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On the Relationship between Exchange Rates and Stock Prices: Evidence from Emerging Markets

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Abstract

This study examines dynamic linkages between the exchange rates and stock prices for twelve emerging market countries for the period from May 1994 to April 2010 by using linear and non-linear Granger causality tests. Our empirical results show that stock prices and exchange rates have linear and non-linear bi-directional causality in most cases. The exceptional countries are Brazil, Poland and Taiwan that there is no evidence for a non-linear Granger causality from stock prices to exchange rates. The results support both the portfolio balance and the goods market theories for eight out of twelve countries.

Keywords: Exchange rate, stock prices, emerging markets, non-linear Granger causality, linear Granger causality, dynamic linkages.
JEL Classification Codes: F30, G15.

I. Introduction

The relations between exchange rate and stock prices have been subjected to extensive research. A number of hypotheses support the existence of a causal relation between stock prices and exchange rates. The extant literature establishes two channels of linkages between exchange rate and stock prices. The first one is the goods market channel (e.g., Dornbusch & Fischer, 1980) which argues that changes in exchange rates affect the competitiveness of multinational firms and consequently their earnings and stock prices. Depreciation of the local currency makes exporting goods cheaper and may lead to an increase in foreign demand and sales. Conversely, when the local currency appreciates, foreign demand of an exporting firm's products shrinks so the firm's profit will decrease and so does its stock price. The opposite case holds for importers. In addition, exchange rate movements affect the values of a firm's outstanding payables and receivables denominated in foreign currencies. The impact of exchange rate fluctuations on stock prices depends on both the weight of a country's international

trade and the degree of the trade imbalance (Pan et al., 2007). According to this argument, we expect a causal effect from exchange rates to stock prices.

The second link is the asset market channel or portfolio balance approach. This theory puts forward that stock price variations can influence exchange rate movements. Based on the portfolio balance approach, exchange rates are determined by market mechanism. An expected increase in stock prices due to economic growth prospects would attract capital from foreign investors and hence causes an increase in the demand for the country's currency and vice versa. Consequently, rising (declining) stock prices are linked to an appreciation (depreciation) in the local currency. On the other hand, movements in stock prices may pressure exchange rates since investors' wealth and money demand may depend on the performance of the stock market (e.g., Gavin (1989)). For example, during the time of a financial crisis, like Russian government bond default in 1998 or Turkish currency crisis in 2001, a sudden disruption of asset demands may result because of the herding behaviour of investors or the loss of confidence in economic and political stability. According to this argument, stock price movements cause exchange rate movements.

Although the theoretical literature suggests causal relations between stock prices and exchange rates, empirical evidence is rather weak. The literature about the relationship between stock markets and exchange rate, mostly, for industrialised countries has found mixed evidence of the impact of exchange rate on stock returns. There are studies (Jorion, 1990, 1991; Amihud, 1994; Bartov and Bodnar, 1994; Bernard and Galati, 2000; Griffin and Stulz, 2001) that have found no impact of exchange rates on firm's investment decisions, while there are some studies (Chow *et al.*, 1997; Choi *et al.*, 1998; De Santis and Gerard, 1998; Doukas *et al.*, 1999; Patro *et al.*, 2002) that have found that stock returns are significantly affected by exchange rate fluctuations. For developing countries, there are only a few studies that have examined the impact of exchange rate fluctuations on stock returns. Fang and Miller (2002) used a GARCH-M model to examine the impact of depreciation on stock returns for five East Asian countries, namely, Hong Kong, South Korea, Singapore, Taiwan, and Thailand, during the Asian financial crisis. They found that domestic currency depreciation and its uncertainty adversely affected stock market returns. Wu (2005) used an EGARCH-X model to examine the relationship between stock returns and exchange rates for a group of seven developed and developing countries. The developing countries that he considered were Indonesia, the Philippines, and Thailand. He found strong evidence of a two-way relationship between stock market volatility and exchange rate changes. Aquino (2005) examined whether Philippines' stock market returns were affected by exchange rate depreciation in the post-Asian financial crisis period. Using a two-factor arbitrage pricing theory model, he found statistically strong evidence that depreciation reduced stock returns. Karmakar (2006) examined the volatility of daily returns in the Indian stock market using the GARCH and TARCH models and found evidence for asymmetric volatility.

In this study, we examine dynamic linkages between exchange rates and stock prices in emerging market countries. These economies are significantly different in terms of size, stage of development, growth, and maturity of financial markets. There are also differences in terms of capital market liberalization and capital control.

The paper is motivated by several reasons. First, prior studies primarily focus on industrialized countries, with less attention paid to non-industrial economies, especially emerging markets. The newly industrialized economies included in our study follow trade-led approach to stimulate their economic growth. Second, unlike developed countries, most developing countries do not adopt a freely floating exchange rate system and have more capital controls. Some of the economies included in our study follow freely floating exchange rate arrangement. Some have capital controls, which might weaken dynamic linkages between foreign exchange and equity markets. Furthermore, the lack of a significant result from examining well-developed countries could be due to the fact that these countries' firms can reduce exchange rate risk by hedging since hedging instruments are more readily available in these countries. Thus, examining the emerging market economies enables us to check the impact of the degree of financial market liberalization and exchange rate arrangement on the linkages between the foreign exchange rates and equity markets. Finally, we use daily data. Because, Griffin, Nardari, and

Stulz (2004) find that equity flows toward a country are mainly driven by the previous day's return in that country's equity market. Thus, it is better to measure interactions between exchange rates and stock prices using higher frequency data rather than low frequency data.

Our empirical results show significant bi-directional causal relations between exchange rates and stock prices for most of the countries. The results are robust when we use non-linear Granger causality tests.

The rest of the paper is organized as follows: The second and third sections describe the testing methods used, i.e., linear and non-linear Granger causality tests. The forth section presents data and empirical results. The fifth section concludes the paper.

II. Methodology for Testing Linear Granger Causality

Granger (1969) first defined causality between two stationary series. A time series Y_t Granger-causes another time series X_t if series X_t can be predicted better by including past values of Y_t than by using only the historical values of X_t. In other words, Y_t does not Granger-cause X_t if

$$\Pr\left(X_{t+m}|X_{t-k}\right) = \Pr\left(X_{t+m}|X_{t-k},Y_{t-k}\right) \tag{1}$$

where Pr( ) denotes conditional probability, $X_{t-k} \equiv \left(X_t,X_{t-1},....,X_{t-k}\right)$, and $X_{t-k} \equiv \left(X_t,X_{t-1},....,X_{t-k}\right)$. Suppose that X_t and Y_t are exchange rate and stock price indices, respectively. Testing for causal relation between two series can be based on the following bivariate autoregression:

$$X_t = \alpha_0 + \sum_{k=1}^{n} \alpha_k X_{t-k+} + \sum_{k=1}^{n} \beta_k Y_{t-k+} + \varepsilon_{x,t} \tag{2.1}$$

$$Y_t = \varphi_0 + \sum_{k=1}^{n} \varphi_k X_{t-k+} + \sum_{k=1}^{n} \theta_k \Delta Y_{t-k+} + \varepsilon_{y,t} \tag{2.2}$$

where α_0 and φ_0 are constants, α_k, β_k, φ_k, and θ_k are parameters, and $\varepsilon_{x,t}$ and $\varepsilon_{y,t}$ are uncorrelated disturbance terms with zero means and finite variances. The null hypothesis that Y_t does not Granger-cause X_t is rejected if the β_k coefficients for $k = 1,2, \dots , n$ in equation (2.1) are jointly significantly different from zero using a standard joint test (e.g., an F test). Similarly, in equation (2.2), if X_t Granger-causes Y_t, the φ_k coefficients for $k = 1,2, \dots , n$ will jointly be different from zero. A bi-directional causality (or feedback) relation exists if both the β_k and φ_k coefficients are jointly different from zero. Using this test, within the framework of a vector autoregression (VAR) model, we will examine the causal relations between exchange rates and stock prices.

III. Methodology for Testing Non-Linear Granger Causality

The problem of linear approach to causality testing is that such tests can have low power detecting certain kinds of non-linear causal relations. The interest in uncovering non-linear casual relationships started with Baek and Brock (1992) who proposed a non-parametric statistical method for uncovering these relationships. Their approach uses the correlation integral, an estimator of spatial probabilities across time, to detect relations between time series. Using their model, non-linear casual relations have been found between money and income (Baek and Brock, 1992), aggregate stock returns and macroeconomic factors (Hiemstra and Jones, 1993), and producer and consumer price indices (Jaditz et al., 1993).

Hiemstra and Jones (1994) modify Baek and Brock's test to allow the variables to which the test is applied to exhibit short-term temporal dependence, rather than the Baek and Brock assumption that the variables are mutually independent and identically distributed.

Consider two stationary time series $\{X_t\}$ and $\{Y_t\}$, $t = 1,2,\dots,T$. Denote the m-length lead vector of X_t by X_t^m, and the Lx-length and Ly-length lag vectors of X_t and Y_t, respectively, by

X_{t-Lx}^{Lx} and Y_{t-Ly}^{Ly}. For given values of m, L_x and $Ly \geq 1$ and for $e > 0$, Y does not strictly Granger cause X if:

$$Pr\left(X_t^m - X_s^m < e \mid X_{t-Lx}^{Lx} - X_{s-Lx}^{Lx} < e, Y_{t-Ly}^{Ly} - Y_{s-Ly}^{Ly} < e\right) = Pr\left(X_t^m - X_s^m < e \mid X_{t-Lx}^{Lx} - X_{s-Lx}^{Lx} < e\right) \quad (3)$$

where Pr( )denotes probability and ‖ ‖ denotes the maximum norm. The probability on the LHS of equation (3) is the conditional probability that two arbitrary m-length lead vectors of $\{X_t\}$ within a distance e of each other, given that the corresponding L_x-length lag vectors of $\{X_t\}$ and L_y-length lag vectors of $\{Y_t\}$ are within e of each other. The probability on the RHS of equation (3) is the conditional probability that two arbitrary m-length lead vectors of $\{X_t\}$ are within a distance e of each other given that their corresponding L_x-length lag vectors are within a distance e of each other. A test based on equation (3) can be implemented as follows:

$$\frac{C_1(m+Lx, Ly, e)}{C_2(Lx, Ly, e)} = \frac{C_3(m+Lx, e)}{C_4(Lx, e)} \quad (4)$$

where C_1, C_2, C_3, and C_4 are the correlation-integral estimators of the joint probabilities which are discussed in detail by Hiemstra and Jones (1994). For given values of m, Lx and $Ly \geq 1$ and for $e > 0$ under the assumption that $\{X_t\}$ and $\{Y_t\}$ are strictly stationary and weakly dependent, if $\{Y_t\}$ does not strictly Granger cause $\{X_t\}$ then,

$$\sqrt{n}\left[\frac{C_1(m+Lx, Ly, e, n)}{C_2(Lx, Ly, e, n)} - \frac{C_3(m+Lx, e, n)}{C_4(Lx, e, n)}\right] \rightarrow N(0, \sigma^2(m, Lx, Ly, e)) \quad (5)$$

where $\sigma^2(m, Lx, Ly, e)$ is variance and an estimator discussed in detail by Hiemstra and Jones (1994).

IV. Data and Empirical Results
The sample includes daily stock market indices (measured in the US dollar) and exchange rates (expressed in local currency per U.S. dollar) of twelve emerging market countries, namely Brazil, India, Indonesia, Korea, Mexico, Philippines, Poland, Russia, Singapore, Taiwan, Thailand and Turkey from. We use Morgan Stanley Capital International (MSCI) market indices. The date covers the period from May 31, 1994 to April 7, 2010. However, the data for Mexico and Russia are available only from May 31 1996. We obtain the exchange rates and stock price indices from Data Stream. The data before 1994 were not included in the study for two reasons. First, most of the Asian countries abandoned the controlled floating exchange rate arrangements in the late 1980's. Second, some countries have currency crisis before 1994. We did not eliminate the Asian currency crisis period. All data series have been taken in natural logarithms.

Empirical Results

A. Linear Granger Causality Tests
In this section, we examine the linear Granger causality between stock prices and exchange rates. Linear Granger causality test requires that the series involved are stationary; otherwise the inference from the *F*-statistic might be spurious because the test statistics will have nonstandard distributions. We take natural logarithms of all series. First, we use the Augmented Dickey-Fuller unit root test of Said and Dickey to check stationarity for the stock market index series. We use Akaike Information Criteria to choose the optimum lag length. We start from the maximum 24 lags and stop at the lag value where *t*-statistic is significant. The results of the unit root tests are displayed in Table 1. As Table 1 indicates, the level series exhibit unit roots, but not in the first differences. Therefore, we conclude that each level series follows an *I*(1) process.

Table 1: ADF tests for random walk in twelve emerging market countries exchange rates and stock price indices denominated in the US dollar.

Country	Variable	Based on Level Series ADF with intercept and trend : τ_t	Lags	Variable	Based on First Difference ADF with intercept and trend : τ_t	Lags
Turkey	E	0.63	6	ΔE	-27.67**	5
	S	-2.48	1	ΔS	61.36**	0
Thailand	E	-1.23	1	ΔE	-70.0**	0
	S	-1.3	0	ΔS	-56.0**	0
Brazil	E	-1.11	3	ΔE	-35.7**	2
	S	-1.57	1	ΔS	-57.3**	0
India	E	-1.34	0	ΔE	-63.5**	0
	S	-1.89	1	ΔS	-57.9**	0
Indonesia	E	-2.08	33	ΔE	-10.5**	30
	S	-1.53	29	ΔS	-10.3**	35
Korea	E	-2.23	30	ΔE	-9.6**	30
	S	-2.23	44	ΔS	-10.3**	30
Mexico	E	-2.85	30	ΔE	-13.3**	19
	S	-2.11	4	ΔS	-27**	4
Philippines	E	-0.66	28	ΔE	-11.22**	18
	S	-1.14	28	ΔS	-12**	17
Poland	E	-1.93	16	ΔE	-14**	15
	S	-2.15	10	ΔS	-19**	9
Russia	E	-1.73	23	ΔE	-10.9**	22
	S	-1.95	18	ΔS	-13.5**	17
Singapore	E	-1.07	30	ΔE	-11.39**	10
	S	-1.83	17	ΔS	-13.85**	16
Taiwan	E	-1.85	24	ΔE	-11.27**	23
	S	-2.42	16	ΔS	-14.33**	15

This table reports the Augmented Dickey Fuller test for unit roots:

$$\Delta X_t = \alpha + \beta t + \rho_0 X_{t-1} + \sum_{i=1}^{k} \rho_i \Delta X_{t-i} + \varepsilon_t ..$$

E denotes the natural log of exchange rate, S denotes the natural log of stock market index. Δ=the difference operator (i.e., $\Delta X = X_t - X_{t-1}$). Lags reported are the numbers of lags that result in smallest Schwartz information criterion values. Critical values with trend (τ_t): -3.41 (5%) and -3.96 (1%) for ADF. * and ** denote rejections of the unit root hypothesis at 5 and 1% significance levels, respectively.

Next, we check the cointegration relation between the corresponding series since the appropriate formulation of a Granger causality analysis may need to incorporate an error correction term into the test if the variables are cointegrated. Granger (1969) indicates that causality tests might reach incorrect conclusions if they fail to include an error correction term. It is possible that they share a common stochastic trend (i.e., they are cointegrated), although all series individually contain a stochastic trend. Moreover, if two series are cointegrated, then an error correction term should be included in the bivariate autoregressions as follows:

$$\Delta X_t = \alpha_0 + \sum_{k=1}^{n} \alpha_k \Delta X_{t-k} + + \sum_{k=1}^{n} \beta_k \Delta Y_{t-k+} + \delta ECT_{t-1} + \varepsilon_{x,t} \tag{6.1}$$

$$\Delta Y_t = \varphi_0 + \sum_{k=1}^{n} \varphi_k \Delta X_{t-k} + + \sum_{k=1}^{n} \theta_k \Delta Y_{t-k+} + \varphi ECT_{t-1} + \varepsilon_{y,t} \tag{6.2}$$

where ECT_{t-1} is an error correction term derived from the long-run cointegrating relationship. The error correction term can be estimated by using the residuals from a cointegrating regression.

We apply Johansen's maximum likelihood method to examine whether or not exchange rates and corresponding country stock market indices are cointegrated. Table 2 reports the Johansen cointegration Trace test statistics. The results indicate that one sided test of the null hypothesis that the series are not cointegrated fails to reject for each pairwise indices, except for Brazil, Russia and Turkey at 1% level. As shown in Table 2, there is no cointegration vector for any of the other stock market indices with exchange rate. Therefore, we conclude not to include error correction term in the Granger causality test equations for those series. We include ECT only for Brazil, India, Russia and Turkey. The lack of cointegration, however, seems to be a common phenomenon for countries that use a managed floating system. Another possible explanation for no cointegration relation is due to the noise contained in daily data. Nevertheless, our finding of no long-run equilibrium relationship between these financial variables are mostly consistent with those of Bahmani-Oskooee and Sohrabian (1992) and Nieh and Lee (2001).

Table 2:   Multivariate cointegration test between exchange rates and stock price indices

Country	H_0	Trace	p-value	Lags
Turkey	$r = 0$	49	0.00***	1
	$r \leq 1$	7.8	0.36	
Thailand	$r = 0$	17	0.36	1
	$r \leq 1$	4.8	0.62	
Brazil	$r = 0$	40	0.00***	1
	$r \leq 1$	3	0.87	
India	$r = 0$	16	0.35	1
	$r \leq 1$	6	0.49	
Indonesia	$r = 0$	4.54	0.85	7
	$r \leq 1$	0.17	0.67	
Korea	$r = 0$	25.8	0.07	4
	$r \leq 1$	12.5	0.49	
Mexico	$r = 0$	18	0.3	1
	$r \leq 1$	5.69	0.5	
Philippines	$r = 0$	18.5	0.29	1
	$r \leq 1$	3.19	0.85	
Poland	$r = 0$	8.7	0.3	1
	$r \leq 1$	2.6	0.1	
Russia	$r = 0$	40	0.0***	5
	$r \leq 1$	5.3	0.5	
Singapore	$r = 0$	7.57	0.5	2
	$r \leq 1$	0.96	0.3	
Taiwan	$r = 0$	9.5	0.6	1
	$r \leq 1$	3.7	0.4	

The table reports the Johansen trace test statistic for cointegration. The trace statistic of the null hypothesis that there are at most r distinct cointegrating vectors is $-T\sum_{r+1}^{2}\log(1-\lambda_i)$, where T is the number of observations and λ's are the 2−r smallest squared correlations (or eigenvalues) of X_{t-1} with respect to X_t corrected for lagged differences. The *p*-values are interpolated from Osterwald-Lenum (1992) Table 1.1. Lags reported are the numbers of lags that result in the smallest Schwartz information criterion values. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

To test for linear Granger causality, we begin by estimating the bivariate VAR models in (2.1) and (2.2). The optimal lag length is chosen by Akaike information criteria (AIC) in the bivariate VAR

system. The pair wise linear Granger causality test results are given in Table 3. The results show that stock prices Granger cause exchange rates for seven countries, namely, Turkey, Thailand, Brazil, India, Indonesia, Philippines, Singapore at 1% significance level and for Poland at 10% significance level. Exchange rates Granger cause stock prices for ten countries, namely, Turkey, Thailand, Brazil, Indonesia, Korea, Mexico, Philippines, Poland, Singapore, Taiwan at 1% significance level. The overlaps in these lists indicate seven bi-directional causalities. For India, there is causality only from stock prices to exchange rate, and there is causality only from exchange rates to stock prices for Korea, Mexico, and Taiwan. Overall, the majority of the countries in the sample exhibit bidirectional causality between stock prices and exchange rates. Note also that the ECT included for the cointegrated series of Turkey, Brazil, India and Russia are not significant in either pair of estimation.

Table 3: Pairwise linear Granger causality tests between exchange rate changes (ΔE) and stock price returns (ΔS)

Country	Null hypothesis	*F*-value	ECT
Turkey	$\Delta S \not\Rightarrow \Delta E$	12.37[**]	-0.000332
	$\Delta E \not\Rightarrow \Delta S$	12.00[**]	-0.000126
Thailand	$\Delta S \not\Rightarrow \Delta E$	11[**]	
	$\Delta E \not\Rightarrow \Delta S$	6.6[**]	
Brazil	$\Delta S \not\Rightarrow \Delta E$	8.6[**]	-0.005
	$\Delta E \not\Rightarrow \Delta S$	130[**]	-0.0025
India	$\Delta S \not\Rightarrow \Delta E$	5.3[**]	0.00
	$\Delta E \not\Rightarrow \Delta S$	1.6	0.15
Indonesia	$\Delta S \not\Rightarrow \Delta E$	4.86[**]	
	$\Delta E \not\Rightarrow \Delta S$	3.60[**]	
Korea	$\Delta S \not\Rightarrow \Delta E$	0.4	
	$\Delta E \not\Rightarrow \Delta S$	0.00[**]	
Mexico	$\Delta S \not\Rightarrow \Delta E$	1.8	
	$\Delta E \not\Rightarrow \Delta S$	34[**]	
Philippines	$\Delta S \not\Rightarrow \Delta E$	8.5[**]	
	$\Delta E \not\Rightarrow \Delta S$	8.2[**]	
Poland	$\Delta S \not\Rightarrow \Delta E$	2.11	
	$\Delta E \not\Rightarrow \Delta S$	22[**]	
Russia	$\Delta S \not\Rightarrow \Delta E$	13.3[**]	-0.00246
	$\Delta E \not\Rightarrow \Delta S$	7.2[**]	-0.00017
Singapore	$\Delta S \not\Rightarrow \Delta E$	2.9[**]	
	$\Delta E \not\Rightarrow \Delta S$	14.9[**]	
Taiwan	$\Delta S \not\Rightarrow \Delta E$	1.7	
	$\Delta E \not\Rightarrow \Delta S$	12.3[**]	

Note: The symbol "$\not\Rightarrow$" implies does not Granger-cause. ΔS and ΔE are the first difference of logged stock price and exchange rates series, respectively. ECT is a lagged error correction term derived from the long-run cointegrating relationship. [*] and [**] denote rejections of the null hypothesis at 5%, and 1% significance levels, respectively.

B. Non-Linear Granger-Causality Tests

Granger (1969) argues that univariate and multivariate non-linear models represent the proper way to model a real world that is "almost certainly non-linear". Large stock price swings and abrupt changes in stock market volatility can only be properly modelled with non-linear models. Based on this idea, we apply the modified Baek and Brock test, fully developed in Hiemstra and Jones to the residuals extracted from the VAR model, so we can examine non-linear Granger causality dynamics. To implement the modified Baek and Brock test, the values for the lead length, *m*, the lag lengths, *Lx* and *Ly*, and the scale parameter, *e*, have to be selected. Unlike in linear causality tests, there are no methods

developed in the literature to select the optimal values for these variables. We follow the Monte Carlo evidence of Hiemstra and Jones (1993), and set the lead lag length at $m = 1$ and $Lx = Ly$ for all cases. Also, we set lag length as two which is determined by VAR model using *AIC* and a common scale parameter of $e = 1.0\sigma$ is used where $\sigma = 1$ denotes the standard deviation of the standardized series.

Table 4 presents the results of non-linear Granger causality tests for the residual series. There is strong evidence of non-linear bi-directional Granger causality between stock prices and exchange rates. Non-linear Granger causality test shows bi-directional causal relations between stock prices and exchange rates for nine of the countries (India, Indonesia, Korea, Mexico, Philippines, Russia, Singapore, Thailand and Turkey). For Brazil and Poland, there is a significant non-linear Granger causality from stock prices to exchange rate, but the reverse non-linear causality is not statistically significant. Taiwan exhibits no significant causal relations in either direction. Similar to the results of the linear analyses, the majority of the countries exhibit significant bi-directional causalities between stock prices and exchange rates. These analyses support both the goods market and portfolio balance hypotheses regarding the causal relations between stock prices and exchange rates.

Table 4: Pairwise non-linear Granger causality tests between exchange rate changes (ΔE) and stock price returns (ΔS)

Country	Null hypothesis	$Ly = Lx$	CS	t-value
Turkey	$\Delta S \not\Rightarrow \Delta E$	2	0.0136	5.07***
	$\Delta E \not\Rightarrow \Delta S$	2	0.0070	2.075*
Thailand	$\Delta S \not\Rightarrow \Delta E$	2	0.027	6.71***
	$\Delta E \not\Rightarrow \Delta S$	2	0.020	5.7***
Brazil	$\Delta S \not\Rightarrow \Delta E$	2	0.020	6.8***
	$\Delta E \not\Rightarrow \Delta S$	2	0.0001	0.018
India	$\Delta S \not\Rightarrow \Delta E$	2	0.020	5.22***
	$\Delta E \not\Rightarrow \Delta S$	2	0.010	4.2***
Indonesia	$\Delta S \not\Rightarrow \Delta E$	2	0.02	7.1***
	$\Delta E \not\Rightarrow \Delta S$	2	0.02`	6.48***
Korea	$\Delta S \not\Rightarrow \Delta E$	2	0.02	6.18***
	$\Delta E \not\Rightarrow \Delta S$	2	0.01	4.5***
Mexico	$\Delta S \not\Rightarrow \Delta E$	2	0.01	3.6***
	$\Delta E \not\Rightarrow \Delta S$	2	0.014	4.02***
Philippines	$\Delta S \not\Rightarrow \Delta E$	2	0.02	7.06***
	$\Delta E \not\Rightarrow \Delta S$	2	0.04	5.9***
Poland	$\Delta S \not\Rightarrow \Delta E$	2	0.01	4.0***
	$\Delta E \not\Rightarrow \Delta S$	2	0.005	1.25
Russia	$\Delta S \not\Rightarrow \Delta E$	2	0.009	4.23***
	$\Delta E \not\Rightarrow \Delta S$	2	0.013	4.74***
Singapore	$\Delta S \not\Rightarrow \Delta E$	2	0.03	7.2***
	$\Delta E \not\Rightarrow \Delta S$	2	0.025	5.7***
Taiwan	$\Delta S \not\Rightarrow \Delta E$	2	0.007	1.6
	$\Delta E \not\Rightarrow \Delta S$	2	-0.0006	-0.114

The symbol "$\not\Rightarrow$" implies does not Granger-cause. ΔS and ΔE are the first difference of logged stock price and exchange rates series, respectively. ECT is a lagged error correction term derived from the long-run cointegrating relationship. * and ** denote rejections of the null hypothesis at 5%, and 1% significance levels, respectively.

V. Conclusion

This paper analyses stock prices and exchange rates for linear and non-linear Granger causality relations for twelve emerging market countries. The results show, in most cases, significant bi-directional causality between stock prices and exchange rates. The majority of the countries exhibit significant bi-directional causality in both the linear and non-linear tests with some exceptions. Brazil and Poland have significant bi-directional causation in the linear test. However, stock market does not non-linear Granger cause the exchange rate in Brazil, Poland and Taiwan. Additionally, exchange rate does not linear Granger causes the stock market in India. Based on the high level of evidence of the considered countries series, we conclude that these tests provide strong evidence for both the portfolio balance theory and the goods market theory. We recommend further analysis to explain the cross-country differences in the econometrics results. We believe the differences result from differences in degrees of capital market liberalization, capital controls, and exchange rate systems across the countries. The issue is also important from the viewpoint of recent large cross-boarder movement of funds.

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