SABAN NAZLIOGLU
Pamukkale University, Turkey, snazlioglu@pau.edu.tr

MUHSIN KAR
Necmettin Erbakan University, Turkey, mkar@konya.edu.tr

GUNAY AKEL
Necmettin Erbakan University, Turkey, gakel@konya.edu.tr

RELATIONSHIP BETWEEN EXCHANGE RATES AND STOCK PRICES IN TRANSITION ECONOMIES EVIDENCE FROM LINEAR AND NONLINEAR CAUSALITY TESTS

Abstract:

The existence of causation linkage between stock prices and exchange rates is one of the popular debate especially since the beginning of 1990s. The aim of this paper is to investigate the nature of the causal transmission mechanism between foreign exchange and stock markets in 9 transition countries (i.e., Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, and Russia) for the periods of 1995-2011. The results of the paper show that uni-directional linear Granger causality running from exchange rates to stock prices for 4 countries (i.e., Czech Republic, Hungary, Poland, and Romania) and a feedback exists between two markets for only Russia when both linear and nonlinear Granger causality are used.

Keywords:

Exchange Rates, Stock Prices, Transition Economies, Linear and Nonlinear Causality Tests

JEL Classification: C22, F31

1. Introduction

The existence of causation linkage between stock prices and exchange rates is one of the hotly debated issues starting in the early 1990s. The last quarter of the 20th century has witnessed significant changes in the international financial system such as the emergence of new capital markets, gradual abolishment of capital inflow barriers and foreign exchange restrictions, or the adoption of more flexible exchange rate arrangements in emerging and transition countries. All the mentioned features have broadened the variety of investment opportunities. On the other hand, they have also increased the volatility of exchange rates and added an important risk to the overall investment decision and portfolio diversification process. Studying the interaction between foreign exchange and stock markets has therefore become more complex and has received more research interest than before. Since the causality implies that dynamics of exchange rates provides information to predict dynamics of stock prices for investment, speculation, and portfolio strategies.

As far as the empirical literature is concerned (see related section in the below), causal relationship between stock price and exchange rate is empirically investigated for mainly developed countries. However, this topic is not examined enough for the transition economies which emerged after the fall of Berlin Wall and dissolution of the Soviet Union. Most of the centrally planned economies has diverted to liberal democracies. With the announcement of independence in the early 1990s, the centrally planned economies have experienced a tremendous structural transformation which set up economic and political institutions as seen in their counterpart in the Western Europe. In the same vein, liberalization involved not only elimination of external barriers but also elimination of domestic restrictions in terms of huge privatization programs and allowing the market forces to set prices rather than a central planning organization. Consequently, a financial system is created to facilitate macroeconomic stabilization and the movement of private capital.

The aim of this paper is to empirically investigate the nature of the causality between exchange rate and stock markets by employing linear and nonlinear approaches in 9 transition countries (i.e., Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, and Russia) for the periods of 1995-2011. This paper contributes to the literature by the selection of sample countries and by employing the nonlinear causality test.

2. Theoretical Background and Literature Review

In the literature, there are a number of causal linkages between stock prices and exchange rates. The good market hypotheses developed by Dornbusch and Fischer (1980) argues that the fluctuations in exchange rates may cause changes in the stock prices. This hypothesis tries to theoretically explain the impacts of changes in exchange rates on the competitiveness of the multinational firms and stock prices. As far as an exporting firm is concerned, an appreciation (depreciation) of the local currency reduces (increases) profit and hence decreases the value of the firm. In particular, a depreciation of the local currency makes exporting goods cheaper for the foreigners and hence increases foreign demand. This will increase the value of an exporting firm. An appreciation of the local currency makes expensive the products of exporting firm for foreign markets and hence decreases the exporting firm’s profit. This will resulted in a decline in the firm’s stock price. On the other hand, an appreciation (depreciation) of the local currency increases (decreases) profit and hence increase the value of importing firm. The effects of the exchange rate fluctuations on the importing firm work just the opposite of the exporting firm.

Additionally, fluctuations in exchange rates influence transaction exposure of a firm. Particularly, changes in exchange rate affect a firm's future payables (or receivables) denominated in foreign currency. For an exporting firm, while an appreciation of the local currency reduces profits, a depreciation of the local currency increases profits. These discussions clearly show that fluctuations in exchange rate may cause movements in the stock prices. Adler and Dumas (1994) argue that, on a macro basis, the effects of fluctuations in exchange rate on stock prices is based on both the importance of a country's international trades in its economy and the degree of the trade imbalance.

On the other hand, the portfolio balance approach argues that fluctuations in stock price may cause movements in exchange rate. An exchange rate is mainly determined by the market powers. Additionally foreign investors, searching for the high return, may internationally diversify their portfolio to maximize their benefits and therefore may invest in the equity securities in a blooming stock market. As a result, a capital inflow from foreign investors causes an increase in the demand of a country's currency and vice versa. This action may increase stock prices and hence result in an appreciation in exchange rates or vice versa.

In addition to returns, level of investment climate in a country is very important for foreign capital. An improvement in a country's investment climate (political stability, efficient and effective (fair) legal system, fiscal discipline, liberalization etc.) will lead to capital inflows and a currency appreciation. Moreover, Gavin (1989) argues that performance of stock market might influence invertors' wealth and demand for money and, therefore, would affect exchange rate. This had been witnessed in the 1997 Asian financial crisis. When there is a loss of confidence in economic and political system or herding behavior of investors in capital markets, a sudden dislocation of asset demands may be seen and results in the shift of portfolio preference from domestic assets to assets denominated in other currencies (e.g., the U.S. dollar), implying a decrease in the demand of money. This sort of behavioral change might lead to a decrease in the domestic interest rate and in turn give support to capital outflows. Consequently, the local currency will suddenly depreciate.

Based on this theoretical literature that suggests causal relations between stock prices and exchange rates, many studies have been carried out to empirically investigate the nature of relationship between two variables.

The initial studies investigating the U.S. economy belong to Jorion (1991), Bodnar and Gentry (1993), and Bartov and Bodnar (1994). They all fail to find a significant contemporaneous relation between U.S. dollar movements and stock returns for U.S. firms. Chamberlain et al., (1997) find that the U.S. banking stock returns are very sensitive to exchange rate movements. While such findings are quite different from those reported in prior studies, Chamberlain et al. (1997) attribute the contrast to their use of daily data.

There are also a number of studies analyzing the fareast countries. Yu (1997) employed daily data on markets of Hong Kong, Tokyo, and Singapore for the period 1983–94 and detected bidirectional relationship in Tokyo, no causation for the Singapore market and causality running from changes in exchange rates to changes in stock prices. Wu (2000) finds that Singapore-dollar exchange rates Granger cause stock prices. He also finds that the explanatory power of exchange rates on stock prices has increased over time. Pan et al. (2007) show a significant causal relation from exchange rates to stock prices for Hong Kong, Japan, Malaysia, and Thailand before the 1997 Asian financial crisis. They also find a causal relation from the equity market to the foreign exchange market for Hong Kong, Korea, and Singapore. Further, while no country shows a significant causality from stock prices to exchange rates during the Asian crisis in 1997, a causal relation from exchange rates to stock prices is found for all countries except Malaysia, which corresponds with the conclusions of Granger *et al.* (2000). Their findings also indicate that the linkages vary across economies with respect to exchange rate regimes, the trade size, the degree of capital control, and the size of equity market. Ramasamy and Yeung (2001) considered causalities between the two markets in nine East Asian economies and realized that the direction of causalities can vary according to the period of study. For the period of the entire four years of the crisis (1997–2000) all countries, apart from Hong Kong, showed that stock prices cause movements in the exchange rates. Results on Hong Kong indicate bidirectional causality. Using bootstrap causality tests with leveraged adjustments, Hatemi-J and Roca (2005) study the link between exchange rates and stock prices in Malaysia, Indonesia, Philippines and Thailand for the periods immediately before and during the 1997 Asian crisis. Two variables are found to be significantly linked in the non-crisis period but not at all during the crisis period.

3. Econometric Methods

3.1. Linear Granger Causality Test

In a standard Granger causality analysis, zero restrictions based on the Wald principle are imposed on the lagged coefficients obtained from the estimation of Vector Autoregressive (VAR) model. However, the Wald statistic may lead to nonstandard limiting distributions depending upon the cointegration properties of the VAR system that these nonstandard asymptotic properties stem from the singularity of the asymptotic distributions of the estimators (Lütkepohl, 2004: 148). Toda and Yamamoto (1995) approach to Granger causality overcomes this singularity problem by augmenting VAR model with the maximum integration degree of the variables. In addition to this advantage, the Toda-Yamamoto causality approach does not require testing for co-integration relationships and estimating the vector error correction model and is robust to the unit root and co-integration properties of the series.

The standard Granger causality analysis requires estimating a VAR (*p*) model in which *p* is the optimal lag length(s). In the Toda-Yamamoto procedure, the following VAR (*p*+*d*) model is estimated that *d* is the maximum integration degree of the variables.

$$y_t = v + A_1 y_{t-1} + \cdots + A_p y_{t-p} + \cdots + A_{p+d} y_{t-(p+d)} + \mu_t . \quad (1)$$

where y_t is vector of k variables, v is a vector of intercepts, μ_t is a vector of error terms and A is the matrix of parameters. The null hypothesis of no-Granger causality against the alternative hypothesis of Granger causality is tested by imposing zero restriction on the first *p* parameters. The so-called modified Wald (MWALD) statistic has asymptotic chi-square distribution with *p* degrees of freedom irrespective of the number of unit roots and of the cointegration relations.

3.2. Nonlinear Granger Causality Test

The linear Granger causality test does not account for nonlinear causal relationships among the variables. In order to test for nonlinear Granger causality, various non-parametric methods are developed. In an early study, Baek and Brock (1992) propose a nonparametric statistical method for detecting non-linear Granger causality by using correlation integral between time series. In the Baek and Brock's test, the time series are assumed to be mutually and individually independent and identically distributed. By relaxing this strict assumption, Hiemstra and Jones (1994) develop a modified test statistic for the non-linear causality which allows each series to display short-term temporal dependence. However, Diks and Panchenko (2005) show that the test advocated by Hiemstra and Jones (1994) may over reject the null hypothesis of non-causality in the case of increasing sample size since it ignores the possible variations in conditional distributions. In a recent study, Diks and Panchenko (2006, hereafter DP) develop a new nonparametric test for Granger causality that overcomes the over-rejection problem in the Hiemstra and Jones's test. In what follows, following Diks and Panchenko (2006) and Bekiros and Diks (2008) I outline the details of the DP nonparametric causality test.

Testing granger causality from one time series (*X*) to another (*Y*) is based on the null hypothesis that X does not contain additional information about Y_{t+1} which is specified as:

$$H_0: Y_{t+1} \left| (X_t^{\ell_X}; Y_t^{\ell_Y}) \sim Y_{t+1} \right| Y_t^{\ell_Y} \tag{2}$$

where *lx* and *ly* respectively denote the past observations (i.e., lag length) of *X* and of *Y*. By assuming $Z_t = Y_{t+1}$ and by dropping time index and lags in the equation (2), the conditional distribution of *Z* given $(X, Y) = (x, y)$ is the same as that of *Z* given $Y = y$ under the null hypothesis. Hence, the equation (2) can be restated in terms of joint distributions that the joint probability density function $f_{X,Y,Z}(x, y, z)$ and its marginals must satisfy the following condition which explicitly states that *X* and *Z* are independent conditionally on $Y = y$ for each fixed value of *y*.

$$\frac{f_{X,Y,Z}(x,y,z)}{f_Y(y)} = \frac{f_{X,Y}(x,y)}{f_Y(y)} \cdot \frac{f_{Y,Z}(y,z)}{f_y(y)} \tag{3}$$

Diks and Panchenko (2006) then re-specify the null hypothesis of no nonlinear Granger causality as follows:

$$q \equiv E\left[f_{X,Y,Z}(X,Y,Z) f_Y(Y) - f_{X,Y}(X,Y) f_{Y,Z}(Y,Z) \right] = 0 \tag{4}$$

where $\hat{f}_W(W_i)$ is a local density estimator of a d_W – variate random vector W at W_i defined by $\hat{f}w(W_i) = (2\varepsilon_n)^{-d_W}(n-1)^{-1} \sum_{j\, j \neq i} \mathrm{I}_{ij}^W$ that $\mathrm{I}_{ij}^W = \mathrm{I}(\|W_i - W_j\| < \varepsilon_n)$ with the indicator function $\mathrm{I}(.)$ and the bandwidth ε_n, depending on the sample size *n*. Given this estimator, the test statistic which is a scaled sample version of q in the equation (4) is developed as:

$$T_n(\varepsilon_n) = \frac{n-1}{n(n-2)} \cdot \sum_i (\hat{f}_{X,Z,Y}(X_i, Z_i, Y_i) \hat{f}_Y(Y_i) - \hat{f}_{X,Y}(X_i, Y_i) \hat{f}_{Y,Z}(Y_i, Z_i)) \tag{5}$$

If $\varepsilon_n = Cn^{-\beta}(C > 0, \frac{1}{4} < \beta < \frac{1}{3})$ for one lag ($\ell_X = \ell_Y = 1$), the test statistic in equation (5) satisfies:

$$\sqrt{n}\frac{(T_n(\varepsilon_n) - q)}{S_n} \xrightarrow{D} N(0,1)$$

where $\xrightarrow{D}$ denotes convergence in distribution and S_n is an estimator of the asymptotic variance of $T_n(.)$ Accordingly, the DP test statistic in the equation (5) for nonlinear causality is asymptotically distributed as standard normal and diverges to positive infinity under the alternative hypothesis. Thereby, the statistic greater than 1.28 rejects the null hypothesis at 10 percent level of significance and supports evidence in favor of a nonlinear Granger causality. Finally, the value of the bandwidth plays an important role in making a decision on existence of nonlinear causality. Since the bandwidth value smaller (larger) than one generally results in larger (smaller) *p*-value (Bekiros and Diks, 2008: 1646), the bandwidth, ε_n, is set to one.

4. Data

The variables are all transformed to natural logarithm. Table 1 summarizes the descriptive statistics. It appears that stock prices have higher standard deviation than exchange rates which results in higher coefficient of variations and thereby more volatility in stock prices relative exchange rates in most of the transition economies. Skewness and Kurtosis statistics for both exchange rates and stock prices are greater than zero, which imply that exchange rates and stock markets in transition countries are not normally distributed that can be attributed investment strategies of global investors and speculator for searching alternative investment areas.

Table 1: Descriptive Statistics

	Bulgaria	Czech Republic	Estonia	Hungary	Latvia	Lithuania	Poland	Romania	Russia
				Exchange rates					
Mean	-2.560	3.500	2.579	3.993	-0.118	1.774	1.622	1.173	3.386
SD	0.314	0.276	0.156	0.244	0.203	0.243	0.178	0.960	0.314
CV	-0.123	0.079	0.060	0.061	-1.719	0.137	0.109	0.819	0.093
Skewness	-0.019	-0.337	0.509	-0.160	-0.725	-0.069	-0.688	-1.373	0.305
Kurtosis	2.142	1.795	2.390	1.768	2.103	1.986	2.555	3.536	1.890
Normality[a]	6.214	16.037	11.458	13.644	24.441	8.818	17.618	65.929	13.486
p-value	0.045	0.000	0.003	0.001	0.000	0.012	0.000	0.000	0.001
				Stock prices					
Mean	6.066	6.600	5.712	6.444	5.784	5.404	10.016	7.714	6.187
SD	0.850	0.510	0.704	0.643	0.517	0.679	0.563	1.078	1.066
CV	0.140	0.077	0.123	0.100	0.089	0.126	0.056	0.140	0.172
Skewness	-0.374	0.336	-0.053	-1.064	-0.236	-0.340	0.093	-0.306	-0.252
Kurtosis	2.304	1.625	1.637	3.926	2.082	1.592	2.032	1.600	1.963

Normality[a]	5.749	19.706	14.403	45.359	6.309	14.462	8.183	16.438	10.742
p-value	0.056	0.000	0.001	0.000	0.043	0.001	0.017	0.000	0.005

SD: standart deviation; CV: coefficient of variation (SD/mean). [a]: Jarque-Bera normality test. p-value is corresponds to the Jarque-Bera normality statistic.

5. Empirical Findings

The Toda-Yamamoto causality approach and nonlinear causality test require investigating unit root properties of the variables. To this end, the unit root tests - developed by Dickey and Fuller (1979), Phillips and Perron (1988), Kwiatkowski et al. (1992)[1] were applied to the series and results show that the variables are integrated of order one. Accordingly, the maximum integration order (d) of the variables will be equal to one in the Toda-Yamamoto procedure and the series in first difference (i.e., stationary/return series) will be used also in nonlinear causality test.

The results for the linear Granger causality test are presented in table 3. Results indicate that the null hypothesis of Granger non-causality from exchange rates to stock prices are rejected in the case of Czech Republic, Hungary, Poland, Romania, and Russia. On the other hand, the null hypothesis of non-causality can not be rejected for Bulgaria, Estonia, Latvia, and Lithuania, implying that exchange rates are not cause of stock prices. When we look at causal linkage from stock prices to exchange rates, the null hypothesis of Granger non-causality is rejected only in the case of Russia. For other six transition economies, the null hypothesis of no causality can not be rejected, which implies that exchange rate markets are not sensitive to stock markets. For Russia, it appears that there is a feedback relation between exchange rate and stock markets. In fact, this finding is not so surprising. Russia is one of most eight countries in the world[2] and in most developed countries it is well known that exchange rate and stock markets are highly correlated to each other.

Table 2: Linear Granger causality test[3]

	Exchange rates $\neq>$ stock prices		Stock prices $\neq>$ exchange rates	
	Statistic	p-value	Statistic	p-value
Bulgaria	0.1387	0.709	2.3487	0.125
Czech Republic	7.8569	0.005	0.0137	0.906
Estonia	0.2081	0.648	0.7406	0.389
Hungary	8.6170	0.003	0.2605	0.609

[1] To save space, the results from unit root analysis are not reported here but available from authors upon request.
[2] The Group of Eight (the G8, formerly the G6 and then G7) is a forum for the governments of seven major economies: Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States. In 1997, the group added Russia, thus becoming the G8.
[3] The Toda-Yamamota causality procedure requires a diagnostic checking procedure. In that respect, we test for serial correlation, heteroscedasticity and functional miss-specification. The Breusch-Godfrey's serial correlation test implies that the residual of the estimated models are free from auto correlation problem. The Ramsey's model miss-specification test clearly shows that the functional forms of the models are appropriately specified. The White's heteroscedasticity and Engel's autoregressive conditional heteroscedasticity (ARCH) tests indicate the validity of homoscedasticity assumption. To save space the results from the diagnostic tests are not reported here but available upon request.

Latvia	0.5753	0.448	1.0325	0.309
Lithuania	2.2810	0.130	0.0234	0.878
Poland	9.3002	0.002	0.0965	0.755
Romania	14.2816	0.000	0.5212	0.470
Russia	8.6014	0.003	7.8481	0.005

Notes: ≠> denotes Granger non-causality hypothesis. The SBC was used to determine the optimal lag lengths for VAR(p+d) models.

As emphasized earlier, linear causality methods is not able to nonlinear causal dynamics between variables of interest. There is a recent consensus on that exchange rates and stock prices exhibits nonlinearities and, consequently, conventional causality test may have low power in detecting causal linkages. To see whether exchange rates and stock prices are characterized by a nonlinear process, we carry out the BDS test proposed by Brock et al. (1996). The BDS test provides a nonparametric statistic for testing the null hypothesis of the identically and independently distributed error term in series. The rejection of the null hypothesis supports evidence of nonlinearity in data. Results from the BDS test on the VAR(p+d) model residuals are listed in table 4.[4] The p-values show that the null hypothesis of identically and independently distributed error term is rejected in favor of nonlinearity for all the transition economies under study. Therefore using linear Granger causality tests for policy implications regarding the nature of causation between exchange rates and stock prices in the transition economies may be misleading. The empirical analysis continues with examining the nonlinear causal linkages between exchange rates and stock prices.

Table 3: Results for the BDS nonlinearity test

	Exchange rates		Stock prices	
	Statistic	p-value	Statistic	p-value
Bulgaria	0.001140	0.0000	0.003567	0.0001
Czech Republic	0.007304	0.0020	0.005179	0.0531
Estonia	0.000266	0.0373	0.002821	0.0000
Hungary	0.002496	0.0000	0.000418	0.0139
Latvia	0.002454	0.0000	0.006162	0.0000
Lithuania	0.019326	0.0000	0.001443	0.0000
Poland	0.002627	0.0000	0.000625	0.0030
Romania	0.001564	0.0000	-0.000300	0.0763
Russia	0.049821	0.0000	0.010408	0.0002

The statistics were based on the residuals of the VAR(p+d) models.

[4] The nonlinear analysis requires filtering out the linear relationships. The BDS test for nonlinearity is therefore applied to the residuals of VAR(p+d) models. The BDS test was performed up to six dimensions (m=2,3,…,6) and the length in standard deviation was set to 0.5. The results were reported for six dimensions to conserve the space, but results for lower dimensions are available upon request.

Before discussing the results from the nonlinear causality test, it is important to note that the Diks-Panchenko nonlinear causality test was applied to the filtered VAR residuals because after removing linear causality with the VAR model, any causal linkage from one residual series of the VAR model to another can be considered as nonlinear predictive power (Hiemstra and Jones, 1994: 1648). Table 4 presents the results from the nonlinear causality test. The test statistics indicate that the null hypothesis of nonlinear Granger non-causality from exchange rates (stock prices) to stock prices (exchange rates) is rejected only for Russia, the null hypothesis although can not be rejected for other six countries. The nonlinear causality analysis provides a feedback relation between exchange rates and stock markets in Russia. Furthermore, it clearly indicates that the nature of causality between exchange rate and stock markets is consistent with neutrality in seven transition economies, which implies that exchange rates and stock prices are not sensitive to perturbations in each other.

Table 4: Non-linear Granger causality test

	Exchange rates ≠> stock prices		Stock prices ≠> exchange rates	
	Statistic	p-value	Statistic	p-value
Bulgaria	0.1180	0.453	0.8138	0.208
Czech Republic	0.7759	0.219	0.9398	0.173
Estonia	0.8288	0.204	0.1960	0.422
Hungary	-0.2175	0.586	0.5242	0.300
Latvia	-0.3685	0.644	1.1151	0.132
Lithuania	0.2070	0.418	0.4605	0.323
Poland	-0.0057	0.502	-1.5183	0.936
Romania	0.8231	0.205	-0.7162	0.763
Russia	1.7407	0.041	2.7906	0.003

≠> denotes nonlinear Granger non-causality hypothesis. The nonlinear causality statistics were based on the residuals of the VAR(p+d) models. The lag length is equal to one ($\ell_X = \ell_Y = 1$). The bandwidth is set to unity.

6. Conclusions

This paper investigates relationship between exchange rates and stock prices in transition economies (i.e., Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, and Russia) by employing yearly data from 1995 to 2011. In order to determine the causal linkage among the variables in question, we employ linear and nonlinear causality test approach. According to linear Granger causality test, there is no causal relationship between the variables in Bulgaria, Estonia, Latvia and Lithuania. So the non-linear Granger causality analyses imply that non-causality from exchange rates (stock prices) to stock prices (exchange rates) is accepted all countries except for Russia. The causality implies that dynamics of exchange rates in those countries provides information to predict dynamics of stock prices fro investment, speculation, and portfolio strategies. Transition economies undergo economic liberalization, where market forces set prices rather than a central planning organization. In addition to this trade barriers are removed, there is a push to privatize state-owned businesses and resources, and a financial sector is created to facilitate macroeconomic stabilization and the movement of private capital. The transition process is usually characterized by the changing and creating of institutions, particularly private enterprises; changes in the role of the state, thereby, the creation of fundamentally different governmental institutions and the promotion of private-owned enterprises, markets and independent financial institutions.

References

Abdalla, I. S. A., Murinde, V., 1997. Exchange Rate and Stock Price Interactions in Emerging Financial Markets: Evidence on India, Korea, Pakistan, and Philippines, Applied Financial Economics 7, 25-35.

Adler, M., Dumas, B., 1984. Exposure to currency risk: Definition and measurement, Financial Management, 13, 41-50.

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

Ajayi, R. A., Mougoue, M., 1996. On the Dynamic Relation between Stock Prices and Exchange Rates, The Journal of Financial Research, 19: 193-207.

Aloui, C., 2008. Price and volatility spillovers between exchange rates and stock indexes for the pre- and post-euro period, Quantitative Finance, 7, 6, 669-685.

Baek, E., Brock, W. A., 1992. General test for nonlinear Granger causality: bivariate model. Working Paper. Iowa State University and University of Wisconsin-Madison.

Bartov, E., Bodnar, G., 1994. Firm valuation, earnings expectations and the exchange-rate effect, Journal of Finance 49, 1755–1785.

Bekiros, S.D., Diks, C.G.H., 2008. The relationship between crude oil spot and futures prices: cointegration, linear and nonlinear causality, Energy Economics 30, 2673-2685.

Bodnar, G., Gentry, W., 1993. Exchange rate exposure and industry characteristics: evidence from Canada, Japan, and the U.S., Journal of International Money and Finance 12, 29–45

Chamberlain, S., Howe, J., Popper, H., 1997. The exchange rate exposure of U.S. and Japanese banking institutions, Journal of Banking and Finance 21, 871-892.

Cheung, Y.W., Ng, L.K., 1996. A causality in variance test and its application to financial market prices. Journal of Econometrics 72, 33–48.

Chow, E.H., Lee, W.Y., Solt, M. S., 1997. The Exchange Rate Risk Exposure of Asset Returns, Journal of Business, 70, 105-123.

Dickey, D.A., Fuller, W.A., 1979. Distribution of the estimators for autoregressive time series with a unit root. Journal of the American Statistical Society 75, 427–431.

Diks, C.G.H., Panchenko, V., 2005. A note on the Hiemstra-Jones test for granger non-causality. Studies in Nonlinear Dynamics and Econometrics 9(2), 1-7.

Diks, C.G.H., Panchenko, V., 2006. A new statistic and practical guidelines for nonparametric Granger causality testing. Journal of Economic Dynamics and Control 30, 1647-1669.

Donnelly R., Sheehy E., 1996. The Share Price Reaction of UK Exporters to Exchange Rate Movements: An Empirical Study, Journal of International Business Studies, 27, 157-65.

Dornbusch, R., Fisher, S., 1980. Exchange Rates and the Current Account, American Economic Review, 70, 960-971.

Dumas, B., Solnik, B., 1995. The World Price of Foreign Exchange Risk, Journal of Finance, 47, 445-477.

Gavin, M., 1989. The Stock Market and exchange Rate Dynamics, Journal of International Money and Finance, 8, 181-200.

Granger, Clive W.J., Huang, B-N., Yang, C-W, 2000. A bivariate causality between stock prices and exchange rates: evidence from recent Asian flu, The Quarterly Review of Economics and Finance, 337-354.

Griffin, J. M., Stulz, R. M., 2001. International competition and exchange rate shocks: A cross-country industry analysis of stock returns, Review of Financial Studies, 14, 215−241

Hafner, C. M., Herwartz, H. (2006). A Lagrange multiplier test for causality in variance. Economics Letters 93 (2006) 137–141.

Hatemi-I, A., Roca, E., (2005) Exchange rates and stock prices interaction during good and bad times: evidence from the ASEAN4 countries, Applied Financial Economics, 15, 539-546.

He, J., Ng, L., 1998. Foreign exchange exposure, risk, and the Japanese Stock Market, Journal of Finance 53, 733–753.

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.

Hong, Y. 2001. A test for volatility spillover with application to exchange rates. Journal of Econometrics 103, 183-224.

Jorion, P., 1991. The Pricing of Exchange Rate Risk in the Stock Market, Journal of Financial and Quantitative Analysis, 26, 361-376.

Kwiatkowski, D., Phillips, P.C.B., Schmidt, P., Shin, Y., 1992. Testing the null hypothesis of stationary against the alternative of a unit root. Journal of Econometrics 54, 159–178.

Lütkepohl, H., 2004. Vector autoregressive and vector error correction models. In Applied Time Series Econometrics, eds (Helmut Lütkepohl and Markus Kratzig), Cambridge University Press: Cambridge.

Mar, C. K., Kao, G. W., 1990. On exchange rate changes and stock price reactions, Journal of Business Finance and Accounting, 11, 441-449.

Pan M-S., Chi-Wing, F. R., Liu, Y., 2006. Angela, Dynamic linkages between exchange rates and stock prices: Evidence from East Asian markets, International Review of Economics and Finance, 16, 503-520.

Phillips, P.C.B., Perron, P., 1988. Testing for a unit root in time series regressions. Biometrica 75, 335–346.

Ramasamy B., Yeung, M., 2001. Selective Capital Controls in Malaysia – Is it time to abandon them?, Asia Pacific Finance Association Annual Conference**,** Bangkok, July 22 – 25 2001.

Roll, R., 1992. Industrial Structure and the Comparative Behaviour of International Stock Market Indices, Journal of Finance, 47, 3-41.

Soenen, L.A., E.S. Hennigar, E. S.,1988.An Analysis of Exchange Rates and Stock Prices - The US Experience between 1980 and 1986, Akron Business and Economic Review, (Winter), 7-16.

Toda, H.Y.,Yamamoto, T., 1995. Statistical inference in vector autoregression with possibly

integrated processes. Journal of Econometrics 66, 225–250.

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, 260−274.

Yu, Q., 1997. Stock Prices and Exchange Rates: Experience in Leading East Asian Financial Centers Tokyo, Hong Kong and Singapore. Singapore Economic Review, 41, 47-56.