Fiscaoeconomia

journal homepage: dergipark.gov.tr/fsecon

Linear and Non-Linear Causality Tests of Stock Price and Real Exchange Rate Interactions in Turkey

Gözde YILDIRIM[1], Zafer ADALI[2]

ARTICLE INFO

Article History:

Date Submitted: 20.10.2017

Date Accepted: 25.11.2017

JEL Classification:

G10

G12

G17

Keywords:

Linear and Non-Linear Causality Analysis,

Stock Price and Real Exchange Rate

ABSTRACT

The purpose of this study is to determine whether there is a causality relationship between stock price and real exchange rates in Turkey. Within this context, the study employs monthly data for real exchange rates based on consumer price index and BIST 100 index as representing stock prices that cover the periods from January 2005 to August 2017. On the other side, Granger causality test, Toda-Yamamoto causality analysis and Diks and Panchenko nonlinear causality test used for this purpose. As a result, Linear Granger causality, Toda-Yamamoto and Nonlinear Granger causality tests reveal that there is a casual relationship between real exchange rate and stock price in Turkish economy for the period of 2005:01 - 2017:08 and the direction of the causality is from stock price to exchange rate. This evidence can be interpreted as the changes in stock prices may strongly have influences on the success of foreign exchange rate policies.

[1] Ph.D. Student, Anadolu University, Institute of Social Sciences, Eskisehir, Turkey, E-mail: gozdeyildirim@anadolu.edu.tr

[2] Res. Asst., Artvin Çoruh University, The Department of Economics, Artvin, Turkey, E-mail: zaferadali@artvin.edu.tr

1. Introduction

Exchange rate and stock market have been compelling research topic for both policymakers and researchers since both of them play a vital role in the development of any country's economy. Especially, in recent years, studies on the linkage between exchange rate and stock price have received increasing attention on the grounds that many developed and developing countries have witnessed the high level of fluctuations both in exchange rates and stock prices. In addition to the price fluctuations, globalization, financial innovation, flexible exchange rate system and free capital mobility have been seen as other reviving reasons by researchers for analyzing the linkage between exchange rates and the stock market.[3] Valid evidences obtained by these analyses become more critical for investors and policymakers because they will be able to properly revise their position and reduce their risks through these evidences. However, theoretical explanations for these interactions offer more satisfied and prevalence consensus considering the causality direction and degree of influence whereas empirical studies have provided a great variety of results.

With respect to the theoretical view, flow-oriented model or the traditional approach is one of the theoretical sights in order to determine the causal direction between stock prices and exchange rates. In the flow-oriented model, Dornbush and Fisher (1980) identified that exchange rate is positively associated with stock price and causality is observed as the direction from exchange rates to stock prices. Trade balance performance and current account mainly determine exchange and thus an increase in exchange rate leads to the expansions of country international trade competitive. As a result, the country experiences higher export and lower import in which local firms' stock value increase because of current and future cash flow. Many studies have tested the validity of the flow-oriented model and their results supported that exchange rates positively impact on stock price through international competitiveness and trade balance (Chiang *et. al*., 2000; Wu, 2000; Fang, 2002, Pan *et al*., 2007; Alagidede *et al.*, 2011; Apaydın and Şahin, 2017(b).

Furthermore, the stock-oriented approach is considered as another sight in terms of the relationship between exchange rate and stock price and is developed by Branson *et. al.* (1977).

[3] See also, Apaydın and Şahin (2017a).

On contrary to flow-oriented model, the stock price can determine the exchange rate. However, the stock-oriented approach is comprised of portfolio balance models and monetary models (Branson, 1983; Frankel, 1983). According to portfolio balance models, change in stock price has adversely impact on exchange rate through direct and indirect ways. In terms of direct way, an increase in stock price encourages foreign investors to buy domestic assets in which leads to capital inflow to country leading to the depreciation of domestic currency (Gavin, 1983). Besides, Indirect way emphasized that any changes in stock price have positive influence on wealth and this situation causes higher money demand which leads to higher interest rates. As a result, the country experienced domestic currency appreciation. Furthermore, exchange rates are determined by the market mechanism so there is no linkage between stock prices and exchange rates. However, in addition to theoretical approach, many studies indicated that stock-oriented approach is experienced by many markets (Aggarwal, 1981; Soenen and Hennigar, 1988; Kim, 2003; Stavarek, 2005; Phylaktis and Ravazzolo, 2005; Tai, 2007; Tsai, 2012).

In addition to theoretical sight and pioneer studies on this view, there has been a great deal of studies for the different country samples and time series techniques. One of these study groups proves that exchange rates have an impact on stock prices (Symth and Nandha, 2003; Abdalla and Murinde, 1997; Ibrahim, 2000; Hatemi and Roca, 2005; Dogru and Recepoglu, 2013; Ceylan and Sahin, 2015). On the other hand, some studies obtain opposite conclusion that stock prices have an influence on exchange rates (Pekkaya and Bayramoglu, 2008; Wu, 2000; Hatemi-Irandoust, 2002; Granger *et. al.* 2000; Ajayi *et. al.* 1998). However, in the literature, some researchers found no interaction between stock prices and exchange rates (Abdalla and Murinde, 1997; Bahmai-Oskooee and Sohrabian, 1992; Nath and Samanta, 2003; Rahman and Uddin, 2009).

The above-mentioned studies linked to theoretical explanation and linear model justified the economic importance of the understanding of the relationship between exchange rates and stock markets. Besides, there is also growing attention for nonlinear studies in this field because of exchange rates and stock market index likely move in a nonlinear structure by virtue of crises, sudden policy changes and international foundations decisions. Additionally, many researchers have tried to categorized nonlinear models with respect to the linkage between exchange rates and stock market prices. According to them, bubbles, target zone, the models of government policies and models of fads or noise trading are main reasons of nonlinearity which associated with extreme events, rumors, speculations, psychological perceptions and looking forwarding expectations (Ma and Kanas, 2000; Krugman, 1991; Froot and Obstfeld, 1991; Frankel and Froot, 1986; Flood and Marion, 1998; Blanchard and Watson, 1982). Generally, stock prices and exchange rates are surrounded with indeterminacy, external shocks, expectations and asymmetric behavior during expansion and contractions; hence, the utilized method the relation between exchange rates and stock price within nonlinear approach become suitable.

Various nonlinear econometric approaches have been used to examine the relationship between exchange rates and stock prices in the related literature. A number of studies (Piccilo, 2008; Ismail and Isa, 2009; Chkili and Nguyen, 2014; Cuestas and Tang, 2015; Kal *et. al.*, 2015) have investigated the nonlinear regime dependent behaviors of these two financial variables through regime switching models that allow transitions in the parameters across cyclical phases, while some of studies (Tabak, 2006; Kumar, 2009; Yau and Nieh, 2009; Alagidede *et. al.*, 2011; Chen and Chen, 2012; Liu and Wan, 2012; Effiong, 2016; Ramirez *et. al.*, 2017) have focused on various type of nonlinear causality tests as contemporary derivations of the Granger Causality Test (1969).

Given these notions, considering the nonlinear properties of macroeconomic and financial data, this study examines whether there is a causal relationship between stock prices and the real exchange rate by utilizing linear Granger causality, Toda-Yamamoto (1995) and Diks and Panchenko (DP) (2006) nonlinear causality tests for the period between 2005:01-2017:08 in Turkish stock and exchange market. The reason to employ three different empirical approach is to compare the determination power of the causality tests and to present whether there is a significant nonlinear relationship between these two financial variables.

This paper consists of four different parts. After the introduction, in the second part, research methodology will be explained. Within this context, data and methodology used in the analysis will be detailed. After that, analysis results will be shared. Finally, in the last section, analysis results and the recommendations will be discussed.

2. Methodology and Data

2.1. Linear Granger Causality Test

Granger causality test developed by Granger (1969), examine if there is a causality relation between two time series variables under the assumption that these time series are stationary. The method tests this relationship by including the current values of one variable (X_t) and the past values of the other variable (Y_t). It also determines the direction of the relationship, if there is a causality relation between X_t and Y_t. Linear Granger causality test is based on the the first moments of the X_t and Y_t (Rahimi *et.al.*, 2016).

To test Granger causality between two stationary variables, we first estimate the VAR (Vector Autoregressive) model, where p refers the lag length and ε_t denotes error term, as showed below:

$$X_t = \alpha_0 + \sum_{i=1}^{p} \alpha_{1i} X_{t-i} + \sum_{i=1}^{p} \alpha_{2i} Y_{t-i} + \varepsilon_{1t} \ , \quad (1)$$

$$Y_t = \beta_0 + \sum_{i=1}^{p} \beta_{1i} X_{t-i} + \sum_{i=1}^{p} \beta_{2i} Y_{t-i} + \varepsilon_{2t} \ . \quad (2)$$

Assuming that X_t and Y_t are exchange rate and stock price indices, respectively. In Equation (1), to test whether there is Granger causality from X_t to Y_t, the null hypothesis is defined as H_0: $\alpha_{2i} = 0$ and Wald or Chi-Square test is applied to this hypothesis. If the null hypothesis is rejected, then X_t Granger causes Y_t. The same method is applied to test whether there is Granger causality from Y_t to X_t for Equation (2).

2.2. Toda-Yamamoto Test

The financial variables are often not stationary. Therefore, in generel, the series are used by providing the stationarity in the series as it is in Granger test. Toda and Yamomoto (1995) draw attention this limitation of the test and develop an extension for non-stationary variables (Akdogu and Birkan, 2016).

In contrast to Granger causality test, The Toda and Yamamoto (1995) procedure can also be applicable to non-stationary series. What is important for the Toda-Yamamoto test is the optimal lag length (k) of the augmented VAR model in levels and the maximum degree of integration (d_{max}) in the series. After these two values are determined, a VAR model is estimated with $k + d_{max}$ lag length and causality analysis is performed by testing the parameter restrictions of this model. The procedure is valid as long as $k \neq 1$. If both series are integrated at zero, I (0), no lag is added to the VAR model and in this case the Toda-Yamamoto test is similar to the Granger causality test (Toda and Yamamoto, 1995).

2.3. Nonlinear Granger Causality Test

The traditional Granger causality test does not take into account the nonlinearity observed in time series dynamics. However, macroeconomic and financial variables exhibit nonlinear behaviors across the time. Neglecting these nonlinear dynamics may cause to misidentification the relationship between two variables or may reduce the estimation power of the test. To overcome this drawback, Baek and Brock (1992) suggest a nonparametric statistical method to detect nonlinear Granger causality between variables (Cakan and Ejara, 2013).

Hiemstra and Jones (1994) argue that the assumption that the time series are mutually independent and identically distributed in the test proposed by Baek and Brock is restrictive and modify the test by allowing the variables exhibit short-term temporal dependence (Akel, 2014). However, Diks and Panchenko (2005) identify a drawback resulting from ignoring the possible variations in conditional distributions in the test proposed by Hiemstra and Jones (1994), which may cause over reject the null hypothesis of noncausality in the case of increasing sample size. In order to overcome the overrejection problem in the Hiemstra and Jones's test Diks and Panchenko (2006) develop a new nonparametric technique to apply for the residuals of the VAR model. This nonparametric and nonlinear Granger causality approach provides more robust informations about the causality relationships between variables (Rahimi *et.al.*, 2016).

2.4. Data

In order to investigate the casual relationship between stock prices and exchange rate in Turkey, the study employs monthly data for real exchange rates based on consumer price index and BIST 100 index as representing stock prices that cover the periods from January 2005 to August 2017. The monthly time series data regarding the real exchange rate is obtained from *Electronic Data Delivery System* (*EDDS*) of the *Central Bank* of the *Republic* of *Turkey*, while BIST100 index is obtained from the official website of Borsa Istanbul. The variables used in their logarithmic forms to bring the variables to the same level.

4. Empirical Results

First, the stationarity characteristics of the time series is investigated. Within this context, both conventional unit root tests comprising of Augmented Dickey Fuller (1981) and Phillips and Perron (1988)[4] and Lee and Strazicich (2003) was employed in terms of unit root test with structural breaks. The results of conventional stationary test are detailed in Table 1. With respect to the ADF and PP tests, the null hypothesis indicates that the series are not stationary. However, both ADF and PP show that series are non-stationary in their level forms since the calculated 't' statistics are less than the critical values at 1% level. In other words, the null hypothesis of a unit root test is accepted on variables levels in a logarithm form with respect to 1% level. Moreover, all variables have not unit root in the first difference. Therefore, we suggest that all variables are integrated of order (1) because the calculated 't' statistics for both logbist and logrexch are greater than critical values at 1% level.

In addition to the conventional unit root tests, Lee and Strazicich (2003) concluded that all variables are not stationary in their level forms since the calculated 't' statistics for both logbist and logrexch are less than the critical values after the level form at 1% significance level. However, both conventional and unit root test with structural breaks emphasized that the variables become stationary after differencing.

[4] The conventional stationary test were conducted by Eviews 9.

Table 1. Unit Root Test[5] Without Structural Break

Variable	Original Level				The First Difference			
	ADF		PP		ADF		PP	
	Constant	Constant and Trend	Constant	Constant and Trend	Constant	Constant and Trend	Constant	Constant and Trend
LOGBIST	-1.353492	-2.698011	-1.431053	-3.003660	-11.698***	-11.658***	-11.698***	-11.658***
LOGREXCH	-1.990638	-3.74737**	-1.601857	-3.3739*	-9.4029***	-9.4423***	-9.5246***	-9.5160***

Table 2. Unit Root Test With Structural Break (LM)[6]

	Model A: breaks in intercept			Model C: breaks in intercept and trend		
	Statistic	1st break	2nd break	Statistic	1st break	2nd break
LOGREXCH	-1.710	2005-M2	2006-M11(-3.84)[7]	-5.218	2005-M10	2006-M11(-5.71)
LOGBİST	-4.530	2006-M07	2013-M12(-3.84)	-5.175	2011-M03	2012-M05(-5.67)

The results for linear Granger causality analysis are demonstrated in Table 3. Since the granger causality analysis procedure is associated with VAR model, the validity of assumption of analysis should be justified. The defining optimal lag is one of the most important required and in this optimal lag and is calculated as 10 in accordance with AIC. However, all diagnostic tests related granger causality analysis based on VAR model were carried out in terms of 10 lag (see, appendix 1). The results of analysis were concluded that the stock-oriented approach is found. In other words, the stock exchange rate in Turkey has effect on the real exchange rate

[5] The optimal lags for ADF Test were determined by The Schwartz Information Criterion; the bandwith for PP was selected with Newey-West using Barlett Kernel.
Note: The null hypothesis is that the series has a unit root . ***,** and * refer significance at the 1,5 and 10% level, respectively.
[6] The GAUSS code file was used for the Lee and Strazicich unit root test.
[7] Note: Critical values are obtained from Lee ve Strazicich (2003). Critical values for Model C are determined accoding to fractional points.

because p-value of the causality run from stock exchange rate to the real exchange rate is less than 0.05.

Table 3. Granger Causality [8]

Dependent Variable: DLOGBIST				Dependent Variable: DLOGREXCH			
Excluded	**Chi-sq**	**df**	**Prob**	**Excluded**	**Chi-sq**	**df**	**Prob**
DLOGREXCH	8.431117	10	0.5868	**DLOGBIST**	22.71596	10	0.0118

In this study, in order to confirm the relationship between stock exchange rate and the real exchange rates, Toda Yamamoto causality analysis is employed. Toda Yamamoto causality analysis also validates whether there is causality relationship between the variables. On the contrary to Granger causality analysis, there is no necessity for the variables to be stationary. However, maximum degree of integration and lag length in VAR model should be defined. The "k" represented as the lag length and "d" represented as the maximum co-integration number in VAR model should be calculated before the analysis (Toda and Yamamoto, 1995).

In terms of prerequisite, "k+d" is calculated as 4 (see appendix 2[9]). According to Table 4, the results of Toda Yamamoto analysis are concluded that the stock exchange rate causes the real exchange rate because p values is less than 0.05. On the other hand, the direction from the exchange rates to the stock exchange rates is not confirmed since p value is greater than 0.05. These conclusions promote the results of Granger causality analysis so the stock-oriented approach is validated as a results of linear causality analysis.

Table 4. Toda Yamamoto [10]

Direction of Causality	(d)	(k)	(d+k)	Chi-sq	Prob.
Logrexch->Logbist	1	3	4	3.566151	0.3123
Logbist->Logrexch	1	3	4	11.40363	0.0097

[8] Diagnostic test in appendix.
[9] The diagnostic tests were conducted by Eviews 9.
[10] Optimal lag for Toda Yamamoto see appendix.

In terms of nonlinear causality analysis, the versions of Hiemstra and Jones (HJ) (1994) and Diks and Panchenko (DP) (2006) are employed in the literature. The Monte Carlo study of Baek and Brock (1992) concluded that the performance of nonlinear approach is superior than linear models because the linear Granger causality analysis can ignore the nonlinear causal relationships among variables. On the other hand, the version of Diks and Panchenko (DP) is superior than Hiemstra and Jones (HJ) in case of increasing sample size (Diks and Panchenko, 2005) so in this study, the version of DP was conducted. In order to the DP test, Lx=Ly[11] is applied and the results of DP nonlinear Granger causality test emphasized that the stock-oriented approach is validated with respect to lag length of 1-2. Both linear and non-linear causality analysis found a conclusion that the stock-oriented approach is affirmed in Turkey.

Table 5. Nonlinear Granger Causality Analysis[12]

Lag (Lx=Ly)	Ho= dlogbist100 does not granger cause dlogrexch		Ho=dlogrexch does not granger cause dlogbist100	
	T- Statistics	Probability	T- Statistics	Probability
Lx=Ly=1	1.965217	0.024695	0.253833	0.399812
Lx=Ly=2	1.979122	0.023901	-0.276557	0.608940
Lx=Ly=3	0.640735	0.260847	-0.003608	0.501439
Lx=Ly=4	0.780604	0.217518	0.413778	0.339518

Conclusion

The exchange rate and stock markets have become important determinants of the dynamics of financial markets in the economy, which have been brought to a new dimension by the globalization channels. Since the results of the analyses enable investors and policymakers to design their investment decisions, evidences from analyses that examine the relationship and direction between these two variables has critical importance.

[11] According to the Monte Carlo results in Hiemstra and Kramer (1997).
[12] The Panchenko's C++ code file was used for the non-linear causality test.

There are two theoretical approaches to determine the causal direction between stock prices and exchange rates. With respect to the flow-oriented approach, exchange rate is positively associated with stock price and the direction of causality is from exchange rates to stock prices. On contrary to flow-oriented model, the stock-oriented approach claims that the stock price can determine the exchange rate and there is a negative relationship between these two variables. Although there is a broad literature that address the dynamic of this relationship, there is no consensus on the relationship between these two variables.

This study investigates the causal relationship between real exchange rate and stock prices for Turkish economy thorough the variations of Granger causality test including its traditional version. Employing the nonlinear version of the causality test provides us more robust information on the interaction between these two financial variables considering their nonlinear dynamics. Linear Granger causality, Toda-Yamamoto and Nonlinear Granger causality tests reveal that there is a casual relationship between real exchange rate and stock price in Turkish economy for the period of 2005:01 - 2017:08 and the direction of the causality is from stock price to exchange rate. This evidence can be interpreted as the changes in stock prices may strongly have influences on the success of foreign exchange rate policies.

The fact that there is a causality relationship between stock prices and foreign exchange rates indicates that capital movements in the stock market have contributed to the appreciation or depreciation of the national currency. If it is intended to appreciation of the domestic currency, the policies should be designed to help create a climate of confidence and ensure fiscal discipline, which make the shares of companies more attractive and increase demand for the stocks. However, in the long run, policies should be created that make it possible to carry out structural reforms aimed at reducing the fragility of the national economy against international capital inflows and outflows.

Thus, a detailed examination of the variables affecting stock prices and the determination of appropriate policy instruments, is of great importance for the value of the domestic currency to move in the desired direction. Since Turkish economy is import-dominated, the appreciation of the domestic currency will contribute to the revival of the economy by reducing company costs. On the other hand, supportive policies should also be carried out in order to prevent the appreciation of domestic currency from being a disadvantage that causes significant breaks for exporting firms.

REFERENCES

ABDALLA, I. S., & MURINDE, V. (1997). Exchange rate and stock price interactions in emerging financial markets: evidence on India, Korea, Pakistan and the Philippines. *Applied financial economics*, 7(1), 25-35.

AGGARWAL, R. (1981). Exchange Rates and Stock Prices: A Study of the US. Capital Markets under Floating Exchange Rates. *Akron Business and Economic Review*, 12, 7-12.

AKDOĞU, S. K., & BİRKAN, A. O. (2016). Interaction between Stock Prices and Exchange Rate in Emerging Market Economies. *Research in World Economy*, 7(1), 80.

AJAYI, R. A., FRIEDMAN, J., & MEHDIAN, S. M. (1998). On the relationship between stock returns and exchange rates: tests of Granger causality. *Global finance journal*, 9(2), 241-251.

AKEL, G. (2014). Relationship Between Exchange Rates and Stock Prices in Transition Economies Evidence from Linear and Nonlinear Causality Tests. *In Proceedings of Economics and Finance Conferences* (No. 0401783). *International Institute of Social and Economic Sciences.*

ALAGIDEDE, P., PANAGIOTIDIS, T., & ZHANG, X. (2011). Causal relationship between stock prices and exchange rates. *The Journal of International Trade & Economic Development*, 20(1), 67-86.

APAYDIN, Ş ve H. ŞAHIN (2017a), " Türkiye'de Kısa Vadeli Sermaye Akımlarının İktisadi Dalgalanmalar Üzerindeki Etkileri: Bir Uzun Dönem Kısıtlı SVAR Modeli", *Politik Ekonomik Kuram,* C. 1, S. 1, 22-72.

APAYDIN, Ş. ve H. ŞAHİN (2017b), "The Effects of Short-term Capital Movements on Sectorial Production: The Case of Turkey", *3rd International Annual Meeting of Sosyoekonomi Society*, April 28-29, Ankara.

BAEK, E. G., & BROCK, W. A. (1992). A nonparametric test for independence of a multivariate time series. *Statistica Sinica*, 137-156.

BAHMANI-OSKOOEE, M., & SOHRABIAN, A. (1992). Stock prices and the effective exchange rate of the dollar. *Applied economics*, 24(4), 459-464.

BLANCHARD, O., WATSON, M.W., 1982. *Bubbles, rational expectations, and financial markets*. In Wachtel, P. (Ed.) Crises in the economic and financial structure. Lexington Books, Lexington, MA.

BRANSON, W.H., HALTTUNEN, H. and MASSON, P. (1977). Exchange Rate in the Short-Run: The Dollar Deutsche Mark Rate. European Economic Review 10(3), pp. 303-324.

BRANSON, W. H. (1983), Macroeconomic Determinants of Real Exchange Rate Risk. In R.J.Herring (ed.) Managing Foreign Exchange Risk. Cambridge: Cambridge University Press.

CAKAN, E., & EJARA, D. D. (2013). On the Relationship between Exchange Rates and Stock Prices: Evidence from Emerging Markets. *International Research Journal of Finance and Economics,* 111, 115-124.

CEYLAN, S., & SAHIN, B. Y. (2015). Relationship between Stock Prices and Exchange Rate. *The Journal of Academic Social Science Studies*, 37, 399-408.

CHEN, S. W., & CHEN, T. C. (2012). Untangling the non-linear causal nexus between exchange rates and stock prices: new evidence from the OECD countries. *Journal of Economic Studies*, 39(2), 231-259.

CHIANG, T. C., YANG, S.Y., & WANG, T. S. (2000), Stock return and exchange rate risk: evidence from Asian stock markets based on a bivariate GARCH model, International Journal of Business, 2, 97-117

CHKILI, W., & NGUYEN, D. K. (2014). Exchange rate movements and stock market returns in a regime-switching environment: Evidence for BRICS countries. *Research in International Business and Finance*, 31, 46-56.

CUESTAS, J. C., & TANG, B. (2015). Asymmetric exchange rate exposure of stock returns: Empirical evidence from Chinese Industries. *The Sheffield Economic Research Paper Series (SERPS)*, No. 201502(021).

DICKEY, D. A., & FULLER, W. A. (1981). Likelihood ratio statistics for autoregressive time series with a unit root. *Econometrica: Journal of the Econometric Society*, 1057-1072.

DIKS, C., & PANCHENKO, V. (2006). A new statistic and practical guidelines for nonparametric Granger causality testing. *Journal of Economic Dynamics and Control*, 30(9), 1647-1669.

DOGRU, B., & RECEPOGLU, M. (2013). Türkiye'de Hissse Senedi Fiyatları ve Döviz Kuru Arasında Doğrusal ve Doğrusal Olmayan Eş Bütünleşme İlişkisi (in Turkish). *Dumlupınar University Journal of Social Sciences, EYD 2013 Special Issue*.

DORNBUSCH, R., & FISCHER, S. (1980). "Exchange rates and current account." *American Economic Review,* 70, 960–971.

EFFIONG, E. L. (2016). Nonlinear dependence between stock prices and exchange rate in Nigeria. *Munich Personal RePEc Archive (MPRA)*, No. 74336.

FANG, W. (2002). The effects of currency depreciation on stock returns: Evidence from five East Asian economies. *Applied Economics Letters*, 9(3), 195-199

FLOOD, R.P., & MARION, N.P., 1998. Perspectives on the recent currency crisis literature, Jan. 1998, *NBER Working Paper* No. 6380.

FRANKEL, J. A. (1983). Monetary and Portfolio-Balance Models of Exchange Rate Determination in Economic Interdependence and Flexible Exchange Rates,J.S.Bhandari and B.H.Putnam eds.,Cambridge:MIT Press.

FRANKEL, J.A., & FROOT, K.A., (1986). The dollar as a speculative bubble: a tale of fundamentalists and chartists. *National Bureau of Economic Research Working Paper* No. 1854, March.

FROOT, K.A., & OBSTFELD, M. (1991). Intrinsic bubbles: the case of stock prices. *American Economic Review*, 81, 1189–1214.

GAVIN, M. (1989). The stock market and exchange rate dynamics. *Journal of International Money and Finance,* 8, 181−200.

GRANGER, C. W. (1969). Investigating causal relations by econometric models and cross-spectral methods. *Econometrica: Journal of the Econometric Society*, 424-438.

GRANGER, C. W., HUANG, B., & YANG, C. (2000). A Bivariate Causality between Stock Prices and Exchange Rates: Evidence from Recent Asian Flu. *Quarterly Review of Economics and Finance*, 40, 337-354

HATEMI, J. A., & IRANDOUST, M. (2002). On the Causality between Exchange Rates and Stock Prices: A Note. *Bulletin of Economic Research*, 54(2), 197-203.

HATEMI, J. A., & ROCA, E. (2005). Exchange rates and stock prices interaction during good and bad times: evidence from the ASEAN4 countries. *Applied Financial Economics*, 15(8), 539-546.

HIEMSTRA, C., & JONES, J. D. (1994). Testing for linear and nonlinear Granger causality in the stock price□volume relation. *The Journal of Finance, 49(5)*, 1639-1664.

HIEMSTRA, C., & KRAMER, C. (1997). Nonlinearity and endogeneity in macro-asset pricing. *Studies in Nonlinear Dynamics & Econometrics*, 2(3).

IBRAHIM, M. H. (2000). Cointegration and Granger causality tests of stock price and exchange rate interactions in Malaysia. *ASEAN Economic Bulletin,* 36-47.

ISMAIL, M. T., & BIN ISA, Z. (2009). Modeling the interactions of stock price and exchange rate in Malaysia. *The Singapore Economic Review,* 54(04), 605-619.

KAL, S. H., ARSLANER, F., & ARSLANER, N. (2015). The dynamic relationship between stock, bond and foreign exchange markets. *Economic Systems*, 39(4), 592-607.

KIM, K. (2003). Dollar exchange rate and stock price: evidence from multivariate cointegration and error correction model. *Review of Financial Economics*, 12, 301-313.

KRUGMAN, P., (1991). Target zones and exchange rate dynamics. *Quarterly Journal of Economics,* 106, 669–682.

KUMAR, M. (2009). A bivariate linear and nonlinear causality between stock prices and exchange rates. *Economics Bulletin*, 29(4), 2884-2895.

LEE, J., & STRAZICICH, M. C. (2003). Minimum Lagrange multiplier unit root test with two structural breaks. *The Review of Economics and Statistics*, 85(4), 1082-1089.

LIU, L., & WAN, J. (2012). The relationships between Shanghai stock market and CNY/USD exchange rate: New evidence based on cross-correlation analysis, structural cointegration and nonlinear causality test. *Physica A: Statistical Mechanics and its Applications*, 391(23), 6051-6059.

MA, Y., & KANAS, A. (2000). Testing for a nonlinear relationship among fundamentals and exchange rates in the ERM. *Journal of International Money and Finance*, 19(1), 135-152.

NATH, G. C., & SAMANTA, G. P., (2003), "Dynamic Relation between Exchnage Rate and Stock Prices – A Case for India", *39th Annual Conference paper of Indian Econometric Society also published in NSE News.*

PEKKAYA, M., & BAYRAMOGLU, M. F. (2008). Hisse Senedi Fiyatlari ve Döviz Kuru Arasindaki Nedensellik Iliskisi: YTL/USD, IMKB 100 ve S&P 500 Üzerine Bir Uygulama. *Muhasebe ve Finansman Dergisi*, (38).

PICCILLO, G. (2009). Foreign exchange and stock market: Two related markets? *Discussion Paper Series / Center for Economic Studies*., 1–44.

PHILLIPS, P. C., & PERRON, P. (1988). Testing for a unit root in time series regression. *Biometrika*, 75(2), 335-346.

PHYLAKTIS, K., & RAVAZZOLO., F. (2005). Stock Prices and Exchange Rate Dynamics. *Journal of International Money and Finance*, Vol. 24, No.7, pp. 1031-1053.

RAHIMI, A., Lavoie, M., & Chu, B. (2016). Linear and nonlinear Granger-causality between short-term and long-term interest rates during business cycles. *International Review of Applied Economics*, 30(6), 714-728.

RAHMAN, M. L., & Uddin, J. (2009). Dynamic relationship between stock prices and exchange rates: Evidence from three South Asian countries. *International Business Research*, 2(2), 167.

RAMÍREZ, C. S. L., Romero-Meza, R., & Venegas-Martínez, F. (2017). Non-Linear Multivariate Dependence between the Mexican Stock Market Index and the Exchange Rate: Efficiency Hypothesis and Political Cycle in Mexico (1994-2012). Revista Mexicana de Economía y Finanzas. *Nueva Época/Mexican Journal of Economics and Finance*, 12(1).

SMYTH, R., & NANDHA, M. (2003). Bivariate causality between exchange rates and stock prices in South Asia. *Applied Economics Letters*, 10(11), 699-704.

SOENEN, L. A., & HENNIGAR, E. S. (1988). An analysis of exchange-rates and stock-prices-the united-states experience between 1980 and 1986. *Akron Business and Economic Review*, 19(4), 7-16.

STAVAREK, Daniel, (2005), "Stock Prices and Exchange Rates In The EU And The United States: Evidence On Their Mutual Interactions", *Czech Journal Of Economics And Finance,* Vol. 55, No.3-4, pp. 141-161.

TABAK, B. M. (2006). The dynamic relationship between stock prices and exchange rates: Evidence for Brazil. *International Journal of Theoretical and Applied Finance*, 9(08), 1377-1396.

TAI, C. S. (2007). Market integration and contagion: Evidence from Asian emerging stock and foreign exchange markets. *Emerging markets review*, 8(4), 264-283.

TODA, H. Y., & YAMAMOTO, T. (1995). Statistical inference in vector autoregressions with possibly integrated processes. *Journal of econometrics*, 66(1), 225-250.

TSAI, I. (2012), "The Relationship Between Stock Price Index and Exchange Rate in Asian Markets: A Quantile Regression Approach", *Journal of International Financial Markets, Institutions and Money*.

YAU, H. Y., & NIEH, C. C. (2009). Testing for cointegration with threshold effect between stock prices and exchange rates in Japan and Taiwan. *Japan and the World Economy*, 21(3), 292-300.

WU, Y. (2000). Stock prices and exchange rates in a VEC model-the case of Singapore in the 1990s. *Journal of Economics and Finance*, 24(3), 260-274.

Appendix:

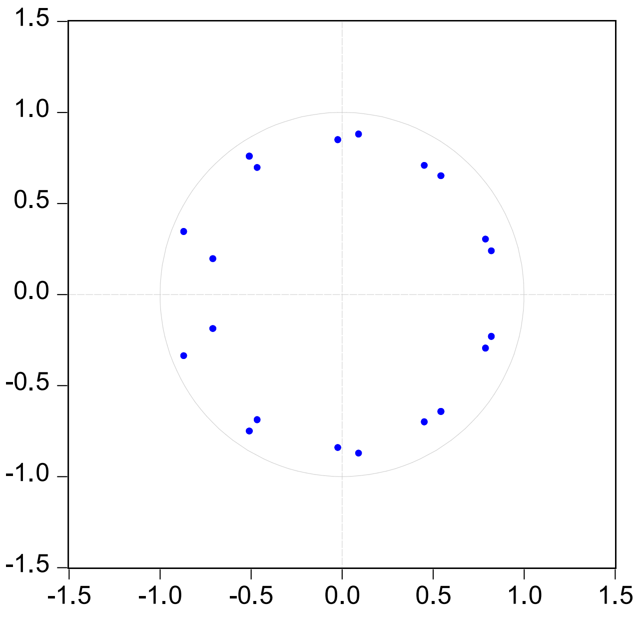
Appendix 1: Granger Causality Diagnostic Test

VAR Residual Serial Correlation
LM Tests
Null Hypothesis: no serial
correlation at lag order h
Date: 12/07/17 Time: 21:13
Sample: 2005M01 2017M08
Included observations: 141

Lags	LM-Stat	Prob
1	1.056530	0.9011
2	6.911176	0.1407
3	6.961822	0.1379
4	3.356900	0.5000
5	7.609324	0.1070
6	7.010671	0.1353
7	1.282166	0.8644
8	4.961938	0.2912
9	2.229204	0.6937
10	3.720654	0.4451
11	1.687372	0.7930

Probs from chi-square with 4 df.

Inverse Roots of AR Characteristic Polynomial



VAR Residual Heteroskedasticity Tests: No Cross Terms (only levels and squares)
Date: 12/17/17 Time: 02:16
Sample: 2005M01 2017M08
Included observations: 142

Joint test:

Chi-sq	df	Prob.
136.2874	120	0.1469

Appendix 2: Optimal Lag for Toda Yamamoto

VAR Lag Order Selection Criteria
Endogenous variables: LOGBIST LOGREXCH
Exogenous variables: C
Date: 12/08/17 Time: 14:29
Sample: 2005M01 2017M08
Included observations: 140

Lag	LogL	LR	FPE	AIC	SC	HQ
0	117.1601	NA	0.000662	-1.645144	-1.603120	-1.628067
1	482.2730	714.5782	3.80e-06	-6.803900	-6.677830	-6.752669
2	499.6365	33.48674	3.14e-06	-6.994808	-6.784690*	-6.909422*
3	505.1236	10.42537*	3.08e-06*	-7.016051*	-6.721887	-6.896511
4	505.9547	1.555439	3.22e-06	-6.970782	-6.592570	-6.817088
5	507.6745	3.169312	3.33e-06	-6.938207	-6.475949	-6.750359
6	511.2359	6.461358	3.35e-06	-6.931941	-6.385636	-6.709939
7	512.9001	2.971763	3.47e-06	-6.898572	-6.268220	-6.642416
8	514.1724	2.235728	3.61e-06	-6.859606	-6.145207	-6.569296
9	517.8175	6.300689	3.63e-06	-6.854535	-6.056089	-6.530071
10	521.6680	6.546001	3.64e-06	-6.852401	-5.969908	-6.493782
11	526.9490	8.826696	3.58e-06	-6.870700	-5.904160	-6.477927
12	527.9677	1.673667	3.74e-06	-6.828110	-5.777524	-6.401183

*indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)