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DYNAMICS BETWEEN EXCHANGE RATES AND STOCK PRICES: EVIDENCE FROM DEVELOPED AND EMERGING MARKETS

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ABSTRACT

This study examines the long- and short-run dynamics between exchange rates and stock prices by using cointegration methodology and multivariate Granger causality tests. We apply the analysis to six countries, including: Japan, United Kingdom, Hong Kong, China, India and Brazil over the period December 2007 to May 2013. The evidence suggests that the global financial crisis 2007-2009 is an important determinant of the link between the domestic stock and foreign exchange markets. The exchange rate is negatively related to the domestic stock market for emerging countries but positively for developed countries for entire sample and during the crisis. However, this relationship became positive for all countries after the crisis, except United Kingdom. The finding also indicates that the exchange rate movements contain some significant information to forecast the stock returns of these markets.

JEL: C3, F4,G1

KEYWORDS: Stock Price, Exchange Rate, Global Financial Crisis, Multivariate Granger Causality Tests

INTRODUCTION

A strong linkage between exchange rates and stock prices has become the focus of sustained research in the financial press. In retrospect of the literature, a number of hypotheses also suggest a causal relation between stock prices and exchange rates. For instance, flow oriented model of exchange rates (Ajayi & Mougoue, 1996) confirm that currency fluctuation effects international competitiveness and the balance of trade position, which in turn effects current and future cash flows of corporation and its stock price. Besides, stock price movement also can influence exchange rate fluctuation. In the portfolio-balance approach, exchange rates just like all other commodities which are determined by market mechanism. A blooming stock market would attract cash flows from foreign investors and hence causes an increase in the demand of a country's currency and vice versa (Pan, et al., 2007). As a result, the rising (declining) stock price is related to an appreciation (depreciation) in exchange rate.

In this paper, we examine dynamic linkages between foreign exchange and stock markets in the major financial markets, including: Japan, United Kingdom, Hong Kong, China, India and Brazil. These countries are significantly different in terms of the size of each economy, degree of development, rate of growth, and maturity of financial markets. Regarding the maturity of financial markets, Japan, United Kingdom and Hong Kong are considered developed markets, whereas China, India and Brazil are considered to be emerging markets.

The recent global financial crisis had debilitating effects on the stock markets of the concerned countries and highlights the importance of the international spillover of financial shocks. Poshakwale (2004) estimate the spillover effects of the financial shocks on 17 EU countries and 9 emerging economies in Europe using a global vector autoregressive model. They find that stock market is a main channel of spreading financial shocks across countries in the short term. This is caused by a strong coupling of countries, stock markets.

Pan et al. (2007) also find that "when stock price plummeted, exchange rate soared in case of Korea, and the volatilities of these variables also increased sharply due to a sudden stop of capital" during the 2007-2009 global financial crisis.

Taking the above situations into account, this paper empirically examines the interaction between exchange rates and stock prices for the periods during and after the 2007-2009 global financial crisis, to explore the long-run and short-run causalities between these variables. The paper tries to answer the following questions. Whether the linkages between analyzed economic variables are of the similar intensity and direction in the developed and emerging markets? How has been the relationship changing over the analyzed period? By including more countries and updating the data, the paper intends to find disparities among those similar countries who suffered from the common shocks of the global financial crisis and to draw more useful policy implications.

The rest of the paper is organized as follows. Section 2 is a literature review. Section 3 explains data and methodological issues. Section 4 presents the empirical results. The final section summarizes the main findings and conclusion.

LITERATURE REVIEW

There has been a strand of literature written on the dynamics relationship between exchange rate and stock price. Frank and Young (1972) were one of the early pioneers to investigate the relationship between exchange rates and stock prices. Their study concluded that the two variables have no significant relation. Ajayi et al. (1998), Stavarek (2004), and Rahman and Uddin (2009) all support the empirical findings of Frank and Young (1972). Specifically, Ajayi et al. (1998) examined the causal relations between changes in exchange rate and stock return by using the data eight Asian emerging markets from December 1987 to September 1991. They find no consistent causal relations could be established for the emerging economies. Stavarek (2004) apply a Vector Error Correction model to investigate the relationship between exchange rate and stock returns for eight European countries and the United States between the years 1969-1992, he documents evidence that no evidence for the relationship between these variables for most of the years and countries involved. Similarly, Rahman and Uddin (2009) investigate the dynamic relationship between stock prices and exchange rates and find no causal relationship for Pakistan, India and Bangladesh.

Contrary to the above studies, Aggarwal (1981) examines the relation of the US Dollar and US Stock prices, and concludes that due to efficiency of stock market the stock adjust quickly to changes in the exchange rate. Using the standard regression analysis, Solnik (1987) also finds that changes in the exchange rate has effect on the stock price return. Additionally, Ma and Kao (1990) examine the correlation between stock prices as a function of exchange rate and report a negative correlation between stock price return and exchange rate. Other study by Qiao (1996) on three leading financial centers in Asia, finds a bi-directional causal relationship in Tokyo, unidirectional causality from exchange rate to Hong Kong stock price and no causal relationship in Singapore. Wu (2000) applies cointegration and error correction analyses, finds that appreciation in exchange rates has long term positive effects in the stock prices in Singapore. Alternatively, Desislava (2005) uses a two-stage least squares model and shows an increase in the exchange rate depresses the stock market for the United State and the United Kingdom. Last but not least, Phylaktis and Ravazzolo (2005) show that the lack of causal relationship between the stock market and exchange rate in a country might be due to the omission of an important variable from the system, which may invalidate the results of some of the previous studies.

The critical variable omitted from the system in previous studies is the US stock market, which can be represented the influence of world stock market. If it is the case, the inference about the long run relationship of variables and the causality structure are invalid in an incomplete system (Caporale & Pittis, 1997). An increase in the US stock index conveys information about an improved situation of the US economy and implies an increase in the US import and other countries' export since there are very strong trade links between the US and other economies. That leads to an appreciation of countries' currencies and a rise in their exchange rate, and on the other side, an increase in the domestic economic activities cause the local stock market to rise. Based on this argument, Kumar (2010) applies Granger causality models to examine the relationship in case of India and shows the evidence of bi-directional causality between exchange rate and stock price.

DATA AND METHODOLOGY

This study examines the interaction between stock prices and exchange rates for the periods before, during and after the 2007-2009 financial crisis. The data used are daily stock market indexes and exchange rate for 6 major financial markets including: 3 developed countries, namely Japan, United Kingdom and Hong Kong, and 3 emerging countries, namely China, India, andBrazil. The sample period runs from December 2007 to May 2013. All the stock index and exchange rate observations were obtained from the Yahoo finance and FX trade, respectively. The sample period is divided into two sub-periods – with period 1, from December 2007 to June 2009 representing the crisis period, and period 2, from July 2009 to May 2013 representing the after crisis period.

Cointegration

The relationship between domestic stock price and the exchange rate can be represented by:

$$SP_t = \alpha_0 + \alpha_1 EX_t + \alpha_2 US_t + v_t \qquad (1)$$

Where SP_t is the log of domestic stock index, US is the log of US stock index, both expressed in real terms, EX_t is the log of nominal exchange rate defined as domestic prices per US dollar and v_t is the random error. The US stock market, which has been taken to represent the world capital markets, has been included as a possible conduit through which the foreign exchange and the local stock markets are linked. In an explicit two country framework, we will expect the increase in the US stock prices to cause a similar chain of events and the dollar to appreciate i.e. a rise in the exchange rate. Thus, the overall effect on the exchange rate will depend on the relative strength of the various competing events and α_1 will be either positive or negative accordingly.

In implementing the tests for cointegration we use the likelihood ratio test due to Johansen (1988). Let $Y_t \equiv$ (SP, EX, US) where SP and US are the stock price indices in real terms in countries and the US, respectively, and EX the exchange rate for each countries versus the US. We have 3 variables in the system in which SP and EX as known as endogenous variables while as US is exogenous variables. If Y_t is cointegrated, it can be generated by a Vector Error Correction Model:

$$\Delta Y_t = \mu + \sum_{i=1}^{k-t} G_i \Delta Y_{t-i} + G_k Y_{t-1} + e_t \qquad (2)$$

where μ is a 2 × 1 vector of drift, G's are 2 × 3 matrices of parameters, and ε_t is a 2 × 1 white noise vector. The Johansen test is performed by calculating trace test statisticsof the null hypothesis that there are at most r cointegrating vectors $0 \leq r \leq 2$.

Multivariate Granger Causality Tests

Apart from the examination of the long-run co-movements of exchange rate and stock market index, we explore the long-run and short-run dynamics by performing Granger causality tests for cointegrating systems. We apply the methodology for multivariate Granger causality tests for cointegrating systems suggested by Dolado and Lutkepohl (1996). In which, weestimate Vector Error Correction Model (VEC) if there is a cointegrating relationship between exchange rate and stock price. Otherwise, we apply a first order differenced Vector Autoregressive Model (VAR) if variables are known to be I(1) with no cointegration.

The method of Dolado and Lutkepoh is performed directly on the least squares estimators to estimate the coefficient of the long run cointergrating vector in levels of the variables. The procedure is based on the argument that the non-standard asymptotic properties of the Wald test on the coefficients of cointegrated VAR systems are due to the singularity of the asymptotic distribution of the least square estimators. Once cointegration is established, the long-run cointergrating vector model for each country can be estimated as equation 1.

In the final step, we obtain the short-run dynamic parameters by estimating a vector error correction model associated with the long-run estimates as in equation 3 and 4. In the spirit of Engle & Granger (1987) and Okere & Iheanacho (2016), "the long run relationship between the variables indicates that there is Granger-causality in at least one direction which is determined by the F-statistic and the lagged error-correction term. The short-run causal effect and is represented by the F-statistic on the explanatory variables while the t-statistic on the coefficient of the lagged error correction term represents the long-run causal relationship". We estimate the error correction term using the residual from a cointegrating regression of SP_t and EX_t . The following regressions are used:

$$\Delta \mathrm{EX_t} = \alpha_0 + \sum_{i=1}^{n} \lambda_i \, \Delta SP_{t-i} + \sum_{i=1}^{n} \rho_i \, \Delta EX_{t-i} + \sum_{i=1}^{n} \varphi_i \, \Delta \mathrm{US}_{t-i} + \pi \mathrm{ECT_{t-1}} + e_{et} \tag{3}$$

$$\Delta \mathrm{SP_t} = \rho_0 + \sum_{i=1}^{n} \delta_i \Delta \, SP_{t-i} + \sum_{i=1}^{n} \theta_i \, \Delta EX_{t-i} + \sum_{i=1}^{n} \upsilon_i \, \Delta \mathrm{US}_{t-i} + \partial \mathrm{ECT_{t-1}} + e_{st} \tag{4}$$

Where ΔEX_t and ΔSP_t denote the first difference data, with ΔEX_t [$= EX_t - EX_{t-1}$] equal to log (EX_t/EX_{t-1}), while ΔSP_t equal to log (SP_t/SP_{t-1}), ΔUS_t equal to log (US_t/US_{t-1}). ECT_{t-1} is a lagged error correction term derived from the long-run cointegrating relationship. Here λ_i, δ_i ,ρ_i, and θ_i are the short run dynamic coefficients of the model's convergence to equilibrium and $\pi$and∂ are the speed of adjustment. The sign before π and ∂ or the sign of error correction term should be negative after estimation. The coefficient π and ∂ tell us at what rate it corrects the previous period disequilibrium of the system.

The null hypothesis that stock price does not Granger-cause exchange rate is rejected if the λ_i coefficients in Eq. (3) are jointly significantly different from zero using the joint test (e.g., an χ^2 test). Similarly, exchange rate is said to Granger-cause stock price if the δ_i coefficients in Eq. (4) are jointly different from zero. A bi-directional causality (or feedback) relation exists if both the ρ_i and θ_i coefficients are jointly different from zero. However, if the variables are not cointegrated we use VAR model in the first difference in the estimation given that both variable are I(1).

RESULTS

Unit Roots Test

The first procedure for any analysis involving time series data is to determine the stationary of each variable by checking for the unit roots. Before done this test, we transform all the time series data into natural logarithms values and plot variables together to examine time-series variables. The results show that these variables are trending and characteristics of non-stationary variables. To recheck this result, the Augmented Dickey-Fuller (ADF) test has been used to conduct the unit root test for the exchange rate and stock market index series of the six countries. According to our results, all variables are non-stationary at the level series but not in the first-difference series. Therefore, all the data can be described as an I(1) process, and hence the Granger causality test should be conducted on the first-difference data.

Cointegration Results

After testing for stationarity, we use the log of US stock market index as an exogenous variable, and apply Johansen cointegration test to find out the long-run cointegrating relationship between stock price and exchange rate. The lag structure is chosen by using Akaike Information Criterion (AIC) value for the unrestricted VAR model. Table 1 contains the Johansen cointegration test results by using smallest AIC values. The trade test for the presence of a long-run relationship between exchange rates and stock prices cannot be rejected at least at the 5 % level of significance for almost cases. Except for the case of China and Japan in the full period and post-crisis period, there is no evidence of a long-run relationship between exchange rates and stock prices.

Table 1: Multivariate Cointegration Test Between Exchange Rates and Stock Market Indexes

Country	*Johansen test statistics*				*LAG*	*AIC*
	Ho: r = 0		*Ho: r <=1*		*(3)*	*(4)*
	Trace Value	*P-value*	*Trace Value*	*P-value*		
Japan						
Dec 2007 –May 2013	11.609	0.177	0.231	0.267	3	- 21.486
Dec 2007 - June 2009	18.002**	0.021	4.042**	0.044	2	-12.457
July 2009 - May 2013	3.207	0.157	0.013	0.999	4	-12.596
United Kingdom						
Dec 2007 - May 2013	426.034***	0.000	2.326	0.127	5	-13.469
Dec 2007 - June 2009	252.432***	0.000	9.258***	0.002	4	-12.288
July 2009 - May 2013	237.032***	0.000	5.301**	0.021	3	-14.529
Hong Kong						
Dec 2007 - May 2013	49.893***	0.000	14.903***	0.000	5	-18.029
Dec 2007 - June 2009	48.757***	0.000	4.689**	0.030	5	-17.508
July 2009 - May 2013	22.862***	0.003	9.119***	0.002	3	-18.748
China						
Dec 2007 - May 2013	8.234	0.447	2.113	0.146	6	-15.565
Dec 2007 - June 2009	8.554	0.408	3.141*	0.076	1	-15.418
July 2009 - May 2013	9.133	0.353	0.076	0.782	6	-15.916
India						
Dec 2007 - May 2013	582.296***	0.000	0.023	0.880	6	-13.145
Dec 2007 - June 2009	444.262***	0.000	3.808*	0.051	3	-13.047
July 2009 - May 2013	309.499***	0.000	0.133	0.715	6	-13.838
Brazil						
Dec 2007 - May 2013	21.779***	0.005	4.262**	0.039	4	-11.053
Dec 2007 - June 2009	26.449***	0.001	10.626***	0.001	4	-9.854
July 2009 - May 2013	23.491***	0.003	0.591	0.442	3	-12.333

This table reports the results of the multivariate cointegration test between exchange rates and stock market indexes by using the likelihood ratio test of Johansen (1988). SP are the log of domestic stock index, US is the log of US stock index, both expressed in real terms. EX is the log of nominal exchange rate defined as domestic prices per US dollar. We have 3 variables in equation 1, where SP and EX as known as endogenous variables while as US is exogenous variables. $SP_t = \alpha_0 + \alpha_1 EX_t + \alpha_2 US_t + v_t$ *(1). The lag structure is chosen by using smallest Akaike Information Criterion (AIC) value for the unrestricted VAR model. *, **, *** indicate significance at the 10, 5, and 1 percent levels respectively.*

When two variables are cointegrated then Granger causality exists in at least one direction. Table 2 shows the long-run relationship between exchange rate and stock market index through the sample period. The results show that the exchange rate is negatively related to the domestic stock market for emerging countries but positively for developed countries, except United Kingdom. However, we find that these relationships become positive and significant for India (α_1= 0.386) and Brazil (α_1= 0.124) after the crisis period. The results are also provided that the US stock market index (α_2) is positively and significant related to the domestic stock markets in all cases which support evidence for the integration of these stock markets with US stock market.

Table 2: Long Run Cointegrating Vector Estimates

Country	Time Period	α_0	α_1	α_2
Japan	Dec 2007 - June 2009	7.629***	0.394**	0.379***
United Kingdom	Dec 2007 - May 2013	0.916***	-0.424***	0.884***
	Dec 2007 - June 2009	0.424***	-0.500***	0.943***
	July 2009 - May 2013	1.679***	-0.379***	0.797***
HongKong	Dec 2007 - May 2013	3.914*	0.948	0.892***
	Dec 2007 - June 2009	21.590***	10.495***	1.103***
	July 2009 - May 2013	14.452***	4.147***	0.449***
India	Dec 2007 - May 2013	-8.262***	-0.437***	1.019***
	Dec 2007 - June 2009	-4.965***	-0.005	0.837***
	July 2009 - May 2013	-8.363***	0.386***	1.053***
Brazil	Dec 2007 - May 2013	9.874***	-1.126***	0.199***
	Dec 2007 - June 2009	7.736***	-0.743	0.405***
	July 2009 - May 2013	6.386***	0.124***	0.516***

This table reports the results of long-run relationship between exchange rate and stock market index in the case that two variables are cointegrated. The least squares regressions of domestic stock price on exchange rate and US stock index is used: $SP_t = \alpha_0 + \alpha_1 EX_t + \alpha_2 US_t + v_t$ *(1) where SP is the log of domestic stock index, EX is the log of nominal exchange rate and US is the log of US stock index. *, **, *** indicate significance at the 10, 5, and 1 percent levels respectively.*

We then perform the test of excluding each of the variables from the cointegrating relationship. The Wald Test is used to test the null hypothesis that the individual elements of α is equal to zero. Table 3 shows that the restriction cannot be rejected for EX_t in case of Hong Kong for full period (Chi-square = 0.842), India and Brazil for the crisis period. It implies that the exchange rate is not participating in the cointegrating vector in these cases. For other cases, the restriction is rejected, which implies that these estimated coefficients of the accepted cointegrating vectors are statistically significant.

Table 3: Test of Exclusion Restrictions for EX and US from the Long Run Cointegrating Vector

Country	Time Period	*Ho: α_0 = 0*	*Ho: α_1 = 0*	*Ho: α_2 = 0*
Japan	Dec 2007 - June 2009	222.299***	5.560**	80.148***
United Kingdom	Dec 2007 - May 2013	589.187***	2,639.898***	39,095.140***
	Dec 2007 - June 2009	7.9187***	195.865***	2,433.595***
	July 2009 - May 2013	44.101***	362.826***	16,307.560***
Hong Kong	Dec 2007 - May 2013	3.602*	0.842	3,566.362***
	Dec 2007 - June 2009	16.721***	5.118***	1,182.949***
	July 2009 - May 2013	39.414***	3.873***	405.912***
India	Dec 2007 - May 2013	32,848.31***	4,705.254***	77,543.38***
	Dec 2007 - June 2009	872.093***	0.049	8,211.768***
	July 2009 - May 2013	17,645.830***	1,869.751***	20,154.770***
Brazil	Dec 2007 - May 2013	809.971***	425.927***	30.783***
	Dec 2007 - June 2009	271.876***	2.557	73.112***
	July 2009 - May 2013	184.218***	85.003***	109.301***

*This table shows the test of exclusion restrictions for EX and US from the Long Run Cointegrating Vector in Table 2. Chi-square statistic to test the null hypothesis that the individual elements of α is equal to zero. *, **, *** indicate significance at the 10, 5, and 1 percent levels respectively.*

In particular, on the case of Japan, Table 2 shows the long-run cointergrating parameter α_1 to be 0.394 and the test of excluding EX and US from the equation in Table 3 are rejected and the both statistically significant with $\chi^2(1)$ equal 5.560 and 80.148, respectively. That means 1% increase in Japanese Yen per US dollar leads to approximately 0.394 % increase in Tokyo stock exchange index for crisis period. Similarly, the coefficient of log US is 0.379 that means 1% increase in New York stock exchange leads to approximately 0.379 % increase in Tokyo stock exchange index in the same period.

Furthermore, the exchange rate is positive and significant relationship to Hong Kong stock exchange index for both crisis and post crisis period. However, this relationship is insignificant for full period, which shows the appearance the impact of the financial crisis in these results. In order to examine whether the global financial crisis from 2007 to 2009 has had impact on the long run relationship between exchange rate and stock market index, we rewrite equation 1 as the following:

$$SP_t = \alpha_0 + \alpha_1 EX_t + \alpha_2 US_t + \alpha_3 Crisis + \alpha_4 Crisis\ EX_t + \alpha_5 Crisis\ US_t + v_t \quad (5)$$

where all variables are as previously defined. Crisis here is a dummy variable, which equals to 1 for the crisis period from December 2007 to June 2009; 0 for post-crisis period from July 2009 to May 2013.

Table 4 reports the estimated coefficients of the crisis variable (α_3) which show that crisis has a positive and very significant impact on Hong Kong, India and Brazil stock market index. On the contrary, the crisis has a negative but also significant impact to London stock index. Importantly, the coefficient of *US* and the interaction terms *Crisis*US* in the case of United Kingdom is statistically significant at 1% level with a coefficient of 0.797 and 0.147, respectively. Economically, 1% increase in New York stock exchange leads to approximately 0.944% (0.797 + 0.147) increase in London stock index during crisis period but only 0.797 % increase in London stock index in post crisis period. This evidence indicates that the effect of US stock market on domestic stock market is more pronounced during crisis period.

Table 4: Effect of Global Financial Crisis on the Long Run Cointegrating Vector Estimates

Country	α_0	α_1	α_2	α_3	α_4	α_5
United Kingdom	1.679***	-0.379***	0.797***	-1.255***	-0.121	0.147***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)
Hong Kong	14.452***	4.147***	0.449***	7.138**	6.347**	0.655***
	(0.000)	(0.000)	(0.000)	(0.026)	(0.027)	(0.000)
India	-8.363***	-0.386***	1.053***	3.397***	-0.391***	-0.216***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Brazil	6.386***	-0.124	0.516***	1.350**	-0.867***	-0.111
	(0.000)	(0.126)	(0.000)	(0.040)	(0.000)	(0.102)

This table shows regression results based on equation (5). We estimates the effect of global financial crisis 2007-2009 on the long run relationship between exchange rate and stock market index by adding crisis variable and the interaction terms into Equation 1. $SP_t = \alpha_0 + \alpha_1 EX_t + \alpha_2 US_t + \alpha_3 Crisis + \alpha_4 Crisis\ EX_t + \alpha_5 Crisis\ US_t + v_t$ *(5) where Crisis is a dummy variable, which equals 1 if the time is from 01 December 2007 to 30 June 2009; 0 if otherwise. The P-values are displayed in parentheses. *, **, *** indicate significance at the 10, 5, and 1 percent levels respectively.*

Multivariate Granger Causality Tests

We examine the dynamics relationship between exchange rate and stock price by performing multivariate Granger causality tests. Table 5 shows the results of the short-run dynamic coefficients associated with the long-run relationships obtained from the equation 3 and 4. When the dependent variable is ΔSP, the results show that most of the exchange rate movements are significant predictors of domestic stock returns. Except for the case of Japan for crisis period and India, the results indicate that no short run relationships exist between exchange rate changes and stock returns. On the other hand, the domestic stock returns are highly responsive to US stock return at various lag in United Kingdom, Hong Kong and Brazil.

Beginning with the results for the long-run in other cases, the coefficient on the lagged error-correction term are significant at 5% or 1% level with the expected sign, which confirm the result of the Johansen test for cointegration. For instance, on the case of United Kingdom for post-crisis period, its value is estimated to -0.061 and significant at 1% level which implies that the speed of adjustment to equilibrium after a shock. Approximately 6.1 % of disequilibrium from the previous day's shock converges back to the long-run equilibrium in the current day.

Besides, when the dependent variable is ΔEX, The results show that stock returns are significant to predict exchange rate movements in Japan, United Kingdom, Hong Kong, India and Brazil for full period. In the case of United Kingdom and Brazil for full sample period, the ρ_i and θ_i coefficients are jointly different from zero. Thus, there is evidence that a bi-directional causality (or feedback) relation exists for stock returns and exchange rate movements for these countries. The results also show the channel through which US stock return and domestic exchange rate are linked, except for Hong Kong in crisis period.

Table 5: Multivariate Granger Causality Tests Between Exchange Rate Movements and Stock Returns Using VECM (to Be continued)

Country	$\Delta SP_t = \rho_0 + \sum_{i=1}^{n} \delta_i \Delta SP_{t-i} + \sum_{i=1}^{n} \theta_i \Delta EX_{t-i} + \sum_{i=1}^{n} \nu_i \Delta US_{t-i} + \partial ECT_{t-1} + e_{st}$ (3)			
	∂ Coefficient [t-statistics]	**Chi-sq (P value)**		**Granger Causality**
		Ho: θi=0	**Ho: υi=0**	
Japan				
03 Dec 2007 - 15 May 2013	-0.022*** [-3.589]	1.575 (0.455)	0.914 0.633	NO
United Kingdom				
03 Dec 2007 - 15 May 2013	-0.037* [-1.765]	19.067 (0.002)	158.365 (0.000)	YES
03 Dec 2007 - 30 June 2009	-0.029 [-0.656]	4.718 (0.318)	50.011 (0.000)	US YES
01 July 2009 - 15 May 2013	-0.061*** [-3.297]	14.322 (0.003)	56.207 (0.000)	YES
Hong Kong				
03 Dec 2007 - 15 May 2013	0.002 [0.735]	4.602 (0.466)	303.801 (0.000)	US YES
03 Dec 2007 - 30 June 2009	0.000 [-0.148]	4.984 (0.418)	0.007 (0.000)	US YES
01 July 2009 - 15 May 2013	0.000 [0.122]	4.191 (0.242)	392.414 (0.000)	US YES
India				
03 Dec 2007 - 15 May 2013	-0.031 [-1.341]	1.903 (0.928)	7.478 (0.279)	NO
03 Dec 2007 - 30 June 2009	-0.146 [-1.589]	0.997 (0.802)	3.533 (0.317)	NO
01 July 2009 - 15 May 2013	-0.005** [-2.098]	1.523 (0.958)	4.515 (0.607)	NO
Brazil				
03 Dec 2007 - 15 May 2013	-0.004*** [3.617]	15.258 (0.004)	5.130 (0.274)	EX YES
03 Dec 2007 - 30 June 2009	-0.012 [0.893]	13.388 (0.010)	0.880 (0.927)	EX YES
01 July 2009 - 15 May 2013	-0.016*** [-3.196]	1.059 (0.787)	15.354 (0.002)	US YES

*This table shows the results of the short-run dynamic coefficients associated with the long-run relationships between exchange rates and stock returns obtained from the equation 3 and equation 4. YES indicates significant causal relationship between exchange rate movement, domestic stock return and US stock return. NO indicates no significant causal relationship was found. US YES indicates significant causal relationship between US stock returns and dependent variable. The P-values are displayed in parentheses. T-statistics are in [ ], the critical t-statistics values are 1.645(10%), 1.960 (5%) and 2.576 (1%). *, **, *** indicate significance at the 10, 5, and 1 percent levels respectively.*

Table 5: Multivariate Granger Causality Tests Between Exchange Rate Movements and Stock Returns Using VECM (Continued)

Country	$\Delta EX_t = \alpha_0 + \sum_{i=1}^{n} \lambda_i \Delta SP_{t-i} + \sum_{i=1}^{n} \rho_i \Delta EX_{t-i} + \sum_{i=1}^{n} \varphi_i \Delta US_{t-i} + \pi ECT_{t-1} + e_{et}$ (4)			
	π Coefficient	**Chi-sq (P value)**		**Granger Causality**
	[t-statistics]	**Ho: λ_i=0**	**Ho: φ_i=0**	
Japan				
03 Dec 2007 - 15 May 2013	-0.007	6.085	49.148	YES
	[1.483]	(0.048)	0.000	
United Kingdom				
03 Dec 2007 - 15 May 2013	-0.003	25.016	89.664	YES
	[-0.395]	(0.000)	(0.000)	
03 Dec 2007 - 30 June 2009	-0.060***	10.046	24.222	YES
	[-3.723]	(0.040)	(0.000)	
01 July 2009 - 15 May 2013	0.002	19.494	94.864	YES
	[0.198]	(0.000)	(0.000)	
Hong Kong				
03 Dec 2007 - 15 May 2013	-0.0002***	2.338	22.438	US YES
	[-3.513]	(0.801)	(0.000)	
03 Dec 2007 - 30 June 2009	-0.00001**	4.743	5.625	NO
	[-2.223]	(0.448)	(0.344)	
01 July 2009 - 15 May 2013	-0.0001***	7.131	30.769	YES
	[-3.340]	(0.068)	(0.000)	
India				
03 Dec 2007 - 15 May 2013	-0.021**	18.696	54.536	YES
	[-2.344]	(0.005)	(0.000)	
03 Dec 2007 - 30 June 2009	0.010	10.800	24.419	YES
	[0.347]	(0.013)	(0.000)	
01 July 2009 - 15 May 2013	0.000	8.289	31.162	US YES
	[0.280]	(0.218)	(0.000)	
Brazil				
03 Dec 2007 - 15 May 2013	0.000	10.814	80.747	YES
	[0.507]	(0.029)	(0.000)	
03 Dec 2007 - 30 June 2009	-0.001	7.666	37.440	US YES
	[-0.763]	(0.105)	(0.000)	
01 July 2009 - 15 May 2013	-0.002	4.340	57.064	US YES
	[-0.759]	(0.227)	(0.000)	

*This table shows the results of the short-run dynamic coefficients associated with the long-run relationships between exchange rates and stock returns . YES indicates significant causal relationship between exchange rate movement, domestic stock return and US stock return. NO indicates no significant causal relationship was found. US YES indicates significant causal relationship between US stock returns and dependent variable. The P-values are displayed in parentheses. T-statistics are in [ ], the critical t-statistics values are 1.645(10%), 1.960 (5%) and 2.576 (1%). *, **, *** indicate significance at the 10, 5, and 1 percent levels respectively.*

Furthermore, the Johansen test results show no cointegrating relationship between exchange rate and stock market index in case of China and Japan for the full sample period and post crisis period. Thus we can't use VER model to examine the Granger causality between the variables. Instead, we use estimate the VAR model in the first difference level. The results are shown in Table 6 which suggests that there is no statistically casual relationship between exchange rate movements and stock market returns in these periods. However, there is unidirectional Granger causality between Shanghai Stock return and china exchange rate movement for the post crisis period. In addition, the results show that the Japanese Yen rate and Chinese Yuan Renminbi movements are highly responsive to US stock return, except for China in the post crisis period. It is interesting to note that US stock return also is significant Granger cause Shanghai stock return at 1% level, but no cause for Tokyo stock return.

Table 6: Multivariate Granger Causality Tests Between Exchange Rate Movements and Stock Returns using VAR

Country	Equation 6			Equation 7			
	Chi-sq (P value)		Granger Causality	Chi-sq (P value)		Granger Causality	Lag
	Ho: θ_i=0	Ho: υ_i=0		Ho: λ_i=0	Ho: φ_i=0		
Japan							
Dec 2007 - May 2013	0.050	0.067	NO	2.653	25.220***	US YES	1
	(0.823)	(0.795)		(0.103)	(0.000)		
July 2009 - May 2013	0.253	0.044	NO	0.741	5.648***	US YES	1
	(0.615)	(0.834)		(0.389)	(0.018)		
China							
Dec 2007 - May 2013	5.126	26.948***	US YES	4.010	18.033***	US YES	6
	(0.528)	(0.000)		(0.675)	(0.006)		
Dec 2007 - June 2009	0.515	11.481***	US YES	0.380	4.141**	US YES	1
	(0.473)	(0.001)		(0.538)	(0.042)		
July 2009 - May 2013	0.003	33.547***	US YES	6.294***	0.775	SP YES	6
	(0.957)	(0.000)		(0.012)	(0.379)		

This table shows the multivariate Granger Causality tests between exchange rate movements (ΔEX) and stock returns (ΔSP) using VAR in the case that Johansen test results show no cointegrating relationship as the equations:

$$\Delta SP_t = \rho_0 + \sum_{i=1}^{n} \delta_i \Delta SP_{t-i} + \sum_{i=1}^{n} \theta_i \Delta EX_{t-i} + \sum_{i=1}^{n} \nu_i \Delta US_{t-i} + e_{st} \quad (6)$$

$$\Delta EX_t = \alpha_0 + \sum_{i=1}^{n} \lambda_i \Delta SP_{t-i} + \sum_{i=1}^{n} \rho_i \Delta EX_{t-i} + \sum_{i=1}^{n} \varphi_i \Delta US_{t-i} + e_{et} \quad (7)$$

*NO indicates no significant causal relationship was found. US YES indicates significant causal relationship between US stock returns and dependent variable. SP YES indicates significant causal relationship between domestic stock return and exchange rate movement. The lag structure is chosen by using smallest Akaike Information Criterion (AIC). The P-values are displayed in parentheses. *, **, *** indicate significance at the 10, 5, and 1 percent levels respectively.*

CONCLUDING COMMENTS

This paper explores the long run and short run dynamics between exchange rate and stock market index in the main stock exchanges over the world for six countries, including Japan, United Kingdom, Hong Kong, China, India and Brazil. Our main concerns are to examine whether these links were affected by the existence of US stock exchange controls, and by the 2007-2009 global financial crisis. The following conclusions have been derived from our analysis. Firstly, our analysis provides evidence that the New York stock index is an important causing (exogenous) variable. The result is also found that the US stock market index is positively and significant related to the domestic stock prices. It acts as a conduit to link the world financial market and local stock markets and confirms the influence of the United State in these countries. This finding casts doubts on the inference of previous studies on the link between exchange rate and stock price, which did not include the influence of the US stock markets.

Secondly, Johansen cointegration test shows that there exists a long run relationship between exchange rate and stock market index. In which, the exchange rate is negatively related to the stock market for emerging countries but positively for developed countries, except United Kingdom. At the same time, the results are provided that the US stock market index is positively and significant related to these local stock markets. Besides, the global financial crisis 2007-2009 has been found to be an important determinant of the link between the domestic stock and foreign exchange markets. We also find that the crisis has a positive and very significant impact to Hong Kong, India and Brazil stock market index, but negative impact to London stock index.

Thirdly, the results of Multivariate causality tests indicate that on the whole, most of the exchange rate movements are significant predictors of domestic stock returns. Except for the case of Japan for crisis period, India and China the results indicate that no short run relationships exist between exchange rate changes and stock returns. On other hand, the stock returns are also significant to predict exchange rate movements in Japan, Hong Kong and India. In the case of United Kingdom and Brazil for full sample period, there is evidence that a bi-directional causality (or feedback) relation exists for stock returns and exchange rate movements. Accordingly, financial managers can obtain more insights in the management of their portfolio affected by these variables (stock market index, exchange rate and US stock index). This should be particularly important to local as well as foreigner investors for diversifying and hedging their portfolio.

Finally, the paper data are drawn from only 6 major financial markets, thus the generalization of this sample for advanced markets and emerging markets is restricted. Besides, one limitation of database research is that the validity of the finding by explaining the results may not be fully reflected the nature of the economic relationship. For instance, unlike developing countries, most developed countries adopt a freely floating exchange rate system and have less capital controls. Therefore, it is reasonable to expect that exchange rates are more fully response to stock market movements in developed countries than developing ones. Similarly, capital controls may weaken the dynamic linkages between exchange rates and equity markets. Thus an interesting avenue of further research is to check in more detail about each country policies and their influence on the relationship between stock and foreign exchange markets.

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