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The Dynamic Linkages between Exchange Rates and Stock Prices: Evidence from Emerging Markets

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Abstract

This paper investigates the dynamic relationship between stock prices and exchange rates for nine emerging markets using Autoregressive Distributed Lag (ARDL) and causality models from January 1998 to May 2014. The sample period subdivided in to two episodes to take in to account the interaction of these series during the tranquil and crisis periods. The findings indicates that the comovement between exchange rates and stock prices become stronger during the crises time, and the direction of causality originates from stock prices to exchange rates during the tranquil period; and from exchange rates to stock prices during crisis once. The result shows certain sensitivity to the level of stability in financial markets.

JEL classification numbers: C22, F31, G15
Keywords: stock prices, exchange rates, ARDL model, emerging markets

1 Introduction

The liberalization of stock markets, the relaxation of capital inflows barriers, developments in information technology and gradual abolition of foreign exchange control in emerging markets have increased the interest of academic researchers and policy makers to examine the dynamic linkage between stock prices and exchange rates. International investors are also interested in the presence (absence) of interdependence between these two markets to diversify their portfolio and thus build an efficient hedging strategy. There are two stands of classical theoretical approaches, namely stock-oriented and flow-oriented models suggesting the existence of comovements between exchange rates and stock prices. Flow-oriented models postulates that change in exchange rates

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have an effect on international competitiveness and trade balance, and then the real output of the country, which eventually affects the firms' current and future cash flows and stock values (Dornbush and Fisher, 1980). Accordingly, flow-oriented approach of exchange rates assumes a positive correlation between exchanges rates and stock prices with the propagation of causality originates from exchange rates. Empirical evidences in consistent with this theory includes Chiang et al., (2000), Wu (2000), Fang (2002), Wongbangpo and Sharma (2002) and Phylaktis and Ravazzolo (2005).

Conversely, the stock-oriented approach predicts that a shift in the stock price affects exchange rates through capital account; and this model can be categorized in to the monetary and portfolio balance models. Portfolio balance approach of exchange rates determination proposes the change in exchange rates like other commodities by the market forces. A boom in the stock markets results a shift in the portfolio from foreign assets to assets dominated in the domestic currency, implying a change in the currency demand and this will cause appreciation or depreciation of currency (Branson, 1983; Frankel, 1983). Furthermore, Equities, being part of wealth, the efficiency of the stock markets may alter the demand for money, which in turn affects interest rates and eventually causing appreciation or depreciation of exchange rates according to the monetary models (Gavin, 1989). Studies in favor of stock-oriented approach of exchange rates includes Soenen and Hennigar (1988), Aggarwal (1981), Kwona and Shinb (1999), Maysami and Koh (2000), and Tai (2007).

Although the theoretical models for the casual linkage between exchange rates and stock prices have been well stated, empirical evidence regarding the relationship is mixed and far from conclusive. For instance, the pioneer work of Franck and Young (1972) using six different exchange rates, did not find any causal linkage between exchange rates and stock prices. While, Aggarwal (1981) and Giovannini and Jorion (1987) examined the interaction of stock markets and foreign exchange using U.S. data and found a significant positive relationship. Similarly, Phylaktis and Ravazzolo (2005) investigated exchange rate and stock price dynamics of six Pacific Basin countries and reported a positively relation between these two markets. However, the study of Soenen and Hanniger (1988) from U.S. data documented a significant negative relationship; and Solnik (1987) and Chow et al. (1997) do not find a contemporaneous linkage between exchange rates and stock prices.

Several previous studies explore the short and long-run linkage between exchange rates and stock prices to better understanding the interaction between these two variables at different time horizon. Nevertheless, empirical findings between the two variables have been diverse. The work of Bahmani-Oskooee and Sohrabian (1992) was among the prior studies to analyze the short and long-run association between exchange rates and stock prices using cointegration and Granger causality test. In the long-run, one group of studies reported the existence of cointegration between exchange rates and stock prices (see Makurjee and Naka, 1995; Qiao, 1996; Ajayi and Mougoue, 1996) while, others could not provide evidence supporting long-run linkage between these two variables (see Bahmani-Oskooee and Sohrabian, 1992; Mansor, 2000; Nieh and Lee, 2001; Muhammad and Rasheed, 2003). Moreover, short-run causality test were employed by several studies to examine the direction and unexpected movements in the exchange rates and stock prices. One segment of studies provides empirical evidence of short-run causality runs from stock prices to exchange rates (see; Ajayi et al., 1998, Mansor, 2000Granger et al., 2000; Hatemi and Roca, 2005 and Lin, 2012) while, others reported causality running from exchange rates to stock prices (see Ibrahim, 2000; Abdalla and Murinde, 1997; Wu, 2000) and bi-directional causality between them (see Bahmani-Oskooee and Sohrabian, 1992; Hatemi and Roca, 2005; Pan et al., 2007). Recent studies such as, Lin (2012) analyze the dymanic linkage between exchange rates and stock prices in the Asian emerging markets (India, Indonesia, Taiwan, Korea, Philippines and Thailand) and reported the existence strong comovement between these two series during the crisis period. Andreou et al. (2013) reported a significant spillover between foreign exchange and stock markets for twelve emerging economies. Liang et al. (2013) also examine the foreign exchange and stock markets in ASEAN-5 countries (Indonesia, Philippines, Malaysia, Thailand and Singapore) using the panel Granger causality and DOLS approaches. They report the existence of both short and long-run impact form exchange rates to stock prices.

In an attempt to provide empirical evidences regarding the interactions between stock prices and exchange rates, this article contributes towards the existing literatures in the following ways. Firstly, despite the existence of greater interest to investigate the financial markets of emerging markets in recent time, a vast majority of these studies have focused on either individual market or specific regions (like Europe, Asia, Middle East and Latin America). As a result there has been very little work allowing for geographic linkages across markets. Therefore, it is of great interest to bridge this gap in the literature by examining a relatively broader set of emerging markets to provide impartial insight for the enquiry of the linkage between the exchange rates and stock prices. Thus, this paper extends the work of Lin (2012) and Haughton and Iglesias (2013) by examining the dynamic linkage between stock prices and exchange rates of nine emerging markets, including Brazil, Czech Republic, Hungary, Malaysia, Mexico, Poland, South Africa, Taiwan and Turkey, which is considered to be advanced emerging markets according to FTSE indices. Analyzing the stock and foreign exchange of these markets provides a more comprehensive notion about the relationship between these two markets.

Secondly, lack of stability in the financial markets and a crisis in an economy may change the nature of exchange rates and stock price relations. In an effort to consider the impact of financial crisis in the interaction between these variables, the sample period in this study (January 1998-May 2014) subdivided in to two episodes the tranquil and crisis periods.

Thirdly, in the case of a sharp deterioration in the value of the domestic currency due to market shock or speculative attack, the central bank might interfere in the market by increasing interest rates to attract foreign investors or to reduce capital outflow; thereby increasing foreign currency supply or sell foreign reserves to keep the currency stable. This intervention by the central banks may put pressure on exchange rates and stock prices relations. To consider this in the analysis, I follow Lin (2012) and Haughton and Iglesias (2013) approach by including two additional parameters i.e. foreign reserves and interest rates to capture the effect of central bank intervention in the stock price-exchange rate analysis.

Finally, economic crises, regime shifts, change in policy and institutional arrangements may result structural break in time series. If such structural changes not addressed in the model specification, the result possibly biased towards erroneous non-rejection of the non-stationary hypothesis. Traditional long-run relationship analysis such as the vector autoregressive (VAR) or the co-integration approaches are incapable to cope with data of structural breaks and integrals of different orders. As a result, this paper employed Autoregressive Distributed Lag (ARDL) or the bound test technique of Pesaran et al. (2001), which enables to handle structural break problems and to cope with data that have integration of different orders. Moreover, it mitigates the potentials problems related with uncertainty concerning the non-stationary problem in the traditional unit root tests.

This paper proceeds as follows. Section 2 explains the data and methodology issues. Then the results from empirical test of ARDL and the causal models presents in Section 3. Some concluding remarks are offer in Section 4.

2 Data and Methodology

2.1 Data Environment

The datasets used in this study are monthly nominal exchange rates relative to the U.S. dollar, stock price indexes, foreign reserves and overnight interest rates of nine emerging markets, namely Brazil, Czech Republic, Hungary, Malaysia, Mexico, Poland, South Africa, Taiwan and Turkey. The selection of these emerging markets is on the basis of their economic importance in the emerging world. According to FTSE indices these markets are considered to be advanced emerging markets. The sample period starts from January 1998 to May 2014. The dynamic linkage between stock prices and exchange rates are investigated for the full sample: January 1998 to May 2014 and two subsample periods: the tranquil periods, ranges from March 2001 to February 2008; and the crisis periods from March 2008 to December 2010 (i.e. the 2008 global financial crisis). These periods helps to examine whether or not transmission between exchange rates and stock prices behaves differently during the crisis period than the tranquil once. The values of all variables changed in to logarithm form. The data for stock prices, exchange rates, foreign reserves and overnight interest rates obtain from DataStream.

The stock price indexes used in this study are: BOVESPA share price index, for Brazil; PX-50 share price index, for Czech Republic; BUX stock exchange index, for Hungary; KUALA LUMPUR SE Composite index, for Malaysia; MXSE IPC Composite index, for Mexico; WARSAW stock exchange WIG index, for Poland; FTSE/JSE All Share Index, for South Africa; TWSE Index, for Taiwan and ISE-100 Index, for Turkey.

2.2 Unit Root Tests

Sometimes the data may exhibit structural breaks in the trend because of economic downturn or major changes in the policy, which in turn result a shift in level, trend or both. For such kind of series, the unit root tests with structural breaks tend to be more appropriate. Perron (1989) argue that the possibility of rejecting a unit root hypothesis diminishes when a structural breaks is overlooked and stationary option holds true. In an attempt to avoid a problem of spurious rejections and handle structural breaks in this paper, I employ Lagrange Multiplier (LM) unit root test, which was proposed by Lee and Strazicich (2003, 2004).

2.2.1 LM Unit Root Test with No Structural Break

Suppose that the data Y_t, t = 1, 2,…, T and the LM unit root test can be estimated using the following data generating process:

$$Y_t = \delta' Z_t + X_t,\ X_t = \phi X_{t-1} + \varepsilon_t,\ Z_t = \gamma_1 + \gamma_2 t \qquad \varepsilon_t \sim \text{iid}\,(0, \sigma^2) \tag{1}$$

Where Z_t contains exogenous variables and δ' is a vector of parameters. The null hypothesis of unit root described by $\phi = 1$. Schmidt and Phillips (1992) reports critical values of LM unit root test with no structural breaks.

2.2.2 LM Unit Root Test with Structural Break

Lee and Strazicich (2003, 2004) propose two types of LM tests as modified version of Schmidt and Phillips (1992) unit root test by including one or two structural breaks. Model A considers one-time or two-time breaks in the level and is said to be the "Crash" model. Model C allows a one-time or two time shift in the level and trend.
LM unit root test that allows a shift in the level can be written as follows:

$$Y_t = \delta' Z_t + X_t, \; X_t = \phi X_{t-1} + \varepsilon_t, \; Z_t = \gamma_1 + \gamma_2 t + \delta D_t \qquad (2)$$

Another model that contains a shift in the level and trend, takes the following form:

$$Y_t = \delta' Z_t + X_t, \; X_t = \phi X_{t-1} + \varepsilon_t, \; Z_t = \gamma_1 + \gamma_2 t + \delta D_t + \lambda DT_t \qquad (3)$$

Model A that contains two shifts in the level with two structural breaks can be shown as $Z_t = [1, t, D_{1t}, D_{2t}]'$, where, the dummy variables, $D_{jt} = 1$ for $t \geq T_{Bj} + 1$, $j = 1, 2$, and zero otherwise. Model C that contains two shifts in level and trend with two structural breaks depicted as $Z_t = [1, t, D_{1t}, D_{2t}, DT_{1t}, DT_{2t}]'$, where $DT_{jt} = t - T_{Bj}$ for $t \geq T_{Bj}$, $j = 1, 2$, and zero otherwise. T_B denotes the date of the structural break, $\delta' = (\delta 1, \delta 2, \delta 3)$.
In addition to the unit root test with no structural break, this paper employed LM unit root test that allows two-break in the level (Model A) and a shift in the level and trend (Model C). Critical values of LM unit root test with two structural breaks are tabulated in Lee and Strazicich (2003).
To select the lag length, I employed the general to specific approach; that was suggested by Hall (1994). As argued by Ng and Perron (1995) and Campbell and Perron (1991), this method generates test statistics that have better dimension than other alternative approaches

2.3 Bound Testing Approach

In order to investigate the dynamic linkage between exchange rates and stock prices of emerging countries, I adopt the autoregressive distributed lag (ARDL) cointegration approach, or bound testing method, that was proposed by Pesaran et al. (2001). ARDL cointegration approach has numerous benefits as relative to other cointegration estimation methods. The flexibility of ARDL model is appealing, it can be used regardless of whether underling variables are I(0) or I(1), but not I(2). Secondly, unlike other cointegration approaches, the ARDL technique are not sensitive to the size of sample, and is comfortably applied even under a small sample size. Thirdly, ARDL cointegration approach can distinguish explanatory and explained variables, and enables testing the existence of linkage between the underling variables. Furthermore, it has better statistical properties by providing unbiased estimates and valid t-statistics.
The ARDL model in the form of unrestricted error correction model (ECM) for stock-oriented and flow-oriented models (i.e. stock price and exchange rates as the dependent variables) can be expressed as follows:

$$\Delta EX_t = c_0 + \sum_{i=1}^{n} \phi_i \Delta EX_{t-i} + \sum_{i=0}^{n} \varpi_i \Delta SP_{t-i} + \sum_{i=0}^{n} \psi_i \Delta FR_{t-i} + \sum_{i=0}^{n} \varphi_i \Delta IR_{t-i} + \delta_1 EX_{t-1} + \delta_2 SP_{t-1} + \delta_3 FR_{t-1} + \delta_4 IR_{t-1} + u_{EXt} \quad (4)$$

$$\Delta SP_t = c_1 + \sum_{i=1}^{n} \eta_i \Delta SP_{t-i} + \sum_{i=0}^{n} \lambda_i \Delta EX_{t-i} + \sum_{i=0}^{n} \pi_i \Delta FR_{t-i} + \sum_{i=0}^{n} \sigma_i \Delta IR_{t-i} + \delta_5 SP_{t-1} + \delta_6 EX_{t-1} + \delta_7 FR_{t-1} + \delta_8 IR_{t-1} + u_{SPt} \quad (5)$$

Where Δ denotes the first difference operator; EX, SP, FR and IR are exchange rates, stock prices, foreign reserves and interest rates respectively. c_0 and c_1 are constants, t is the time trend variable, while u_t stands for error terms. The first part of equation (4) and (5) with δ_i (i = 1…8) denotes the long-run trend of the model; while the second element with ϕ_i, ϖ_i, ψ_i, φ_i, η_i, λ_i, π_i, σ_i signifies the short-run dynamics. In this study the structural lags length of the ARDL approach is determined by using minimum Schwarz Bayesian Criterion (SBC).

In order to explore the existence of a long-run linkage, the null hypothesis of no cointegration among variables in the model, i.e. Ho: δ_i (i = 1 ... 8) = 0, is test against the alternative hypothesis H1: δ_i (i = 1 ... 8) ≠0 using the Wald test (F-statistic). Pesaran et al. (2001) propose the upper and the lower bound of critical values for the F-statistic. The upper bound postulates that all the regressors are *I*(1); while the lower bound critical values supposes that all the regressors are *I*(0). If the F-statistic is above the upper critical value, the null hypothesis can be rejected. Conversely, if the calculated F-statistic is below the lower bound, the null hypothesis of no cointegration cannot be rejected. However, when the F-statistic falls between their particular bounds, inference would be inconclusive.

2.4 Causality Analysis

Causality analysis has been increasingly used to investigate the short-run causal linkage among the variables. In the absence of long-run cointegrating relationship between the variables, the causal short-run linkage between variables can be identified by using the standard Granger causality test. However, if the two series are cointegrated, a natural extension to estimate short-term relation is using the error correction model. Error correlation model can distinguish a short-run dynamics between the variables and may detect the origin of causation that cannot be identified by the standard Granger causality test. The standard Granger causality test to examine the direction of casual linkage between exchange rates and stock price can been done using the following equation:

$$\Delta EX_t = c_0 + \sum_{i=1}^{n} \varphi_i \Delta EX_{t-i} + \sum_{i=0}^{n} \rho_i \Delta SP_{t-i} + \varepsilon_t \quad (6)$$

$$\Delta SP_t = c_1 + \sum_{i=1}^{n} \alpha_i \Delta SP_{t-i} + \sum_{i=0}^{n} \beta_i \Delta EX_{t-i} + \varepsilon_t \quad (7)$$

Where Δ denotes the first difference operator; EX and SP are exchange rates and stock prices respectively. c_0 and c_1 are constants, t is the time trend variable, while ε_t stands for

serially uncorrelated error terms. The null hypothesis of SP does not Granger-cause EX rejected if ρ_i coefficients jointly in equation (6) different from zero using a standard test (the F-test). Likewise, EX Granger-cause SP if the β_i coefficients in equation (7) are different from zero. Moreover, bi-directional causal relationship exists when both ρ_i and β_i coefficients jointly different from zero.
The causality model in the form of error correction model of ARDL for stock prices and exchange rates series can be written as follows:

$$\Delta EX_t = c_0 + \sum_{i=1}^{n} \phi_i \Delta EX_{t-i} + \sum_{i=0}^{n} \varpi_i \Delta SP_{t-i} + \sum_{i=0}^{n} \psi_i \Delta FR_{t-i} + \sum_{i=0}^{n} \varphi_i \Delta IR_{t-i} + \mu ECT_{t-1} + \varepsilon_t \quad (8)$$

$$\Delta SP_t = c_1 + \sum_{i=1}^{n} \eta_i \Delta SP_{t-i} + \sum_{i=0}^{n} \lambda_i \Delta EX_{t-i} + \sum_{i=0}^{n} \pi_i \Delta FR_{t-i} + \sum_{i=0}^{n} \sigma_i \Delta IR_{t-i} + \tau ECT_{t-1} + \varepsilon_t \quad (9)$$

Where EX, SP, FR and IR refers to exchange rates, stock prices, foreign reserves and interest rates, respectively. Δ is the first difference in these variables. ECT_{t-1} refers to the error correction term generated from the long-run cointegrating and it measures the magnitude of past disequilibrium. While, ε_t stands for serially uncorrelated error terms. The coefficients, μ and τ of the ECT_{t-1}, denotes the deviation of the regressors from the previous period's equilibrium. The error correction model has additional feature which is overlooked by the standard Granger testing approach. In addition to testing the joint significance of the coefficient of the lagged explanatory variables, i.e. the explained variable response to the short-run shocks in the explanatory variable; error correction model tests the speed of adjustment of the explained variable to the lagged deviations from the long-run relationship by looking at the significance of the coefficient of the error-correction term μ and τ. The lags length of the error correction model of ARDL is determined by using minimum Schwarz Bayesian Criterion (SBC).

3 Empirical Results and Discussions

3.1 Summary Statistics

Table 1 reports summary statistics for different time periods: the full sample, March 2001 to February 2008 and March 2008 to December 2010. These periods encompass the full sample, tranquil and crisis periods respectively. In the sample period from March 2001 to February 2008, the average changes of exchange rates are negative in most sample countries as compared to the crisis period, which reveal that the currency depreciation in the tranquil time is higher than during the crises period. Conversely, the average monthly stock returns emerge as being positive and appreciation during this particular period. This period also characterized by less volatility of foreign exchange and stock return changes than the crisis time, so that lower investment risks. In most countries the average changes of interest rates remain negative for all sample periods, indicating the capital inflow to emerging markets diminishes their interest rates. Nevertheless, the volatility of the change in interest rate is higher during the crisis periods, implying that central banks use interest rates as a policy tool to control economic crisis.

Table 1: Summary statistics

	Brazil	Czech Republic	Hungary	Malaysia	Mexico	Poland	South Africa	Taiwan	Turkey
Panel A: Full sample									
Exchange rates									
Mean	0.0034	-0.0029	0.0003	-0.0013	0.0021	-0.0007	0.0038	-0.0005	0.0115
Std. Dev.	0.0626	0.0375	0.0419	0.0189	0.0294	0.0405	0.0491	0.0152	0.0482
Stock price									
Mean	0.0084	0.0041	0.0048	0.0060	0.0112	0.0064	0.0103	0.0005	0.0158
Std. Dev.	0.0879	0.0718	0.0806	0.0666	0.0658	0.0725	0.0506	0.0725	0.1280
Foreign reserves									
Mean	0.0098	0.0090	0.0077	0.0096	0.0117	0.0078	0.0110	0.0082	0.0084
Std. Dev.	0.0642	0.0345	0.0488	0.0359	0.0371	0.0367	0.0284	0.0131	0.0406
Interest rates									
Mean	-0.0060	-0.0249	-0.0103	-0.0043	-0.0084	-0.0111	-0.0054	-0.0157	-0.0100
Std. Dev.	0.0817	0.1712	0.1159	0.0780	0.0763	0.0443	0.0431	0.1363	0.2768
Panel B: March 2001 to February 2008									
Exchange rates									
Mean	-0.0022	-0.0097	-0.0060	-0.0020	0.0012	-0.0065	0.0002	-0.0005	0.0032
Std. Dev.	0.0559	0.0305	0.0306	0.0072	0.0184	0.0310	0.0532	0.0125	0.0493
Stock price									
Mean	0.0164	0.0147	0.0142	0.0077	0.0186	0.0133	0.0136	0.0046	0.0193
Std. Dev.	0.0736	0.0537	0.0589	0.0452	0.0510	0.0638	0.0415	0.0685	0.1173
Foreign reserves									
Mean	0.0201	0.0122	0.0034	0.0185	0.0104	0.0110	0.0179	0.0110	0.0148
Std. Dev.	0.0589	0.0336	0.0539	0.0307	0.0331	0.0364	0.0279	0.0141	0.0356
Interest rates									
Mean	-0.0035	-0.0040	-0.0049	0.0026	-0.0098	-0.0157	-0.0010	-0.0093	-0.0393
Std. Dev.	0.0442	0.1521	0.1340	0.0170	0.0844	0.0444	0.0433	0.0760	0.1777
Panel C: March 2008 to December 2010									
Exchange rates									
Mean	-0.0005	0.0036	0.0052	-0.0010	0.0042	0.0070	-0.0049	-0.0017	0.0067
Std. Dev.	0.0518	0.0533	0.0683	0.0220	0.0419	0.0620	0.0559	0.0190	0.0494
Stock price									
Mean	0.0025	-0.0072	-0.0028	0.0033	0.0084	-1.99E-0	0.0022	0.0018	0.0114
Std. Dev.	0.0840	0.1007	0.0971	0.0521	0.0719	0.0842	0.0528	0.0843	0.1030
Foreign reserves									
Mean	0.0118	0.0040	0.0216	-0.0047	0.0139	0.0074	0.0072	0.0093	-0.0004
Std. Dev.	0.0189	0.0356	0.0504	0.0450	0.0507	0.0511	0.0220	0.0130	0.0233
Interest rates									
Mean	-0.0014	-0.0655	-0.0139	-0.0074	-0.0142	-0.0125	-0.0203	-0.0631	-0.0253
Std. Dev.	0.0460	0.2060	0.0830	0.0690	0.0406	0.0398	0.0521	0.2914	0.0452

3.2 Unit Root Test

It is important to test the stationarity of the data before the estimation of ADRL or causality models to avoid the problem of spurious regression. Moreover, sometimes the data may shows a structural break in the trend due to economic downturn or major policy changes, which might result a change in level, a change in the trend or both. Thus, the unit root tests in light of structural breaks are more fitting for such kind of data. To address these issues this paper used LM unit root test (Lee and Strazicich 2003, 2004) to check the stationarity of the data.

The results of LM unit roots test for the three models are shown in Table 1. First, the least restrictive model, i.e. LM test with no structural break (Panel A) is estimated and the results suggest that with the exception of the null hypothesis for the exchange rates in Mexico, stock prices of Malaysia and interest rates for Brazil, Mexico and Taiwan, the result do not reject the null hypothesis in all series, indicating that most series are non-stationary. Then in an attempt to look at the effect of structural breaks in the data, LM unit root tests with two structural breaks in the level (Model A) and two structural breaks in the level and trend (Model C) conducted. Using the LM test for unit root with two structural breaks in the level (Model A), the unit root null hypothesis is rejected only for exchange rates of Mexico, stock prices of Malaysia and interest rates of Brazil and Mexico. While, Model C, that allows a shift in the level and trend, indicates that the null hypothesis of a unit root is rejected in the first-difference of all series. This implies that variables are integrated of different orders.

Unlike the commonly used co-integration test of Engle and Granger (1987) and Johansen and Juselius (1990), that requires the variables to be integrated of the same order, ARDL model or bound testing approach provides a compressive test for investigating a long-run linkage regardless of the order of variables.

3.3 Bound Test for Cointegration

Before conducting the bound test, LM test of autocorrelation and the recursive residuals stability tests of CUSUM and CUSUMSQ are performed. The result for the recursive residuals and serial correlation test reveals the absence of model specification problem.

The bound test results of various sample periods are presented in Table 3. The cointegration test for the full sample periods reveals that the null hypothesis of no co-integration between stock prices and exchange rates cannot be rejected for most sample countries.

Table 2: LM unit toot test

	Brazil	Czech Republic	Hungary	Malaysia	Mexico	Poland	South Africa	Taiwan	Turkey
Panel A: LM unit root test with no structural break									
Exchange rates									
S_t	-0.0197	-0.0280	-0.0312	-0.0696	-0.1093**	-0.0379	-0.0294	-0.0651	-0.0081
	(-1.3890)	(-1.5238)	(-1.5143)	(-2.2704)	(-3.3492)	(-1.6845)	(-1.7307)	(-2.2134)	(-0.9078)
Stock price									
S_t	-0.0341	-0.0196	-0.0354	-0.1313**	-0.0346	-0.0351	-0.0513	-0.0683	-0.0673
	(-1.8442)	(-1.3866)	(-2.0113)	(-3.6127)	(-1.8469)	(-1.8605)	(-2.4695)	(-2.4518)	(-2.5994)
Foreign reserves									
S_t	-0.0089	-0.0262	-0.0368	-0.0226	-0.0758	-0.0264	-0.0109	-0.0103	-0.0217
	(-0.9844)	(-1.6034)	(-1.9064)	(-2.1805)	(-2.6673)	(-1.4185)	(-1.6908)	(-1.4813)	(-1.5920)
Interest rates									
S_t	-0.1009**	-0.0240	-0.0552	-0.0367	-0.0671**	-0.0229	-0.0431	-0.0410*	-0.0836
	(-3.7237)	(-1.2915)	(-2.1230)	(-2.1507)	(-3.6278)	(-2.1037)	(-2.7864)	(-2.9330)	(-1.9456)
Panel B: LM unit root test with structural break (Model A)									
Exchange rates									
S_{t-1}	-0.0232	-0.0440	-0.0441	-0.0962	-0.1395*	-0.0626	-0.0355	-0.1076	-0.0102
	(-1.4999)	(-1.9481)	(-1.8237)	(-3.0956)	(-3.7945)	(-2.1615)	(-2.0014)	(-2.8870)	(-1.1166)
Stock price									
S_{t-1}	-0.0463	-0.0251	-0.0508	-0.1781**	-0.0443	-0.0460	-0.0610	-0.1053	-0.1078
	(-2.1629)	(-1.5608)	(-2.4187)	(-4.2534)	(-2.0934)	(-2.1265)	(-2.8480)	(-3.1025)	(-3.3076)
Foreign reserves									
S_{t-1}	-0.0110	-0.0522	-0.0669	-0.0282	-0.1050	-0.0464	-0.0126	-0.0138	-0.0270
	(-1.2364)	(-2.2674)	(-2.5773)	(-2.5694)	(-3.1358)	(-1.9576)	(-1.9523)	(-1.7728)	(-1.8507)
Interest rates									
S_{t-1}	-0.1376**	-0.0593	-0.0949	-0.0418	-0.0888**	-0.0288	-0.0551	-0.0478 (-	-0.1225
	(-4.5215)	(-2.0363)	(-3.1728)	(-2.2766)	(-4.3100)	(-2.4224)	(-3.2209)	3.2988)	(-2.5380)
Panel C: LM unit root test with structural break (Model C)									
Exchange rates									
S_{t-1}	-1.0705***	-1.1880***	-1.5389***	-0.6438**	-0.9655***	-1.0367***	-1.1737***	-0.8031***	-1.2548***
	(-14.7536)	(-9.3742)	(-8.3221)	(-5.5052)	(-13.2820)	(-8.4503)	(-7.4174)	(-5.9235)	(-8.2232)
Stock price									
S_{t-1}	-1.1093***	-0.9570***	-1.0790***	-0.9801***	-1.1552***	-1.0227***	-1.0404***	-1.0690***	-1.1080***
	(-10.9605)	(-13.1693)	(-11.3453)	(-6.6600)	(-7.7034)	(-14.0638)	(-6.3965)	(-8.0190)	(-15.3221)
Foreign reserves									
S_{t-1}	-0.9017***	-0.9957***	-1.0026***	-0.5838***	-1.1333***	-2.0582***	-0.6647**	-0.6325***	-1.1128***
	(-7.2215)	(-13.6891)	(-13.7832)	(-7.5351)	(-9.0953)	(-8.2976)	(-5.3691)	(-5.9610)	(-8.5879)
Interest rates									
S_{t-1}	-0.9563***	-1.4849***	-1.2805***	-0.8226***	-1.2073***	-0.6802***	-0.7885***	-0.9318***	-1.8707***
	(-6.9181)	(-12.2899)	(-8.1593)	(-7.5000)	(-7.8670)	(-5.9656)	(-6.9996)	(-7.7328)	(-10.4403)

Note: The numbers in parenthesis are LM *t*-statistics. Critical values of the LM unit root test with no structural breaks are reports by Schmidt and Phillips (1992) and critical values of LM test with two structural breaks of model A and C are tabulated in Lee and Strazicih (2003). *, **and *** indicates rejection of unit root hypothesis at 10%, 5% and 1% significance levels respectively.

This finding is in line with the conclusions of Mansor (2000), Nieh and Lee (2001), Muhammad and Rasheed (2003) and Lin (2012). However, long-run associations are found among the series when exchange rates are regressand in Taiwan and Turkey and stock prices in Poland. In an effort to consider the impact of financial crisis in the interaction between these variables, the bound test further classified in to two subsample periods: the tranquil period, starting from March 2001 to February 2008; and the crisis time, from March 2008 to December 2010. As shown in the Table 3; even though, the null hypothesis of no co-integration cannot be reject for most countries for the full sample period, the subsample test reveals interesting result. Long-run cointegrations among variables are found when exchange rates are regressand in Malaysia and stock prices in South Africa during both the tranquil and crisis periods. Moreover, it is also noteworthy to note the presences of comovement among variables when the regressions are normalized on exchange rates in Turkey during the tranquil time and in Brazil during the crisis periods. From the bound test it can be noted that the long-run linkage between exchange rates and stock prices is stronger in the crises time than during the tranquil period.

Table 3: The Results of Bound test

	Brazil	Czech Republic	Hungary	Malaysia	Mexico	Poland	South Africa	Taiwan	Turkey
Panel A: Full sample									
F(EX|SP, FR, IR)									
F-statistics	2.9669	1.9684	1.9209	2.3136	2.8887	3.6789	1.5249	4.5637*	4.8688*
F(SP| EX, FR, IR)									
F-statistics	2.7454	1.5239	0.5992	4.1641	3.6897	5.0470*	1.7933	3.3243	2.2231
Panel B: March 2001 to February 2008									
F(EX|SP, FR, IR)									
F-statistics	3.7072	1.7819	1.1029	7.4254*	2.7880	1.9792	0.6674	3.8082	6.4914*
F(SP| EX, FR, IR)									
F-statistics	3.3254	3.1107	0.6426	2.1078	1.7283	2.2221	4.4715*	3.8446	2.1523
Panel C: March 2008 to December 2010									
F(EX|SP, FR, IR)									
F-statistics	4.5133*	1.4033	1.9042	4.4214*	1.4105	1.3276	3.4590	2.6231	1.5450
F(SP| EX, FR, IR)									
F-statistics	2.5699	2.0215	2.0682	5.8541*	2.3698	3.1617	6.1864*	3.0424	4.1904

Note: Critical values are obtained from Pesaran et al. (2001); CI(iii), Case III: Unrestricted intercepts and no trend. The lower bound I(0) and upper bound I(1) for the F-test statistic at 5% significance levels are 3.23 and 4.35 respectively.
* denote the existence of cointegration at 5% significance levels.

3.4 Causality Analysis

This section examines the issue of causality to pinpoint the short-run causal relations between exchange rates and stock prices. Table 4 reports the causality test results for different sample periods based on the standard Granger causality approach and the error correlation model. The significance of the coefficient of lagged explanatory variable tasted by Wald χ^2 and the error correlation terms by the t-test. In the full sample period the test suggests a bi-directional causality between stock prices and exchange rates in Brazil and Poland. Moreover, a unidirectional Granger causality found from stock prices to exchanges rate in Taiwan and from exchange rates to stock prices in Mexico. Statistically significant and negative coefficient of ECT in Poland and Turkey implies the long-run causality (feedback effect) between stock prices and exchange rates. The result from testing of the direction of causality between exchange rates and stock price in the subsample provides interesting sights. The correlation between stock price and exchange rates is strong during the crisis period than the tranquil period. This finding is in line with the results obtained in the bound test. During the crisis period, bi-directional causal relation is found in Brazil, South Africa and Taiwan. There are also cases showing unidirectional short-run causality originate from exchange rates to stock prices in Mexico and Poland; and from stock prices to exchange rates in Malaysia and Taiwan.
The statistically significant coefficients of the ECM provide additional insight on the nexus of stock prices and exchange rates. For instance, the negative and significant error correlation coefficient in Brazil and South Africa during the crisis period implies approximately 82.45% of the divergences from the long-run equilibrium in Brazil and 138% of disequilibrium from long-run linkage in South Africa will be corrected in the subsequently month by the adjustments in the foreign exchanges. This shows that the

speeds of adjustment (convergence) are high and the corrections to the disequilibrium are done rapidly. While during the tranquil period, the error correlation coefficient suggests that adjustment of stock prices to its equilibrium value in the subsequently month will correct about 32.04%, 23.43% and 16.72% of the deviation from the long-run correlation in Turkey, Malaysia and South Africa, respectively. These findings suggests that the direction of causality runs more from exchange rates to stock prices during crisis period; and from stock prices to exchange rates during the tranquil once.

Table 4: Causality test

	Brazil	Czech Republic	Hungary	Malaysia	Mexico	Poland	South Africa	Taiwan	Turkey
Panel A: Full sample									
Granger F test									
Ex dnc SP	3.9962*	3.4934	2.3250	3.7710	12.7034*	4.7462*	0.6943	0.2940	0.0413
SP dnc Ex	4.0181*	0.0462	0.0041	0.5167	3.7674	9.1027*	1.3212	8.1064*	2.4351
Error correlation coefficient of equation									
EX	-	-	-	-	-	-0.0933*	-	0.1042*	-0.0282*
SP	-	-	-	-	-	-0.050	-	-0.0425	-0.0921*
FR	-	-	-	-	-	-0.0237*	-	-0.0037	-0.0317*
IR	-	-	-	-	-	0.0076	-	-0.0430*	-0.1233*
Panel B: March 2001 to February 2008									
Granger F test									
Ex dnc SP	4.6070*	3.7445	0.5859	0.6323	2.2721	0.5292	0.9141	0.0745*	0.1020
SP dnc Ex	10.0818*	0.6442	1.4992	0.5884	0.0272	3.8545*	0.0528	4.4252	8.7673*
Error correlation coefficient of equation									
EX	-	-	-	-0.0602	-	-	0.0188	-	-0.2244*
SP	-	-	-	-0.2343*	-	-	-0.1672*	-	-0.3204*
FR	-	-	-	-0.0355	-	-	-0.0413	-	-0.0056
IR	-	-	-	-0.0074	-	-	-0.1013*	-	0.0222
Panel C: March 2008 to December 2010									
Granger F test									
Ex dnc SP	6.7580*	0.9258	0.0163	1.9197	8.3978*	6.1413*	6.2653*	7.3330*	0.0298
SP dnc Ex	12.8365*	0.2456	1.4143	8.3438*	2.3675	1.0849	3.8077*	6.9374*	5.7377*
Error correlation coefficient of equation									
EX	-0.8245*	-	-	-0.6974	-	-	-1.3836*	-	-
SP	0.1105	-	-	-0.0535	-	-	-0.3292	-	-
FR	0.0164	-	-	0.1737*	-	-	-0.0408	-	-
IR	-0.0057	-	-	-0.0129*	-	-	-0.5391	-	-

Note: the dnc signifies does not cause
* denotes statistical significance at 5% levels.

The result from investigating emerging markets shows significant causal linkage between stock prices and exchange rates for most of sample countries; even so it not easy to identify which theory explains better this relationship. For instance, in Hungary and Czech Republic, there is no causal relationship between exchange rates and stock prices in the long and short-run and this finding is not totally in line with the premise that the link between exchange rates and stock prices may rises due to appreciation (depreciation) of currency or form the innovations in the stock price. However, the finding in other countries reveals at least partial causal relationship between these variables. In Mexico and Poland, exchange rates causes stock price movement in the crisis period. Moreover, the error correlation coefficient suggests that exchange rate adjustment in the subsequently month could correct disequilibrium from the long-run relationship. Thus, currency appreciation (depreciation) would cause stock price movement and this relationship is in accord with the flow-oriented theory that appreciation (depreciation) of currency would have an effect on international competitiveness and on the real output of the country and consequently trade balance position, which in turn affects the equity inflows (outflows) and hence the stock prices.

Conversely, the finding that stock prices cause exchange rates movement is in line with the portfolio balance theory. The causality test shows significant Granger causality runs from stock prices to exchange rates in Poland and Turkey during the tranquil period. This result is also supported by the significant error correlation coefficient of stock prices in Malaysia, South Africa and Turkey. Thus, it seems that booming in stock market results capital inflows and a change in portfolio from foreign assets to assets dominated in the domestic currency and this will leads to appreciation of currency. Nevertheless, for the countries with no causality runs from exchange rates to stock prices or from stock prices to exchange rates, they are not consistent with stock-oriented or flow-oriented theory. Pan et al., (2007) provide two the possible explanation for the countries that do not show causal relationship. The first explanation is that these countries may set restrictions on foreign equity investment relative to others. While the other reason is that when the size of stock market is small, it is challenging to detect the effect of stock prices on exchange rates since; exchange rates are more likely to be influenced by other economic fundamentals than stock price.

4 Conclusion

This paper examines the dynamic linkage between exchange rates and stock prices in nine emerging markets, including Brazil, Czech Republic, Hungary, Malaysia, Mexico, Poland, South Africa, Taiwan and Turkey over January 1998 to May 2014. The results of empirical analysis highlight a number of interesting issues.

Firstly, the findings from the bound and causality tests reveals that the stability of the financial markets significantly affects the relationship between exchange rates and stock prices and it need to be taken into account for investigating the dynamic linkage. Secondly, the result suggests that even if there is no consistent long-run equilibrium association between stock prices and exchange rates; the comovement between stock prices and exchange rates is stronger in the crises time than the tranquil period and the direction of causality originates from exchange rates to stock prices during crisis period; and from stock prices to exchange rates during the tranquil once. Thirdly, the causal relationship between exchange rates and stock prices tends to support the flow-oriented theory during the crisis time and the stock-oriented model in the tranquil period. Finally, the result suggests that the relationship between these two series influenced by the degree of capital control and maturity of financial markets. The investigation of the dynamic linkage between exchange rates and stock prices can be extended by incorporating other potential factors, which might influence the relationship.

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