-4.56E-07 (3.8E-05) [-0.01187]	0.018395 (0.05862) [0.31377]	1	-0.00029* (0.00013) [-2.19450]	-0.053815 (0.07061) [-0.76219]	1	-0.00134* (0.00055) [-2.42241]	1.568386 (1.00943) [1.55374]	1	0.00019* (6.3E-05) [3.08680]	-0.099565 (0.44085) [-0.22585]

Poland	1	-4.49E-06 (3.6E-06) [-1.25953]	0.431798 (2.34112) [0.18444]	1	-4.81E-06 (4.0E-06) [-1.20814]	-2.709803 (2.78574) [-0.97274]	1	-4.89E-05* (2.4E-05) [-2.05947]	18.36226 (22.6386) [0.81110]	1	-2.59E-05 (2.3E-05) [-1.13353]	-6.554015 (6.72959) [-0.97391]
Qatar	5	4.61E-06 (1.1E-05) [0.41901]	28.49604 (131.093) [0.21737]	1	-2.05E-07 (2.7E-07) [-0.75573]	-1845.303 (4064.86) [-0.45397]	1	-4.14E-07 (5.8E-07) [-0.72014]	-5128.04* (2475.15) [-2.07181]	1	-4.28E-06 (3.4E-06) [-1.24953]	-18.85197 (45.6401) [-0.41306]
Romania	1	-4.78E-07 (9.6E-06) [-0.04963]	2.713439 (1.80797) [1.50082]	1	-1.96E-05 (6.8E-05) [-0.29071]	-72.08719 (49.2921) [-1.46245]	1	-0.00013* (5.4E-05) [-2.35881]	-9.177554 (26.3804) [-0.34789]	1	3.00E-05 (1.9E-05) [1.59885]	5.165465 (2.99735) [1.72334]
Russia	4	0.000790 (0.00080) [0.98863]	-0.261368 (1.11657) [-0.23408]	2	0.000623 (0.00092) [0.67602]	0.114227 (1.48491) [0.07693]	1	-0.00071* (0.00020) [-3.46969]	5.174307 (3.02621) [1.70983]	1	-0.001367 (0.00074) [-1.85635]	-0.248838 (0.18640) [-1.33500]
S Africa	1	6.16E-05* (2.3E-05) [2.66328]	0.354191 (0.27927) [1.26828]	3	-0.000286 (0.00063) [-0.45423]	-1.913075 (2.09486) [-0.91322]	1	-0.000787 (0.00071) [-1.11162]	-6.751572 (3.55186) [-1.90085]	1	0.000234* (9.5E-05) [2.47201]	2.64661* (0.93350) [2.83514]
S Korea	3	-0.2547* (0.05415) [-4.70400]	-0.004597 (0.01226) [-0.37495]	3	-0.098488 (0.08664) [-1.13679]	-0.004384 (0.01054) [-0.41612]	1	-0.194214 (0.11665) [-1.66499]	8.17E-05 (0.02126) [0.00384]	1	-0.012362 (0.00946) [-1.30643]	0.0377* (0.01435) [2.62676]
Taiwan	2	0.000821 (0.00046) [1.78468]	0.409623 (1.47406) [0.27789]	1	7.72E-05 (8.0E-05) [0.96337]	0.066830 (0.11285) [0.59220]	1	-0.00108* (0.00044) [-2.47425]	2.28363* (1.13195) [2.01743]	1	3.56E-05 (0.00020) [0.18092]	0.421391 (0.25428) [1.65719]
Thailand	1	-0.000108 (8.2E-05) [-1.31079]	-0.024682 (0.05325) [-0.46353]	1	-0.000251 (0.00015) [-1.62595]	-0.057182 (0.06074) [-0.94136]	1	-0.00117* (0.00055) [-2.13421]	0.818668 (1.70604) [0.47986]	1	0.000222 (0.00012) [1.84784]	0.081052 (0.29626) [0.27358]
Turkey	1	3.74E-09 (4.0E-09) [0.93706]	3524.66* (1223.30) [2.88129]	1	-3.05E-09 (5.1E-09) [-0.59421]	1456.198 (993.062) [1.46637]	1	-8.93E-08* (4.2E-08) [-2.10852]	44397.09 (25951.0) [1.71080]	1	2.22E-08 (1.5E-08) [1.43487]	7204.22* (3059.07) [2.35503]

UAE	1	-3.96E-08 (4.9E-08) [-0.81488]	-2941.871 (2694.56) [-1.09178]	1	4.73E-07* (1.5E-07) [3.05557]	9366.712 (10100.1) [0.92739]	1	-5.73E-07* (2.5E-07) [-2.30572]	-8505.771 (4370.75) [-1.94607]	1	4.28E-08 (3.2E-08) [1.35234]	-4756.080 (7676.92) [-0.61953]
Ukraine	1	-0.000121 (8.4E-05) [-1.43365]	0.052570 (0.13022) [0.40370]	1	-1.79E-05 (1.9E-05) [-0.93392]	364.3295 (355.395) [1.02514]	1	-0.00041* (0.00014) [-2.84763]	9.50608* (3.02336) [3.14422]	1	-0.000279 (0.00024) [-1.15601]	0.011623 (0.09077) [0.12806]

Results: between stock indices and currency market values. Stock index to Forex rate (St to Fx) and Forex rate to Stock index (Fx to St) VAR estimates along with Standard errors in ( ) & t-statistics in [ ] reported for specified lag length decided by minimization of Schwarz Info Criteria (SIC). Values for Bangladesh is not reported for Pre-crisis and Crisis periods.
VAR at 5% level of Significance.
Source: Authors' own work

We re-verify the relationship between Stock returns and changes in forex rates by using the Dynamic Conditional Correlations (DCC) method for each pair of sample stock and currency market returns. The mean correlation coefficients for returns, their maximum, and minimum values are presented in table 5. The results for the total period show a negative correlation for 24 economies. The negative correlation implies that positive (negative) stock returns are accompanied by currency appreciation (depreciation) which is consistent with theory as well as with most of the prior research (Tsai (2012) and Cho et al. (2014)). Only four countries, namely Bangladesh, Egypt, UAE, and Ukraine, exhibit positive mean correlations for this period which may be because these countries experience high inflation and high-interest rate regimes during the study period. Considering average mean correlation coefficients for 24 countries for which a negative relationship is observed, one gets an average correlation of -0.274. Using this as a benchmark, ten countries, namely Brazil, Mexico, Chile, Colombia, Russia, Indonesia, India, Taiwan, Romania, and S Korea, exhibit a strong relationship between stock return and forex rates as their mean correlation coefficients are higher than this benchmark. The same benchmark is also used for sub-period evaluation. The dynamic correlation for sample countries spiked from pre-crisis to crisis, reconfirming the contagion effect during the global financial crisis. Though the correlation marginally declined in the post-crisis period but remained substantially higher than those for the pre-crisis period. This post-crisis higher correlation implies that the stock market and forex rate return association has become stronger after the global financial crisis compared to the pre-crisis period.

Table 5: Dynamic Conditional Correlation (DCC) Coefficients between stock and currency market returns

Country	Total period			Pre crisis			Crisis			post Crisis		
	Mean	**Max**	**Min**	**Mean**	**Max**	**Min**	**Mean**	**Max**	**Min**	**Mean**	**Max**	**Min**
Argentina	**-0.1796**	0.0154	-0.4985	**-0.2016**	-0.08665	-0.4985	**-0.1925**	-0.0983	-0.282	**-0.1509**	0.01539	-0.4337
Bangladesh	**0.02135**	0.0762	-0.88188							**0.02135**	0.07617	**-0.8819**
Brazil	**-0.6063**	**0.1348**	-0.8978	**-0.4899**	**0.13479**	-0.8813	**-0.8196**	**-0.6856**	**-0.8751**	**-0.7425**	**-0.5264**	**-0.8978**
Bulgaria	**-0.0941**	-0.0483	-0.13434	**-0.074**	-0.05475	-0.0921	**-0.0829**	-0.0483	-0.1075	**-0.1019**	-0.0653	-0.1343
Chile	**-0.5145**	0.1147	-0.80992	**-0.431**	0.11472	-0.698	**-0.5787**	-0.3521	-0.7559	**-0.6573**	-0.3162	-0.8099
China	**-0.0986**	0.3308	-0.59954	**-0.0619**	0.33082	-0.4536	**-0.0282**	0.33082	-0.4536	**-0.1417**	0.25072	-0.5995
Colombia	**-0.4744**	0.0808	-0.87552	**-0.3229**	0.08084	-0.6897	**-0.6141**	-0.4213	-0.746	**-0.6907**	-0.3904	-0.8755
Czech Repub	**-0.0479**	0.1841	-0.25694	**0.01333**	0.18407	-0.142	**-0.1318**	-0.0576	-0.1982	**-0.1152**	0.04881	-0.2569
egypt	**0.20223**	0.2095	-0.184	**0.20324**	0.20952	**0.1965**	**0.20358**	0.20688	0.20273	**0.20059**	0.2073	-0.3071
Hungary	**-0.15**	0.455	-0.6099	**-0.0211**	0.45505	-0.3943	**-0.3222**	0.07399	-0.4847	**-0.2919**	0.03952	-0.6099
India	**-0.3392**	-0.0219	-0.63932	**-0.2147**	-0.0219	-0.4342	**-0.485**	-0.3397	-0.6393	**-0.5019**	-0.3692	-0.6081
Indonesia	**-0.3667**	**-0.1494**	-0.55525	**-0.327**	-0.14939	-0.5472	**-0.4558**	-0.2414	-0.5355	**-0.413**	-0.1533	-0.5552
Malaysia	**-0.2572**	0.4198	-0.67419	**-0.1566**	0.41984	-0.5565	**-0.3714**	-0.1414	-0.5964	**-0.3962**	0.00358	-0.6742
Mexico	**-0.5673**	-0.098	-0.82285	**-0.4838**	-0.09804	-0.784	**-0.6833**	-0.5082	**-0.8005**	**-0.706**	**-0.5359**	-0.8228
Pakistan	**-0.0494**	0.3907	**-0.37303**	**0.03619**	0.39074	**-0.3356**	**-0.0675**	0.17543	-0.3322	**-0.1532**	0.0514	-0.373
Peru	**-0.2672**	-0.021	-0.46545	**-0.229**	-0.02096	-0.4079	**-0.3003**	-0.162	-0.4261	**-0.3216**	-0.1723	-0.4654
Philippines	**-0.2489**	0.2203	-0.55991	**-0.1378**	0.22025	-0.5445	**-0.4492**	-0.3644	-0.5599	**-0.3886**	-0.1865	-0.5419
Poland	**-0.2166**	0.2036	-0.58484	**-0.1272**	0.20361	-0.3845	**-0.2443**	0.04006	-0.3716	**-0.3528**	-0.1012	-0.5848

Qatar	**-0.1564**	0.4316	-0.20164	**-0.1582**	-0.15082	-0.1731	**-0.163**	-0.1406	-0.2016	**-0.154**	0.43157	-0.1877
Romania	**-0.297**	0.0118	-0.64205	**-0.4005**	**-0.23036**	-0.5598	**-0.4149**	-0.2706	-0.642	**-0.2482**	0.0118	-0.5906
Russia	**-0.3737**	0.2248	-0.84221	**-0.1388**	0.22479	-0.4641	**-0.4252**	-0.24	-0.6052	**-0.6926**	-0.3331	-0.8422
S Korea	**-0.296**	0.054	-0.60986	**-0.1954**	0.05404	-0.407	**-0.4575**	-0.3579	-0.5002	**-0.4816**	-0.3292	-0.6099
S Africa	**-0.2087**	0.3943	-0.55085	**-0.0978**	0.39433	-0.3457	**-0.3509**	-0.1848	-0.4897	**-0.3579**	-0.1797	-0.5508
Taiwan	**-0.3008**	0.3627	-0.59656	**-0.2612**	0.36269	-0.5546	**-0.376**	-0.1109	-0.5966	**-0.3688**	0.05819	-0.5735
Thailand	**-0.1937**	0.2544	-0.50124	**-0.1241**	0.25441	-0.4951	**-0.2698**	-0.1135	-0.3838	**-0.3236**	0.02394	-0.5012
Turkey	**-0.2614**	0.4388	-0.75418	**-0.0541**	0.43878	-0.73	**-0.6678**	**-0.5685**	-0.7542	**-0.5495**	-0.2875	-0.7461
UAE	**0.01939**	0.0945	**-0.06851**	**0.02474**	0.08915	-0.0298	**0.02133**	0.09453	-0.0685	**0.01015**	0.07482	-0.0518
Ukraine	**0.00387**	0.5232	-0.4157	**-0.0211**	0.0429	-0.1794	**-0.0229**	0.26568	-0.4157	**0.01383**	0.52324	-0.2906

Source: Authors' own work

Volatility linkages between stock and currency markets

Volatility linkages are studied by employing BEKK-GARCH (Baba, Engle, Kraft, & Kroner, 1990). Such analysis is essential to understand the information transmission process between the second moment of two markets measured by the variance of returns. Stock and currency market volatilities for each sample country are estimated using a parsimonious GARCH (1,1) model. The BEKK GARCH findings of the relationship between the Stock market and foreign exchange volatility on a short-term basis (noise spillovers) and long-term (volatility spillovers) are reported in table 6. Since the study is focused only on emerging market economies, due importance is given to the findings of noise spillovers along with the volatility spillovers.

Examining the noise spillovers for the total period, we find that twenty countries exhibit this association with more significant influence from forex to Stock for sixteen countries (namely Brazil, Bulgaria, Chile, China, Czech Republic, Hungary, Indonesia, Pakistan, Peru, Philippines, Romania, Russia, S Korea, Turkey, UAE, and Ukraine), whereas Argentina, Bangladesh, India, and Qatar have spillovers from Stock to forex, thus, confirming the dominance of relationships from forex to stock market during the total period. The results of sub-periods also observe a similar pattern of stronger linkages from forex to Stock during the pre-crisis period where out of twenty countries exhibiting linkages, only four show stock to forex market spillovers. This relationship reduces to seventeen countries during the crisis period showing a minor decoupling effect. The post-crisis period witnesses noise spillovers in fifteen countries with the dominance of forex to Stock. The decoupling effect is present in five countries, i.e., Brazil, Malaysia, Mexico, S Korea, and Thailand, which exhibit short-term spillovers during pre- and post-crisis but not during the crisis period. In contrast, Bulgaria, S Africa, and Ukraine show this association only during the crisis, implying a contagion effect. Seven countries, namely Argentina, Chile, China, Colombia, Philippines, Poland, and Romania, exhibit noise spillovers for all three sub-periods, whereas Egypt and Taiwan are only two countries where noise spillovers are absent.

Analysis of long-term Volatility spillovers for the total period finds the relationships in seventeen countries out of which fifteen countries namely Brazil, Bulgaria, Chile, China, Czech Republic, Hungary, India, Indonesia, Pakistan, Philippines, Romania, Russia, S. Africa, S. Korea, and Turkey exhibit dominance of spillover from forex to Stock. In contrast, Egypt and Malaysia show a relationship from Stock to forex. This result is identical to that of noise spillovers for the total period. The analysis of sub-periods observes associations for fifteen

countries, primarily with forex to stock volatility spillovers. Nine of these fifteen countries are the same, which have exhibited long-term associations during the total period. However, this association sharply decreases to eight countries during the crisis period indicating a decoupling effect, which gets restored to seventeen countries during the post-crisis period with a clear dominance of forex to stock spillovers. This increase in the number of countries after the global financial crisis implies that the stock market and forex rate volatility association have become more prominent than the pre-crisis period, as in the case of return associations.

Table. 6: Testing Volatility linkages using BEKK GARCH model.

		Panel A	Panel B	Panel C	Panel D											
Country		**Coefficient**	**Std. Error**	**z-Statistic**	**Prob.**	**Coefficient**	**Std. Error**	**z-Statistic**	**Prob.**	**Coefficient**	**Std. Error**	**z-Statistic**	**Prob.**	**Coefficient**	**Std. Error**	**z-Statistic**	**Prob.**
Argentina	**ALPHA(2)**	0.138300	0.110704	1.249270	0.2116	0.436510	0.068846	6.340396	0.0000	-0.604468	1.955282	-0.309146	0.7572	-0.122310	0.144113	-0.848709	0.3960
	ALPHA(3)	0.288727	0.031316	9.219738	0.0000	-0.349268	0.049599	-7.041817	0.0000	-0.030011	0.014482	-2.072295	0.0382	-0.168050	0.083402	-2.014944	0.0439
	BETA (2)	0.495987	0.301469	1.645237	0.0999	0.391199	0.113280	3.453387	0.0006	-9.478141	1.938404	-4.889662	0.0000	0.431996	0.151444	2.852506	0.0043
	BETA (3)	0.356506	0.229590	1.552795	0.1205	0.460097	0.052823	8.710089	0.0000	-0.009150	0.072146	-0.126827	0.8991	0.432885	0.095022	4.555644	0.0000
Bangladesh	**ALPHA(2)**	-0.022466	0.614818	-0.036540	0.9709									-0.022466	0.614818	-0.036540	0.9709
	ALPHA(3)	0.031270	0.004796	6.519998	0.0000									0.031270	0.004796	6.519998	0.0000
	BETA (2)	-0.964197	0.645956	-1.492665	0.1355									-0.964197	0.645956	-1.492665	0.1355
	BETA (3)	0.003136	0.013551	0.231439	0.8170									0.003136	0.013551	0.231439	0.8170
Brazil	**ALPHA(2)**	-0.307752	0.036487	-8.434487	0.0000	-0.539836	0.072279	-7.468813	0.0000	-1.897674	1.184089	-1.602645	0.1090	-0.637331	0.189458	-3.363965	0.0008
	ALPHA(3)	-0.268188	0.011114	-24.13068	0.0000	0.311860	0.016795	18.56914	0.0000	-0.003246	0.232177	-0.013981	0.9888	0.095162	0.049886	1.907600	0.0564
	BETA (2)	0.097218	0.028465	3.415287	0.0006	0.678554	0.075214	9.021592	0.0000	-1.165019	0.683853	-1.703611	0.0885	-1.323278	0.484562	-2.730877	0.0063
	BETA (3)	0.118559	0.021697	5.464323	0.0000	0.187695	0.048787	3.847224	0.0001	0.503324	0.227123	2.216081	0.0267	0.189038	0.110908	1.704467	0.0883
Bulgaria	**ALPHA(2)**	0.206431	0.084604	2.439962	0.0147	0.313712	0.506183	0.619759	0.5354	-1.762046	0.420477	-4.190588	0.0000	-0.659565	3.679072	-0.179275	0.8577
	ALPHA(3)	0.043864	0.012686	3.457712	0.0005	0.050577	0.080954	0.624760	0.5321	-0.005875	0.035717	-0.164498	0.8693	-0.009423	2.770283	-0.003401	0.9973
	BETA (2)	-0.150171	0.041560	-3.613333	0.0003	0.436158	1.356315	0.321576	0.7478	0.478685	1.749349	0.273636	0.7844	0.622569	5.189136	0.119975	0.9045
	BETA (3)	0.015782	0.007501	2.104054	0.0354	0.139697	0.365585	0.382120	0.7024	-0.023584	0.150325	-0.156888	0.8753	0.360111	3.495483	0.103022	0.9179
Chile	**ALPHA(2)**	0.925598	0.054820	16.88420	0.0000	-0.142497142497	0.085016	-1.676115	0.0937	2.237054	0.273040	8.193135	0.0000	0.913451	0.158388	5.767168	0.0000
	ALPHA(3)	0.028708	0.007863	3.650920	0.0003	0.023037	0.008901	2.588182	0.0096	-0.295857	0.087882	-3.366527	0.0008	-0.171628	0.050895	-3.372233	0.0007
	BETA (2)	2.528473	0.140551	17.98970	0.0000	-0.042268	0.033722	-1.253417	0.2101	-0.412315	1.187193	-0.347302	0.7284	1.682991	0.530337	3.173434	0.0015
	BETA (3)	0.200740	0.030401	6.603117	0.0000	0.006938	0.003753	1.848663	0.0645	0.244672	0.196880	1.242746	0.2140	0.341398	0.096954	3.521234	0.0004
China	**ALPHA(2)**	-0.619048	0.303873	-2.037191	0.0416	-5.866415	1.965447	-2.984773	0.0028	-7.680421	3.152264	-2.436478	0.0148	-2.436349	0.390066	-6.245989	0.0000
	ALPHA(3)	-0.141728	0.001430	-99.09119	0.0000	-0.123539	0.001270	-97.25609	0.0000	-0.002706	0.002714	-0.996989	0.3188	-0.006726	0.006718	-1.001244	0.3167
	BETA (2)	4.094354	0.587760	6.966033	0.0000	2.654538	0.847276	3.133028	0.0017	-1.455726	1.472499	-0.988609	0.3229	-1.176508	0.514927	-2.284808	0.0223
	BETA (3)	0.037150	0.005760	6.449884	0.0000	0.008997	0.006097	1.475484	0.1401	-0.000403	0.002431	-0.165665	0.8684	0.031243	0.008560	3.649909	0.0003
Colombia	**ALPHA(2)**	-0.330461	5.309385	-0.062241	0.9504	-0.974834	0.149090	-6.538581	0.0000	1.184739	0.329336	3.597360	0.0003	-0.163504	0.198601	-0.823279	0.4103
	ALPHA(3)	0.250044	0.882926	0.283199	0.7770	0.028623	0.010379	2.757919	0.0058	-0.363146	0.135060	-2.688782	0.0072	-0.198796	0.058917	-3.374195	0.0007
	BETA (2)	0.548065	7.120128	0.076974	0.9386	-0.106951	0.211044	-0.506773	0.6123	-0.382834	1.569515	-0.243919	0.8073	-0.939747	0.473481	-1.984760	0.0472
	BETA (3)	0.442898	7.159149	0.061865	0.9507	-0.025701	0.026746	-0.960923	0.3366	-0.049243	0.446751	-0.110225	0.9122	0.383392	0.126558	3.029389	0.0025
Czech republic	**ALPHA(2)**	-0.376954	0.045564	-8.273104	0.0000	-0.010805	0.160536	-0.067304	0.9463	-0.873315	0.230326	-3.791651	0.0001	0.142120	0.145521	0.976632	0.3288
	ALPHA(3)	-0.028891	0.015277	-1.891121	0.0586	0.077368	0.014587	5.304073	0.0000	0.025661	0.078063	0.328717	0.7424	0.075856	0.075472	1.005093	0.3149
	BETA (2)	-0.293943	0.134719	-2.181900	0.0291	1.530813	2.292519	0.667743	0.5043	-0.900235	0.250323	-3.596290	0.0003	0.535470	0.487910	1.097476	0.2724
	BETA (3)	0.024707	0.041817	0.590830	0.5546	0.130245	0.162780	0.800126	0.4236	0.142777	0.167958	0.850079	0.3953	0.433693	0.484019	0.896024	0.3702
Egypt	**ALPHA(2)**	0.078239	0.108195	0.723125	0.4696	1.152200	0.343113	3.358081	0.0008	0.350855	84.38101	0.004158	0.9967	-0.242679	0.305155	-0.795265	0.4265
	ALPHA(3)	-0.005909	0.086177	-0.068565	0.9453	-0.006133	0.004784	-1.281942	0.1999	0.099224	6.779342	0.014636	0.9883	0.434034	0.330134	1.314720	0.1886
	BETA (2)	0.490918	0.300826	1.631897	0.1027	1.077677	0.620307	1.737329	0.0823	0.514508	21.91069	0.023482	0.9813	0.459973	1.194464	0.385087	0.7002
	BETA (3)	0.486963	0.217272	2.241258	**0.0250**	0.000378	0.012935	0.029198	0.9767	0.463101	17.97421	0.025765	0.9794	0.522342	1.652949	0.316006	0.7520
Hungary	**ALPHA(2)**	-0.160338	0.071504	-2.242364	0.0249	0.098839	0.108604	0.910090	0.3628	-2.018654	0.374960	-5.383646	0.0000	0.329265	0.130851	2.516326	0.0119
	ALPHA(3)	0.005599	0.013737	0.407627	0.6835	0.004875	0.011093	0.439470	0.6603	-0.021121	0.086056	-0.245433	0.8061	-0.102098	0.044827	-2.277623	0.0227
	BETA (2)	1.743587	0.129895	13.42307	0.0000	-0.033668	0.052501	-0.641283	0.5213	0.007823	0.457623	0.017094	0.9864	0.098764	0.229495	0.430353	0.6669
	BETA (3)	0.357069	0.047793	7.471111	0.0000	-0.004916	0.008455	-0.581424	0.5610	0.262452	0.091134	2.879847	0.0040	0.342704	0.128793	2.660893	0.0078

India	**ALPHA(2)**	-0.129872	0.087747	-1.480082	0.1389	-2.374980	0.361195	-6.575335	0.0000	-1.581977	1.272367	-1.243333	0.2137	-0.447210	0.278852	-1.603752	0.1088
	ALPHA(3)	-0.015591	0.004112	-3.792037	0.0001	0.032399	0.007093	4.567960	0.0000	0.111885	0.039995	2.797437	0.0052	0.037606	0.024591	1.529225	0.1262
	BETA (2)	2.640229	0.169282	15.59659	0.0000	-2.552157	0.497552	-5.129425	0.0000	-2.322450	26.31587	-0.088253	0.9297	-1.510401	0.417238	-3.619996	0.0003
	BETA (3)	0.066229	0.012758	5.191014	0.0000	0.111036	0.014083	7.884256	0.0000	0.232382	1.890600	0.122915	0.9022	0.117330	0.158433	0.740568	0.4590
Indonesia	**ALPHA(2)**	-0.237881	0.036922	-6.442818	0.0000	0.126617	0.030537	4.146294	0.0000	0.159031	0.559350	0.284313	0.7762	0.024793	0.104805	0.236568	0.8130
	ALPHA(3)	0.074690	0.011774	6.343517	0.0000	0.068921	0.037236	1.850945	0.0642	-0.176276	0.040305	-4.373546	0.0000	0.043850	0.024718	1.774011	0.0761
	BETA (2)	0.383483	0.029731	12.89825	0.0000	0.523717	0.092448	5.664988	0.0000	-0.967876	0.649643	-1.489859	0.1363	1.347138	0.295612	4.557114	0.0000
	BETA (3)	0.253688	0.028294	8.966015	0.0000	0.467963	0.145077	3.225624	0.0013	0.162016	0.114777	1.411574	0.1581	0.117921	0.104828	1.124899	0.2606
Malaysia	**ALPHA(2)**	-0.194290	0.399179	-0.486724	0.6265	0.900155	0.065430	13.75762	0.0000	-0.055598	0.752591	-0.073876	0.9411	-0.246385	0.056241	-4.380878	0.0000
	ALPHA(3)	0.199196	0.117020	1.702237	0.0887	-0.108170	0.008827	-12.25419	0.0000	-0.032761	0.073106	-0.448134	0.6541	0.099808	0.044111	2.262687	0.0237
	BETA (2)	0.485015	0.251664	1.927231	0.0540	-0.508857	0.146844	-3.465298	0.0005	2.238221	1.405514	1.592457	0.1113	1.072652	0.190897	5.619006	0.0000
	BETA (3)	0.480455	0.143797	3.341192	0.0008	0.209727	0.011583	18.10653	0.0000	0.253537	0.108164	2.343997	0.0191	0.055381	0.163065	0.339625	0.7341
Mexico	**ALPHA(2)**	0.295572	1.667440	0.177261	0.8593	-1.642141	0.757938	-2.166589	0.0303	1.084143	9.829150	0.110299	0.9122	0.741147	0.247928	2.989361	0.0028
	ALPHA(3)	-0.015332	0.624829	-0.024538	0.9804	0.388607	0.347611	1.117934	0.2636	-0.219395	4.410881	-0.049739	0.9603	0.116863	0.064452	1.813187	0.0698
	BETA (2)	0.572222	7.743161	0.073900	0.9411	0.525831	1.648153	0.319042	0.7497	0.505967	9.646515	0.052451	0.9582	1.173257	0.516760	2.270410	0.0232
	BETA (3)	0.410729	4.706400	0.087270	0.9305	0.445221	1.005670	0.442711	0.6580	0.461278	6.996132	0.065933	0.9474	0.067800	0.141102	0.480504	0.6309
Pakistan	**ALPHA(2)**	-1.309239	0.113302	-11.55534	0.0000	1.174212	0.126933	9.250617	0.0000	2.916652	1.073444	2.717098	0.0066	-0.465021	1.159236	-0.401144	0.6883
	ALPHA(3)	-0.044704	0.012042	-3.712224	0.0002	0.010655	0.032466	0.328199	0.7428	0.009662	0.011323	0.853296	0.3935	-0.068293	0.633773	-0.107757	0.9142
	BETA (2)	1.249717	0.194079	6.439228	0.0000	-0.058159	0.172990	-0.336199	0.7367	-1.219671	1.612754	-0.756266	0.4495	0.481344	3.130931	0.153738	0.8778
	BETA (3)	0.204809	0.022000	9.309347	0.0000	0.224539	0.045667	4.916932	0.0000	-0.031048	0.036698	-0.846049	0.3975	0.485267	2.568671	0.188918	0.8502
Peru	**ALPHA(2)**	-1.314248	0.426382	-3.082329	0.0021	-1.662861	0.219327	-7.581667	0.0000	1.165119	1.253684	0.929356	0.3527	-0.840118	0.451993	-1.858696	0.0631
	ALPHA(3)	0.092112	0.011276	8.169201	0.0000	0.002319	0.004700	0.493365	0.6218	-0.067492	0.038230	-1.765420	0.0775	-0.012319	0.009763	-1.261731	0.2070
	BETA (2)	-0.809703	0.898286	-0.901386	0.3674	-3.378918	0.483669	-6.986009	0.0000	-0.197787	2.558266	-0.077313	0.9384	-0.105355	0.555771	-0.189565	0.8497
	BETA (3)	0.140393	0.145502	0.964891	0.3346	0.049228	0.037326	1.318860	0.1872	0.048265	0.075291	0.641049	0.5215	0.019354	0.025485	0.759451	0.4476
Philippines	**ALPHA(2)**	-1.872946	0.178123	-10.51488	0.0000	-1.453905	0.159563	-9.111810	0.0000	-0.126188	0.545522	-0.231315	0.8171	0.650860	0.181259	3.590781	0.0003
	ALPHA(3)	-0.914769	0.051811	-17.65598	0.0000	0.209340	0.006360	32.91732	0.0000	0.110424	0.045962	2.402487	0.0163	0.042251	0.024158	1.748923	0.0803
	BETA (2)	0.515350	0.061987	8.313785	0.0000	-1.303953	0.117745	-11.07437	0.0000	-0.620418	1.492524	-0.415684	0.6776	1.334931	1.169314	1.141636	0.2536
	BETA (3)	0.410134	0.063451	6.463811	0.0000	0.208947	0.017622	11.85728	0.0000	-0.025730	0.142381	-0.180709	0.8566	0.308834	0.092089	3.353644	0.0008
Poland	**ALPHA(2)**	-0.735955	0.788393	-0.933487	0.3506	-0.254276	0.138247	-1.839293	0.0659	1.217072	0.414840	2.933830	0.0033	-0.183164	0.164003	-1.116834	0.2641
	ALPHA(3)	-0.127495	0.108194	-1.178392	0.2386	0.089967	0.010234	8.790762	0.0000	0.206839	0.122152	1.693290	0.0904	0.100119	0.043239	2.315488	0.0206
	BETA (2)	0.886765	1.967533	0.450699	0.6522	0.089967	0.010234	8.790762	0.0000	0.619544	0.583722	1.061369	0.2885	-0.328230	0.157355	-2.085912	0.0370
	BETA (3)	0.333485	0.318223	1.047958	0.2947	0.149121	0.033012	4.517135	0.0000	0.483942	0.165440	2.925185	0.0034	0.127277	0.073222	1.738244	0.0822
Qatar	**ALPHA(2)**	-0.645789	0.556277	-1.160914	0.2457	-12.78517	50.35989	-0.253876	0.7996	14.29141	26.26354	0.544154	0.5863	-0.544885	1.248679	-0.436369	0.6626
	ALPHA(3)	0.003723	0.000310	12.02900	0.0000	-0.000857	0.004305	-0.199182	0.8421	0.001535	0.000899	1.708778	0.0875	-0.005197	0.000387	-13.41360	0.0000
	BETA (2)	-0.570596	0.864902	-0.659723	0.5094	19.12211	63.08967	0.303094	0.7618	-8.747571	69.74002	-0.125431	0.9002	-0.313748	0.439661	-0.713612	0.4755
	BETA (3)	0.001459	0.001078	1.353718	0.1758	0.001061	0.027458	0.038651	0.9692	-0.000361	0.002111	-0.170745	0.8644	0.003647	0.005409	0.674297	0.5001
Romania	**ALPHA(2)**	-0.516258	0.083078	-6.214166	0.0000	2.549096	0.843996	3.020272	0.0025	-0.641209	0.380107	-1.686919	0.0916	-0.153367	0.155575	-0.985806	0.3242
	ALPHA(3)	-0.144765	0.024091	-6.009205	0.0000	-0.196934	0.039767	-4.952192	0.0000	0.089632	0.042165	2.125742	0.0335	-0.104192	0.029495	-3.532561	0.0004
	BETA (2)	1.707345	0.267027	6.393893	0.0000	-1.459529	2.019500	-0.722718	0.4699	1.241501	1.102932	1.125637	0.2603	-1.901626	0.354704	-5.361162	0.0000
	BETA (3)	0.206553	0.037581	5.496241	0.0000	0.157652	0.170013	0.927295	0.3538	0.313854	0.178971	1.753658	0.0795	0.432299	0.082606	5.233266	0.0000
Russia	**ALPHA(2)**	-0.370747	0.075223	-4.928642	0.0000	-0.176395	0.099162	-1.778852	0.0753	1.158965	0.870108	1.331978	0.1829	0.289276	0.160159	1.806177	0.0709
	ALPHA(3)	-0.004443	0.004793	-0.926801	0.3540	0.031984	0.001144	27.96553	0.0000	-0.066939	0.035206	-1.901316	0.0573	0.018315	0.034206	0.535430	0.5924
	BETA (2)	-0.232880	0.045839	-5.080352	0.0000	0.063809	0.269772	0.236528	0.8130	-1.138587	0.687663	-1.655734	0.0978	-1.188515	0.335721	-3.540189	0.0004
	BETA (3)	-0.019477	0.002053	-9.488379	0.0000	0.010994	0.014371	0.765040	0.4442	0.049677	0.020722	2.397339	0.0165	0.384203	0.159014	2.416155	0.0157
S Africa	**ALPHA(2)**	0.002986	0.046866	0.063721	0.9492	-0.075398	0.093723	-0.804473	0.4211	0.080461	0.233936	0.343942	0.7309	0.313385	0.323062	0.970046	0.3320
	ALPHA(3)	0.029255	0.048643	0.601421	0.5476	-0.060641	0.035644	-1.701316	0.0889	0.450135	0.155181	2.900708	0.0037	0.014732	0.232792	0.063283	0.9495

	BETA (2)	0.430050	0.089448	4.807824	0.0000	0.479730	0.178410	2.688917	0.0072	0.605585	0.569778	1.062843	0.2879	0.655730	0.862366	0.760385	0.4470
	BETA (3)	0.471150	0.100236	4.700434	0.0000	0.359417	0.109570	3.280257	0.0010	0.124281	0.226017	0.549874	0.5824	0.334400	0.589955	0.566823	0.5708
S korea	**ALPHA(2)**	0.470407	0.087063	5.403044	0.0000	-0.233011	0.031714	-7.347276	0.0000	-0.461264	0.336232	-1.371862	0.1701	-0.246776	0.149869	-1.646608	0.0996
	ALPHA(3)	0.013213	0.002819	4.687017	0.0000	-0.011405	0.003039	-3.752748	0.0002	0.047111	0.082514	0.570945	0.5680	0.126687	0.046887	2.701973	0.0069
	BETA (2)	-0.582253	0.088734	-6.561790	0.0000	-9.47E-05	0.012421	-0.007627	0.9939	-0.451028	0.158945	-2.837640	0.0045	0.451111	0.419619	1.075047	0.2824
	BETA (3)	0.042774	0.015914	2.687920	0.0072	-0.004930	0.001722	-2.863191	0.0042	0.105712	0.058666	1.801930	0.0716	-0.344836	0.091805	-3.756167	0.0002
Taiwan	**ALPHA(2)**	-0.625788	6.604310	-0.094755	0.9245	-0.042451	0.306580	-0.138466	0.8899	1.887347	3.963945	0.476128	0.6340	-0.341320	0.206776	-1.650673	0.0988
	ALPHA(3)	0.275303	0.319505	0.861654	0.3889	0.004858	0.005643	0.861027	0.3892	0.044071	0.070692	0.623418	0.5330	-0.003908	0.018867	-0.207118	0.8359
	BETA (2)	0.647493	1.737257	0.372710	0.7094	1.784455	1.072037	1.664546	0.0960	-2.740731	18.13496	-0.151130	0.8799	-3.271159	1.001688	-3.265647	0.0011
	BETA (3)	0.342611	1.110139	0.308620	0.7576	0.060522	0.014833	4.080126	0.0000	0.094847	0.119134	0.796135	0.4260	0.036685	0.151243	0.242554	0.8084
Thailand	**ALPHA(2)**	-0.172256	2.373152	-0.072585	0.9421	-0.655053	0.105250	-6.223806	0.0000	0.494684	0.518861	0.953403	0.3404	0.254954	0.276932	0.920639	0.3572
	ALPHA(3)	0.182630	0.326494	0.559366	0.5759	-0.002951	0.002444	-1.207310	0.2273	0.004499	0.015491	0.290455	0.7715	-0.032882	0.015358	-2.140953	0.0323
	BETA (2)	0.606509	1.668343	0.363540	0.7162	-0.387734	0.137011	-2.829942	0.0047	-0.168541	0.358382	-0.470284	0.6382	0.250401	0.312042	0.802458	0.4223
	BETA (3)	0.360415	0.653755	0.551299	0.5814	0.013575	0.014025	0.967910	0.3331	0.008465	0.008761	0.966200	0.3339	-0.035762	0.014883	-2.402901	0.0163
Turkey	**ALPHA(2)**	1.283341	0.088510	14.49937	0.0000	1.174426	0.107857	10.88874	0.0000	1.284607	0.578108	2.222089	0.0263	-0.432276	2.828289	-0.152840	0.8785
	ALPHA(3)	-0.231248	0.006236	-37.08338	0.0000	-0.228274	0.008535	-26.74410	0.0000	-0.017691	0.073458	-0.240829	0.8097	0.138044	0.964514	0.143123	0.8862
	BETA (2)	0.974022	0.070691	13.77853	0.0000	-1.225028	0.112640	-10.87562	0.0000	0.042873	0.866705	0.049466	0.9605	0.923626	3.490798	0.264589	0.7913
	BETA (3)	0.298358	0.020832	14.32222	0.0000	0.275298	0.025032	10.99803	0.0000	-0.025076	0.265775	-0.094352	0.9248	0.326980	0.977898	0.334370	0.7381
Uae	**ALPHA(2)**	-70.54051	14.83135	-4.756177	0.0000	-70.54051	14.83135	-4.756177	0.0000	110.8491	51.85978	2.137477	0.0326	-4.693350	24251.52	-0.000194	0.9998
	ALPHA(3)	-0.001590	0.000469	-3.393310	0.0007	-0.001590	0.000469	-3.393310	0.0007	0.001468	0.000823	1.784454	0.0743	-1.404722	410.4408	-0.003422	0.9973
	BETA (2)	11.89043	55.38415	0.214690	0.8300	11.89043	55.38415	0.214690	0.8300	101.2019	277.1083	0.365207	0.7150	0.480355	378.8081	0.001268	0.9990
	BETA (3)	0.000437	0.000358	1.222932	0.2214	0.000437	0.000358	1.222932	0.2214	0.000403	0.001498	0.269345	0.7877	0.480787	341.8037	0.001407	0.9989
Ukraine	**ALPHA(2)**	-0.090897	0.026620	-3.414651	0.0006	-0.269034	4.834886	-0.055644	0.9556	-0.382589	0.106768	-3.583356	0.0003	-0.025346	1.979936	-0.012801	0.9898
	ALPHA(3)	-0.194380	0.076287	-2.548000	0.0108	-0.019622	0.024612	-0.797258	0.4253	0.185642	0.044304	4.190191	0.0000	-0.375986	0.884164	-0.425245	0.6707
	BETA (2)	0.489094	0.299627	1.632342	0.1026	3.759186	6.640557	0.566095	0.5713	0.150091	0.152954	0.981278	0.3265	0.498900	27.09844	0.018411	0.9853
	BETA (3)	0.502169	0.356329	1.409287	0.1588	-0.018620	0.035584	-0.523266	0.6008	-0.021255	0.047978	-0.443008	0.6578	0.498342	26.99612	0.018460	0.9853

Panel A is for Total period; Panel B for Pre-crisis period; Panel C for Crisis period and Panel D for Post-crisis period
Alpha is short term (noise) and beta is long term (volatility) spillover; 2 is forex to stock and 3 is stock to forex spillover
Source: Authors' Own work

In sum, volatility linkages are more widespread than return linkages as they are observed for a more significant number of countries. Return linkages are mainly from Stock to forex in the pre-crisis period and from forex to Stock in the post-crisis period. In contrast, volatility linkages are mainly from forex to Stock in both pre- and post-crisis periods. Moreover, contagion effects are observed during the crisis period while examining return association. In contrast, volatility linkages exhibit decoupling effects more pronounced for long-term volatility spillovers than for sort-term noise spillovers.

SUMMARY AND CONCLUSION

This study examines the return relationships and volatility linkages between Stock and currency markets for 28 emerging economies. The data for the study are weekly MSCI stock index values (in local currency) and foreign exchange rates (indirect quotes) for the sample markets. The study period is from January 1st, 1988, to July 4th, 2019, but the opening date varies for different countries depending on the availability of data for both markets. Both returns and volatility linkages are evaluated for the total study period and three subperiods, namely: Pre-GFC, GFC, and Post GFC periods.

The causal relationships for the total period between Stock and forex returns are found in ten countries with the dominance of forex to the stock market based on VAR results. Performing sub-period analysis, we observe the increasing presence of return relationships from 10 countries in the pre-GFC period to 19 countries during the GFC period, implying a contagion effect. This number reduces to nine in the post-GFC period. The nature of relationships is predominantly from Stock to forex in pre-crisis and crisis periods but changes from forex to Stock during the post-crisis period. This shift may be because the market participants started focusing more on fundamentals after the global financial crisis. Four countries: China, Egypt, India, and the Philippines, exhibit significant return relationships in both pre- and post-crisis periods, whereas Chile is the only country for which stock and forex market relationship is not observed for any period. The DCC for each pair of sample stock and currency market returns shows a negative correlation in 24 countries for the total period, implying that positive (negative) stock returns are accompanied by currency appreciation (depreciation). These findings conform with prior research. However, a positive relationship is observed for four countries: Bangladesh, Egypt, UAE, and Ukraine. The explanation may lie in relative PPP and IRP theorems whereby these countries may have experienced higher inflation and high-interest rate regime during the study period. During the GFC period, the DCC values spike for many

countries from the pre-crisis period reconfirming the contagion effect. The DCC values marginally declined in the post-crisis period but remained substantially higher than those for the pre-crisis period. This relatively higher correlation during the post-crisis period implies more robust stock market and forex rate return associations than the pre-crisis period.

Volatility linkages (long-term basis) are estimated using the multivariate BEKK GARCH model. The dominance of spillover from forex to stock markets is observed for total and sub-periods. It is also observed that only eight countries exhibit volatility associations during the crisis period compared to fifteen during pre-crisis and seventeen during the post-crisis period implying decoupling effect during GFC. It is interesting to note that the first-moment relationships (based on returns) between stock and currency markets experience the contagion effect during the crisis period while, in contrast, the second-moment relationships (based on volatility) exhibit a decoupling effect. Contrary to this, the mean volatility correlation coefficients, which are positive values for most countries for the total period, represent lower correlation during the pre-crisis period, which increases sharply during the crisis period, implying contagion effects. These values marginally decline in the post-crisis period. However, they remain substantially higher than those for the pre-crisis period proving a stronger volatility association between stock and forex markets after the global financial crisis.

These results have important implications for many stakeholders like policy makers, multilateral financial institutions, international portfolio managers, and academia. After the global financial crisis, the dominance of forex to stock market return and volatility linkages underlines the increasing relevance of economic fundamentals. The government of emerging economies firstly needs to accept the increasing linkages between forex and stock markets after the financial crisis and then use the information for policy formulation. They may strengthen the forex rates by addressing the inflation and policy rate issues, which will trigger stock price movements. These findings, along with other fundamentals, may be used as a signal for investments by global fund managers. The findings will help monetary authorities in their decision-making process concerning changes in exchange rates. Whether they should interrupt exchange rates to stimulate export growth or keep allowing their currency values to be determined by the economic fundamentals may be guided by these findings. Multilateral institutions may take advantage of the results of this study in their lending decisions, whereas international portfolio managers may decide their fund allocations accordingly. This study also enriches the existing literature of international finance on emerging market economies. It undertakes a comprehensive analysis of return and volatility linkages between stock and forex

markets for geographically dispersed emerging economies. It hence is vital from the theoretical point of view as the results support the 'Flow oriented model' as suggested by Dornbusch and Fisher 1980.

Further research may be carried out to find the behavior of higher-order linkages between stock and currency markets as indicated through their skewness and kurtosis. The contagion effect observed in return relationships and the decoupling effect in volatility relationships also need further examination. Comparative research on stock and currency market relationships on a set of mature and emerging economies shall provide further policy suggestions. The role of macroeconomic variables in explaining return and volatility linkages shall also be an exciting research proposition. The present research attempts to fill some void in this critical area of international finance research.

NOTE

1. The Bretton Wood System (1946 -1971) collapsed with the announcement of the suspension of conversion of USD into gold by the US president on August 15th, 1971 (Bordo 1981). An attempt to revive the fixed exchange rates through the Smithsonian Agreement in December 1971 also failed. By March 1973, the major currencies began to float against each other, opening the currency market.

2. Asian currency crisis, also known as the Asian Financial crisis, started in Thailand on July 2nd1997 (https://corporatefinanceinstitute.com/resources/knowledge/finance/asian-financial-crisis/) (https://www.federalreservehistory.org/essays/asian-financial-crisis) and gripped east and south-east Asian countries. Thailand, Indonesia, and South Korea were the worst-hit economies by the crisis. However, sound fiscal policies of these countries and intervention by IMF with US$ 40 billion stabilization program followed by a coordinated effort by the economies for the financial stability and better financial supervision in the region controlled the situation by the end of 1999.

3. All sample return series have been annualized by multiplying their weekly percentage values by 52, whereas sample volatility series have been annualized by multiplying their weekly percentage values by the square root of 52 (√52).

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