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The dynamic relationship between stock prices and exchange rates: evidence from four transition economies

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Abstract

This article examines the dynamic relationship between exchange rates and stock prices in four Easter European markets, Czech Republic, Hungary, Poland and Slovakia, using stock price and exchange rate data from these countries, as well as stock prices from the United States, Germany and the United Kingdom. The data set consists of daily data over a 7 year period from 1999 to 2006. Both the long-run and the short-run association between these variables are analyzed. We employed the Johansen cointegration technique, Vector Error Correction Modeling and the standard Granger causality test to analyze the relationship between these two financial variables. Our findings show that there is no evidence of stock prices and exchange rates moving together either in the long-run or in the short-run, with the exception of Slovakia, where cointegrating relationships were found. In terms of our causality analysis our results show a unidirectional causal relationship form the exchange rates to the stock prices in the case of Hungary, Poland and Czech Republic. There is also evidence of causality from the Hungarian exchange rate to the United Kingdom stock prices, from the Polish exchange rates to the United Kingdom stock prices, from the Czech Republic exchange rate to the United Kingdom stock prices and from the Slovakian exchange rates to the United Kingdom stock prices. And finally we also found evidence of causality from the stock prices to the stock prices in the case of Hungary to United Kingdom, United Kingdom to Poland, and the United States to Poland.

1. Introduction

The aim of this article is to provide an empirical analysis of the interaction between exchange rate fluctuations and stock prices in four Eastern European Countries. A positive relationship between the exchanges rate and stock prices may result from a real interest rate disturbance as the real interest rises, capital inflow increases and the exchange rate falls (Wu, 2001). On the other hand the theory of arbitrage suggests that a higher real interest rate reduces the present value of the firms' future cash-flows and causes the stock prices to fall. Changes in the exchange rate affects the international competitiveness of countries where exports are strong and fluctuations in foreign exchange rates can lead to substantial changes in the relative performance of equity portfolios, when expressed in a common currency (Malliaropulos, 1998). From a practical point of view, knowledge of the linkage between assets prices is necessary for investors in their search of diversification opportunities and for the hedging of their investments. Accurate information on the relationship between exchange rates and stock markets is important for economic and financial policy-makers and regulators as a basis to formulate appropriate policies (Hastemi-J and Roca, 2005).

There are a number of existing studies that attempt to determine the impact on stock prices of exchange rates, however, however the findings are not uniform (Ibrahim, 2000). Some studies give evidence of positive effects on exchange rates on stock markets (Aggarwal, 1981), while others found negative effects (Soenen and Henningar, 1988). Other studies concluded that the exchange rate changes have no significant impact on the stock market (Solnik, 1984). Thus, the existing literature provides mixed results when analysing the relationship between exchange rates and stock prices. Furthermore, there is a lack of research in this area related to Eastern European countries. Our research will contribute to the existing literature in adding to the existing empirical evidence on this issue, as well as providing updated evidence on this relationship for Hungary and the Czech Republic and new evidence for Poland and Slovakia , which to our knowledge, have not previously been the focus of research on this issue.

The layout of the paper is as follows. Section 1 reviews the existing empirical evidence on this issue to date. Section 2 sets out the data and methodology used to investigate the issue. Section 3 discusses the results from the econometric analysis and Section 4 draws some conclusions from our research.

2. Literature Review

A large number of studies have investigated the relationship between stock prices and exchange rates for a variety of countries, using a variety of approaches; we focus here on the results from relatively recent studies. Yau and Nieh (2006) employed various linear and non-linear time series methodologies to investigate the short-term and long-term relationships among the stock prices of Taiwan and Japan and the NTD/Yen exchange rate during the period of January 1991 to July 2005. They found that the conventional Johansen test and advanced GH test are consistent and both showed no long-term co-movement among the three variables. Furthermore, the results from the Granger causality test shown that bidirectional feedback relationship between stock prices of Taiwan and Japan are significant. However, there is no significant linkage or causal relationship found between each of the stock prices and the NTD/Yen exchange rate.

Hatemi-J and Roca (2005) used bootstrap causality tests with leveraged adjustments to analyse the link between exchange rates and stock prices in Malaysia, Indonesia, Philippines and Thailand, before and during the Asian financial crisis of 1997. They used daily data for nominal exchange rates and the Morgan Stanley Capital international price indices for Stock prices form 1 January to 31 December 1997. The sample period was divided into two sub-periods: period one from 1 January to 31 July 1997 representing the period before the crisis or normal situation and period two from 2 July to 31 December 1997 representing the crisis period. They found that during the period before the Asian crisis, with the exemption of Philippines exchange rates and stock prices were significantly related, with the direction of causality running from the former to the latter in the case of Indonesia and Thailand, and from the latter to former in the case of Malaysia. However, during the crisis period this relationship ceased to exist in any of the countries.

Grambovas (2003) is one of the few studies which analyses this issue and includes certain Eastern European countries, analysing the interaction between exchange rate fluctuations and equity prices for Greece, The Czech Republic, and Hungary. His data set consisted of weekly observation – Friday closing values- of the general stock exchange indexes of stock exchanges for Athens (CI), Budapest (BUX), Prague (PX-50), New York (Dow Jones Industrials) and Frankfurt (DAX-30) and spot foreign exchange rates for Greece in relation to the British pound (GBP), Hungary and the Czech Republic in relation to the deutsche mark (DEM). The data period covers January 1, 1994, to February 28, 2000. He used a trivariate model that included an additional variable as a proxy for the international financial environment based on the rationale that changes in international stock markets can lead to changes in the relevant domestic stock exchange due to issues of international investor sentiment. The article studies the long-run and short-run dynamics between stock prices and exchanges rates, and the results indicate that there is relationship between Hungarian exchange rates and stock prices, as well in the case of Greece. He concluded that these results illustrate that changes in the stock markets may affect exchange rates.

Shamsuddin and Kim (2003) investigated the integration of the Australian stock market with its two leading partners, US and Japan, taking into account the interdependence between foreign exchange rates and stock prices. The data used was the end-of-week closing stock price indexes for Australia, Japan and the US, and the Australian dollar value of the Japanese yen and US dollar. The national stock indexes used were the Standard and Poor's 500 Composite Index for the US, the Tokyo Stock price Index (TOPIX) for Japan and the all ordinaries index (AOI) for Australia. They analysed the pre-Asian crisis period that cover two sub-periods: January 1991 to December 1993, and January 1994 to July 1997. The post-Asian crisis period covers form January 1998 to May 2001. Their methodology consisted of VAR models and multivariate time series models for each period. They found a cointegrating relationship among the variables prior to the Asian crisis, but such a relationship did not exist in the post-Asian period. The multivariate models indicated that in the pre-crisis period, the Australian stock market was primarily led by the US stock markets (as opposed to Japan), however, in the post-crisis period, the Australian stock markets have become more dependent upon its own its own past and less on the US market. They also found that stock returns are led by foreign exchange rates but that the former do not significantly influence the latter.

Smyth and Nandha(2003) investigated the interaction between exchange rates and stock prices for four South Asian countries (Bangladesh, India, Pakistan and Sri Lanka) using daily data over the period 1995 to 2001. Both Engle and Granger two step and Johansen cointegration methods were used and the results suggest that there is no long-run equilibrium relationship between these two financial variables in any of the four countries. Granger causality tests indicated that there was uni-directional causality running from exchange rates to stock prices in India and Sri Lanka, but in Bangladesh and Pakistan exchange rates and stock prices are independent.

Hatemi-J and Irandoust (2002) used the Granger testing procedure developed by Toda and Yamamoto (1995) to analyse the relationship between stock prices and exchange rates in Sweden using monthly nominal effective exchange rates and stock prices covering the period 1993-98. Their results showed that Granger causality is unidirectional and is running from stock prices to effective exchange rates.

Nieh and Lee (2001) found no long-run significant relationship between stock prices and exchange rates in the G-7 countries. Their analysis covered the period from October 1, 1993 to February 15, 1996 using daily closing stock market indices and foreign exchange rates for the G7 countries (Canada, France, Italy, Japan, UK and the US). The methodology used consisted of the Engle-Granger (EG) two step and the Johansen maximum likelihood cointegration test. They studied the dynamic relationships between the stock prices and the exchange rates for each G-7 countries; their results reject most of the previous studies that suggest a significant relationship between stock prices and exchange rates as they rejected the existence of a significant relationship between stock prices and exchange rates.

Granger, Huang and Yang (2000), analyse the relationship between stock prices and exchange rates using Asian data. They employed daily data and the methodology consisted of the use of impulse response functions to explore the relationship between the two variables and their dynamics. In addition, they used advance unit root and cointegration techniques, to study the exchange rates and stock prices for Hong Kong, Indonesia, Japan, South Korea, Malaysia, the Philippines, Singapore, Thailand and Taiwan over the period that from January 3, 1986 to June 16, 1998. They divided the sample into three sub-periods: Period one (1987-Crash) covered from January 3, 1986 to November 30, 1987; Period two (after Crash) started from December 1, 1987 and ended on May 31, 1997 and period three (the Asian flu period), continued from June 1, 1997 through June 16, 1998. Their findings showed that during period one, there existed little interaction between currency and stock markets except for Singapore. The study also indicated that changes in the exchange rates lead stock prices in Singapore. In period two (or after the Crash period) there is no definite pattern of interaction between the two markets, however, during period three (the Asian flu period) seven of the nine nations suggested significant relations between the two markets. In the case of South Korea, changes in the exchange rates lead the stock prices. The reverse direction is found in Hong Kong and the Philippines. The rest of the markets (Malaysia, Singapore, Thailand and Taiwan) are characterized by feed back interactions in which changes in exchange rates can take the lead and vice-versa.

Ibrahim, M.H (2000) analysed the interactions between stock prices and exchange rates in Malaysia using bivariate as well as multivariate cointegration techniques, and the Granger causality test for the period January 1979 to June 1996. His results suggest the absence of cointegration between stock prices and exchange rates in a bivariate context. However, in a multivariate framework they found that there seems to be a long-run relationship between the stock price index and exchange rate measure, reserves and money supply. He also found unidirectional causality from the stock market to the exchange rate. Additionally, a feed back effect from the bilateral RM/US$ rate to the stock market was also observed.

Morley and Pentecost (2000) investigated the nature of the relationship between stock prices and spot exchange rates using monthly data over the period 1982 to 1994 for the G-7 economies. The methodology used consisted of the Engle and Granger test for cointegration between pairs of exchange rate and relative stock market price indices. Their findings indicated that most of the countries tested do not have a common, bilateral long-term trend, with the exception of the UK and Canada.

Philaktis and Ravazzolo (2000) investigated the long-run and short-run dynamics between stock prices and exchange rates and the channels through which exogenous shocks impact on these markets through the use of cointegration methodology and multivariate Granger causality tests. They performed their analysis on Hong Kong, Indonesia, Malaysia, Singapore, Thailand and the Philippines over the period 1980 to 1998. Their main findings showed no long-run relationship between the real exchange rate and the local stock market in each Pacific Basin country. The US stock market was found to be an important causal variable, which acts as a conduit through which the foreign exchange and the local markets are linked. The results from the trivariate systems suggest that for all the countries the real exchange rate and US stock prices are positively related to domestic stock prices.

Wu (2000) used an error correction model to explore the asymmetric effects of four different exchange rates on Singapore stock prices and the effects sensitivity to economic volatility. The methodology consisted in a p-dimensional vector autoregressive model with Gaussian errors that was formulated into a VECM. The model consisted of six variables: the Strait Times price index of Singapore, Dow Jones Industrial Average Index, four bilateral exchange rates that linked the Singapore dollar with the Malaysian ringgit, Indonesia rupiah, US dollar and Japanese Yen. The study divides the weekly data of the 1990s into four sub-periods: (04/03/91-01/25/95), pre-crisis period (02/01/95-05/25/97), crisis period (07/02/97-12/3098) and recovery period (01/06/99-05/31/00). The results suggest that there is an asymmetry in terms of the equilibrium stock price and exchange rate relationship with respect to the different countries. It appears that Granger causality runs only in one way from exchange rates to stock prices. The cointegration analysis suggested that for most of the selected periods in the 1990s both the Singapore currency appreciation against the US dollar and Malaysian ringgit depreciation against the Japanese yen and Indonesia rupiah have positive long-run effects on stock prices.

These studies illustrate that the existing literature provides mixed results on the relationship between exchange rates and stock prices and that there is a dearth of existing evidence on this issue for Eastern European countries. Our research attempts to address the gap in this area by updating the existing evidence for the Czech Republic and Hungary, and providing new evidence on this issue for Poland, and Slovakia.

3. Data and Methodology

The analysis will be conducted with the purpose of investigating the relationship between the Exchange Rates and Stock Prices for the Czech Republic, Hungary, Poland and Slovakia for the period 1999-2006. The data consists of daily (5 days) closed stock market indices and foreign exchange rates with a total of 1964 observations on the exchange Rates (CZECH KORUNA, Hungarian FORINT, Polish ZLOTY) and stock Prices (Prague Se PX, Budapest BUX, Warsaw General Index, Slovakia SAX 16) for each country plus the stock indexed of the US, the UK and Germany (DAX, FTSE 100, Down Jones Industrial) as proxies for the international financial environment. Given that it is well known in the literature that using monthly data may not be adequate in describing the effect of capital movements, we employ daily data to capture such effects. The length of the time period covered will facilitate a comparison of the relationship between currency depreciation and stock returns in each country as well as allowing us to examine the extent of differences in the relationship between stock prices and exchange rates across the individual markets.

The methodology that will be used for this analysis involves the use of time series techniques including, testing for unit roots using Dickey-Fuller (DF) and Augmented Dickey-Fuller (ADF) test (1979), testing for serial correlation of errors, using LMF (Lagrange Multiplier), testing for cointegration, using the Engle Johansen Cointegration Test (1992) and Granger multivariate causality tests (1981) to investigate the relationship between the various markets.

As an initial step in the analysis, we perform tests for stationarity on each of the relevant variables that are included in our analysis. For this particular issue, the stationary test procedure developed by Dickey and Fuller (1979) will be used. This technique considers three different regression equations that can be implemented to test for the presence of unit root:

1. $\Delta Y_t = \gamma Y_{t-1} + \varepsilon_t$ Pure random model.
2. $\Delta Y_t = a_0 + \gamma Y_{t-1} + \varepsilon_t$ Model that add an intercept and drift term.
3. $\Delta Y_t = a_0 + \gamma Y_{t-1} + a_{2t} + \varepsilon_t$ Model that adds an intercept and linear time trend.

The Augmented Dickey-Fuller test (ADF) procedure will be used to test for stationarity in the presence of serial correlation and the model that will be used in this case is:

$$\Delta Y_t = \alpha + \gamma Y_{t-1} + \sum_{i=2}^{p} \Delta Y_{t-i+1} + \varepsilon_t$$

After applying these equations and demonstrating evidence that the series are stationary, the Lagrange Multiplier (LMF) test, will be implemented to test for the existence of serial correlation in the error term. This test will allow us to verify that our residuals are white noise. We use the Lagrange Multiplier test as this test is valid in the presence of lagged dependent variables and also tests for higher order autocorrelation.

$$Y_t = \beta_0 + \beta_1 X_{1t} + \ldots + \beta_k X_{kt} + \mu_t \text{ ;}$$

$$\text{with } \mu_t = \rho_1 \mu_{t-1} + \ldots + \rho_p \mu_{t-p} + \varepsilon_t$$

$$\hat{\mu}_t = Y_t - \hat{\beta}_0 - \hat{\beta}_1 X_{1t} - \ldots - \hat{\beta}_k X_{kt}$$

After applying these equations and demonstrating that our series are stationary and there is no existence of serial correlation in the error term, we proceed and perform the cointegration test on variables.

We will use the Johansen Cointegration test to investigate the long-run relationship between Stock Prices and Exchange Rates. The results of the test can be quite sensitive to the lag length (Enders, 2004). The most common procedure is to estimate a Vector Autoregression model using the undifferenced data in order to determine the lag length for the Johansen test. We will first estimate the lag selection tests up 20 lags. This test will give us the following output: the Likelihood Ratio test (LR), Final Prediction Error (FPE), Akaike's Information Criteria (AIC), Schwarz Information Criteria (SC) and the Hannan Quinn Criteria (HQ). Following Johansen et al (2000), we will select the results from the HQ criteria, due to the fact that, when information criteria suggests different lag, it is common practice to prefer Hannan Quinn. After performing our VAR models for the Johansen test we will need to ensure that there is no serial correlation in the lag length selected from our VAR model, therefore, we will implement the Lagrange Multiplier (LM), test for serial correlation up to the number of lags that our VAR indicates. We will also test for normality on the errors using Cholesky, Doornik and Urzua normality test, JB test and finally we will also test for the no existence of heteroskedasticity. When we have verified that our errors are not serial correlated, normal and homokedastic we will be able to proceed and conduct the Johansen Cointegration Test.

Our first step will be to summarize the results for the 5 possible models that are possible to choose for the Johansen test. These results will give us an idea of the output that we could get through the 5 models. After we run this option we will proceed to conduct the Johansen test. As we mentioned before, there are 5 possible models to choose form, Harris and Solis (2003) note that model 1 i.e.: with no deterministic components in the data or cointegration relations is unlikely to occur in practice, as generally an intercept is needed to take into account of the units of measurement of the variables. Hence, this leaves a choice between models 2 to 5. They also note that model 5 with quadratic trends, is economically hard to justify, as the variables are entered in logs, this would imply an every increasing or decreasing rate of change. This leaves a choice between models 2 to 4. Johansen (1992) suggest choosing the appropriate model according to the Pantula principle; all three models are estimated and the results are presented for each, the test procedure involves moving through each model for the null hypothesis of r=0 (no existence of cointegrating relationship between the variables), then r=1, etc and picking the model where the null hypothesis is rejected for the first time.

After we have run our cointegration analysis we proceed and investigate the possible causal relationships between stock prices and exchange rates in each country. Normally a bivariate model is selected in terms of analyzing the relationship between stock prices and exchange rates, as illustrate below.

$$EX_t = \beta_0 + \beta_1 PI_t + \varepsilon_t$$

where EX is the exchange rate and PI is the stock price index. Economic theory supports the existence of a long-run relationship in the above system. Such a relationship derives from the connection of both the exchange rate and equity prices with the level of general economic activity, as demonstrated by Philaktis and Ravazzolo (1999). In addition, empirical studies have demonstrated that a significant relationship has been found in a number of countries (Quiao, 1996; Bahmani-Oskooee and Domac 1997). Moreover, where cointegration has not been demonstrated, this may not be because of its absence but actually because of the omission of one or more important variables (Grambovas, 2003). Therefore, we have decided to include another variable to capture the possibility that changes in international stock markets can lead to changes in the relevant domestic stock exchange due to issues of international investor sentiment. In our case to proxy the international environment we introduce three different variables; the German, UK and US stock markets in order to analyze three different scenarios. The trivariate case can be described as:

1. $EX_t = \beta_0 + \beta_1 PI_t + \beta_2 GEI_t + \varepsilon_t$
2. $EX_t = \beta_0 + \beta_1 PI_t + \beta_2 UKI_t + \varepsilon_t$
3. $EX_t = \beta_0 + \beta_1 PI_t + \beta_2 USI_t + \varepsilon_t$

Where GEI is the DAX XETRA Index, UKI the FTSE 100 Index and USI the Dow Jones Industrial Index

After we have implemented the basic battery of econometric techniques (Dickey & Fuller Test, LMF, Engle & Granger Test) to establish whether equity markets move together in the long term, we also want to analyze whether there is any causal relationships between the various markets. Thus we proceed and implement a causality test between the markets. A critical issue in the Granger causality tests is to establish the optimal number of lags for the variables included in the regression. We use both the Akaike Information Criterion and the Hannan Quinn criterion to specify the optimal number of lags for the Granger causality test.

The basic idea of the Granger causality test is that a variable X (Koop, 2004) Granger causes Y, if past values of X can help to explain Y. One important thing to bear in mind is that if Granger causality holds, this does not guarantee that the inverse will hold, that is that X causes Y. Nevertheless, if past values of X have explanatory power for current values of Y, it at least suggests that X might be causing Y.

Our initial model for causality test will be:

$$Y_t = \alpha_0 + \beta_1 Y_{t-1} + \beta_2 X_{t-1} + \beta_3 Z_{t-1} + \varepsilon_{yt}$$

1. $EX_t = \alpha_0 + \beta_1 EX_{t-1} + \beta_2 PI_{t-1} + GEI_{t-1} + \varepsilon_{yt}$
2. $PI_t = \alpha_0 + \beta_1 PI_{t-1} + \beta_2 EX_{t-1} + GEI_{t-1} + \varepsilon_{yt}$

3. $EX_t = \alpha_0 + \beta_1 EX_{t-1} + \beta_2 PI_{t-1} + UKI_{t-1} + \varepsilon_{yt}$
4. $PI_t = \alpha_0 + \beta_1 PI_{t-1} + \beta_2 EX_{t-1} + UKI_{t-1} + \varepsilon_{yt}$

5. $EX_t = \alpha_0 + \beta_1 EX_{t-1} + \beta_2 PI_{t-1} + USI_{t-1} + \varepsilon_{yt}$
6. $PI_t = \alpha_0 + \beta_1 PI_{t-1} + \beta_2 EX_{t-1} + USI_{t-1} + \varepsilon_{yt}$

This model will allow us to interpret the causality relationship between the countries. The regression model implies that last periods values of X have explanatory power for the current value of Y. Our coefficient β_2 is the coefficient measuring the influence of X_{t-1} on Yt. If β_2=0, this means that past values of X have no effect on Y and there in no way that X could Granger cause Y.

In other words, past values of X have no explanatory power for Y beyond that provided by past values for Y.

If β_2 is statistically significant (e.g.: p-value < 0.05) we will conclude that X Granger causes Y. Therefore, if our contrast hypothesis tests conduct us to accept our null we will conclude that Granger causality does not occur.

$$\left.\begin{array}{l} H_0 : \beta_2 = 0 \\ Ha : \beta_2 \neq 0 \end{array}\right\}$$ If we accept our null, this means that Granger causality does not occur.

An important factor to take into account in our causality analysis is that we would be able to find that Y Granger causes X, but also X Granger causes Y or not. In terms of our analysis, this means that it will be possible to find that stock prices may cause exchange rates but that does not means that the opposite effect should occur.

If we find that two variables are cointegrated, it will be necessary to estimate an error correction mechanism including a variant (ECM). The ECM allows us to examine short run behavior between the various equity markets. To perform our ECM we follow the methodology set out in the Granger Representation Theorem (1981). This states that if Y and X are cointegrated, their relationship can be expressed as an ECM. Thus for the equity markets which we find are cointegrated we will construct the error correction mechanism through the following equation:

$$\Delta Y_t = \beta_0 + \lambda e_{1,t-1} + \beta_1 \Delta Y_{t-1} + \beta_2 \Delta X_{t-1} + \beta_3 Z_{t-1} + \varepsilon_{yt}$$

If we find that our variables are cointegrated and the residuals are stationary our ECM will be formulated as follows:

$$\Delta Y_t = \beta_0 + \lambda e_{1,t-1} + \beta_1 \Delta Y_{t-1} + \beta_2 \Delta X_{t-1} + \beta_3 Z_{t-1} + \varepsilon_{yt}$$

$$e_{t-1} = Y_{t-1} - \alpha_0 - \beta_2 X_{t-1} - \beta_3 Z_{t-1}$$

$$\lambda < 0 \qquad \text{Hypothesis to test in our ECM}$$

Where e_{t-1} are the residuals from the cointegrating regression in which the DF test has been performed. One interesting consequence (Koop, 2004) of the Granger Representation Theorem is worth noting is: If X and Y are cointegrated then is expected that some form of Granger causality must occur. That is, either X must Granger causes Y or Y must Granger cause X or both. If two variables are found to be cointegrated and error correction term must be included in the causality model as an explanatory variable, if we do not do this, and following Granger (1981) methodology a causality test between two cointegrated variables may produce misleading results.

To summarise the main points of the methodology set out above, we begin by performing Dickey Fuller, or Augmented Dickey Fuller tests where serial correlation is present, in order to ensure that the variables included in the analysis are stationary and that the results from the cointegration and causality analyses are not spurious. We follow this with the Johansen cointegration test. Following this, we conduct Granger causality tests for our variables to establish whether movement in stock prices have an impact on movements in exchange rates, and apply Akaike's information criteria to ensure that the lag length specified in the causality tests is optimal. Where we find that our variables are cointegrated, we included the errors from the cointegrating regression in the Granger causality tests in the form of an error correction mechanism (ECM) to examine whether there may also be a short run relationship between the variables. The results of our empirical analysis are presented in the next section.

4. Empirical Results

Following the steps have outlined in our methodology we begin by performing unit root tests on our variables[1]. The results obtained from the ADF test are shown in the Table 1. For comparison purposes, we have also performed the Phillips Perron (PP) test for unit roots. The ADF results indicate that we cannot reject our null hypothesis of the existence of unit root in levels for all our variables. The PP test results are consistent with the results from the ADF. We apply the ADF and PP tests for unit roots on the data in first differences. Our null hypothesis of a unit root can be rejected in all of our variables and for all of our countries. This means that we are in the presence of time series integrated at level one I(1), meaning that our series are all stationary at the same level. Thus, we conclude that all the series are I(1) processes.

TABLE 1: UNIT ROOT TESTS

Type of Test		ADF		PP	
Countries	**Variables**	**Levels**	**1st Diff.**	**Levels**	**1st Diff.**
Czech Republic	CZE	0.5344	19.0384*	0.5386	44.1260*
	CZI	0.4182	13.2265*	0.4949	40.7338*
Hungary	HGE	2.0405	31.8661*	1.9891	4.07551*
	HGI	0.3403	13.0366*	0.4010	41.5615*
Poland	POE	1.5001	19.4770*	1.6241	46.1103*
	POI	1.3379	16.1436*	1.2725	42.3800*
Slovakia	SLE	1.1184	28.8191*	1.1007	41.6648*
	SLI	0.0909	9.0546*	0.0185	46.1846*
Germany	GE	1.3310	19.0267*	1.2744	44.4622*
UK	UK	1.3108	16.0706*	1.2643	46.1370*
US	US	2.7288	32.7127*	2.6060	45.1036*

CZE:Czech Republic Exchange Rate, CZI: Czech Republic Stock Prices, HGE: Hungary Exchange Rates, HGI:Hungary Stock Prices, POE: Poland Exchange Rates, POI:Poland Stock Prices, Exchange Rates, SLE: Slovakia Exchange Rate, SLI: Slovakia Stock Prices, GE:Germany Stock Prices, UK:United Kingdom Stock Prices, US:United States Stock Prices

* Indicates rejection of the null hypothesis at 1% significance

Our next step in our analysis consists of performing our Lagrange Multiplier test (LMF) to verify the non-existence of errors serial correlation. We use the LMF test because this test is valid in the presence of lagged dependent variables as well as having the advantage of checking for first and higher orders of serial correlation. The p-values in Table 2 indicate that we can reject the null hypothesis of serial correlation for all of our variables at 1% significance level.

[1] The econometric results are generated from the Eviews package.

TABLE 2:LAGRANGE MULTIPLIER (LM)TEST FOR SERIAL CORRELATION

Type of Test		LM	
Countries	**Variables**	**LM-Statistic**	**p-values**
Czech Republic	CZE	2.5463	0.1107*
	CZI	2.4280	0.1193*
Hungary	HGE	20260	0.1580*
	HGI	1.4513	0.2284*
Poland	POE	4.4364	0.0353*
	POI	0.6205	0.4309*
Slovakia	SLE	2.9623	0.0114*
	SLI	0.0961	0.7565*
Germany	GE	0.6051	0.4367*
United Kingdom	UK	0.9367	0.3332*
United States	US	1.1425	0.2852*

CZE:Czech Republic Exchange Rate, CZI: Czech Republic Stock Prices, HGE: Hungary Exchange Rates, HGI:Hungary Stock Prices, POE: Poland Exchange Rates, POI:Poland Stock Prices, SLE: Slovakia Exchange Rate, SLI: Slovakia Stock Prices, GE:Germany Stock Prices, UK:United Kingdom Stock Prices, US:United States Stock Prices

Following Ma and Kao (1990) and Grambovas (2003) our cointegration analysis will be applied to all of our variables using a trivariate model, taking into consideration an additional variable as a proxy for the international financial environment. We consider three possible proxies for the international environment, that is, the German stock market, the United Kingdom stock market and the United States stock market. Thus, we analyse the impact of fluctuations of the DAX XETRA, FTSE 100 and the Dow Jones Industrial on each market.

In performing the Johansen cointegration test we first implemented a VAR model with the objective to decide the optimal numbers of lags for the test. We also tested the VAR for serial correlation; Table 3 shows the optimal lag length for each model based on the Hannan Quinn criteria as well as the results from the LM test for serial correlation which we have performed to verify that our VAR model is free of serial correlation. The p-values indicate that we fail to reject the null hypothesis of no serial correlation for all models at 1% significance.

The null hypothesis is of no cointegrating relationship between stock prices and exchange rates for each of the countries. The results that we obtained from the cointegration tests are shown in Tables 4-15. There are three tables for each country showing the results for cointegration between stock prices and exchange rates including the additional variable reflecting the international financial environment in Germany, the UK and the US. In picking between the three Johansen models (models 2-4), we follow the Pantula principle; all three models are estimated and the results are presented for each, the test procedure involves moving through each model for the null hypothesis of r=0 (no existence of cointegrating relationship between the variables), then r=1, etc and picking the model where the null hypothesis is rejected for the first time.

The results from the Johansen methodology indicate that there is no cointegrating relationship between the stock price and exchange rate in Hungary; all three models capturing the international financial environment are consistent in showing lack of cointegration. This is also the case for Poland and the Czech Republic. It is only in the case of Slovakia and Germany that the null hypothesis of no cointegration is rejected at 1% significance levels; hence we can conclude that a long-run relationship exists between the Slovakian exchange rate and stock prices, where the German stock price is included as an additional explanatory variable in the cointegrating regression. Both the Trace Statistic and the Max-Eigenvalue Statistic support rejection of the null hypothesis of no cointegration at 1% significance level. Therefore, we include an error correction term to capture the short-run relationship between the exchange rates and stock prices when performing the causality test in the Slovakian case.

TABLE 3: VAR LAG LENGTH SELECTION AND LM SERIAL CORRELATION TEST

Type of Test		LM	
Countries	**No. of Lags HQ criteria**	**LM-Statistic**	**p-values**
Hungary & GE	2	15.5515	0.0769*
Hungary & UK	2	16.3123	0.0606*
Hungary & US	3	8.8163	0.4544*
Poland & GE	2	16.3769	0.0594*
Poland & UK	3	8.8494	0.4513*
Poland & US	3	17.5239	0.0411*
Czech Republic & GE	1	8.0839	0.5257*
Czech Republic & UK	2	8.3264	0.5016*
Czech Republic & US	3	9.0905	0.4290*
Slovakia & GE	0	21.6000	0.0102*
Slovakia & UK	1	15.6737	0.0740*
Slovakia & US	1	17.0314	0.0482*

* Indicates fail to reject the null hypothesis of no serial correlation at 1% significance

TABLE 4: JOHANSEN COINTEGRATION TEST: HUNGARY AND GERMANY

Type of Test		JOHANSEN COINTEGRATION TEST				
Models	**No. of CE(s)**	**Trace Statistic**	**1% CV**	**Max-Eigen St**	**1% CV**	**Cointegration**
Model 2	None	26.4385	41.1950	18.8789	27.0678	No
	At most 1	7.5596	25.0781	6.7786	20.1612	No
	At most 2	0.7809	12.7607	0.7809	12.7607	No
Model 3	None	19.3187	35.4581	13.6595	25.8612	No
	At most 1	5.6591	19.9371	5.6591	18.5200	No
	At most 2	9.67E-07	6.6348	9.67E-07	6.6348	No
Model 4	None	26.4181	41.0814	12.1802	29.2615	No
	At most 1	12.3580	23.1523	5.7164	21.7442	No
	At most 2	5.6427	6.6348	1.3738	6.6348	No
Summary	Test	None No Intercept No Trend	None Intercept No Trend	Linear Intercept No Trend	Linear Intercept Trend	Quadratic Intercept Trend
Variables	Trace	0	0	0	0	0
	Max-Eig	0	0	0	0	0

TABLE 5: JOHANSEN COINTEGRATION TEST: HUNGARY AND UNITED KINGDOM

Type of Test		JOHANSEN COINTEGRATION TEST				
Models	**No. of CE(s)**	**Trace Statistic**	**1% CV**	**Max-Eigen St**	**1% CV**	**Cointegration**
Model 2	None	18.7893	41.1950	11.7285	27.0678	No
	At most 1	7.0608	25.0781	4.8675	20.1621	No
	At most 2	2.1933	12.7607	2.1933	12.7607	No
Model 3	None	13.5587	35.4581	9.8382	25.8612	No
	At most 1	3.7305	19.9371	3.6266	18.5200	No
	At most 2	0.1038	6.6348	0.1038	6.6348	No
Model 4	None	38.1844	49.3627	27.1128	30.8339	No
	At most 1	11.0715	31.1538	8.0136	23.9753	No
	At most 2	3.0579	16.5538	3.0579	16.5538	No
Summary	Test	None No Intercept No Trend	None Intercept No Trend	Linear Intercept No Trend	Linear Intercept Trend	Quadratic Intercept Trend
Variables	Trace	0	0	0	0	0
	Max-Eig	0	0	0	0	0

TABLE 6: JOHANSEN COINTEGRATION TEST: HUNGARY AND UNITED STATES

Type of Test		JOHANSEN COINTEGRATION TEST				
Models	**No. of CE(s)**	**Trace Statistic**	**1% CV**	**Max-Eigen St**	**1% CV**	**Cointegration**
Model 2	None	28.0149	4.1950	17.2342	2.70678	No
	At most 1	10.7806	25.0781	8.4220	20.1612	No
	At most 2	23.1485	12.7607	2.3485	12.7607	No
Model 3	None	23.0080	35.4581	6.6622	25.8612	No
	At most 1	6.3457	19.9371	6.1436	18.5200	No
	At most 2	0.2020	6.6348	0.2020	6.6348	No
Model 4	None	33.9658	49.3627	21.9445	30.8339	No
	At most 1	12.0212	31.1538	8.5746	23.9753	No
	At most 2	3.4466	16.5538	3.4466	16.5538	No
Summary	Test	None No Intercept No Trend	None Intercept No Trend	Linear Intercept No Trend	Linear Intercept Trend	Quadratic Intercept Trend
Variables	Trace	0	0	0	0	0
	Max-Eig	0	0	0	0	0

TABLE 7: JOHANSEN COINTEGRATION TEST; POLAND AND GERMANY

Type of Test		**JOHANSEN COINTEGRATION TEST**				
Models	**No. of CE(s)**	**Trace Statistic**	**1% CV**	**Max-Eigen St**	**1% CV**	**Cointegration**
Model 2	None	26.6212	41.1950	16.1975	27.0678	No
	At most 1	9.4236	25.0781	8.2825	20.1612	No
	At most 2	1.1411	12.7607	1.1411	12.7607	No
Model 3	None	18.0571	35.4581	11.6807	25.8612	No
	At most 1	6.3763	19.9371	6.1053	18.5200	No
	At most 2	0.2710	6.6348	0.2710	6.6348	No
Model 4	None	21.6674	49.3627	13.1291	30.8339	No
	At most 1	8.5382	31.1538	6.1241	23.9753	No
	At most 2	2.4041	16.5538	2.4041	16.5538	No
Summary	Test	None No Intercept No Trend	None Intercept No Trend	Linear Intercept No Trend	Linear Intercept Trend	Quadratic Intercept Trend
Variables	Trace	0	0	0	0	0
	Max-Eig	0	0	0	0	0

TABLE 8: JOHANSEN COINTEGRATION TEST; POLAND AND UNITED KINGDOM

Type of Test		**JOHANSEN COINTEGRATION TEST**				
Models	**No. of CE(s)**	**Trace Statistic**	**1% CV**	**Max-Eigen St**	**1% CV**	**Cointegration**
Model 2	None	17.2481	41.1950	9.1904	27.0678	No
	At most 1	8.0577	25.0781	4.7863	20.1612	No
	At most 2	3.2713	12.7607	3.2713	12.7607	No
Model 3	None	11.5546	35.4581	7.2143	25.8612	No
	At most 1	4.3403	19.9371	4.0091	18.5200	No
	At most 2	0.3309	6.6348	0.3309	6.6348	No
Model 4	None	37.0236	49.3627	27.8138	30.8339	No
	At most 1	9.2098	31.1538	6.5575	23.9753	No
	At most 2	2.6522	16.5538	2.6522	16.5538	No
Summary	Test	None No Intercept No Trend	None Intercept No Trend	Linear Intercept No Trend	Linear Intercept Trend	Quadratic Intercept Trend
Variables	Trace	0	0	0	0	0
	Max-Eig	0	0	0	0	0

TABLE 9: JOHANSEN COINTEGRATION TEST; POLAND AND UNITED STATES

Type of Test		JOHANSEN COINTEGRATION TEST				
Models	**No. of CE(s)**	**Trace Statistic**	**1% CV**	**Max-Eigen St**	**1% CV**	**Cointegration**
Model 2	None	22.4381	41.1950	12.5843	27.0678	No
	At most 1	9.8537	25.0781	7.5856	20.1612	No
	At most 2	2.2681	12.7607	2.2681	12.7607	No
Model 3	None	17.3279	35.4581	11.5527	25.8612	No
	At most 1	5.7751	19.9371	5.1395	18.5200	No
	At most 2	0.6356	6.6348	0.6356	6.6348	No
Model 4	None	27.5175	49.3627	18.8355	30.8339	No
	At most 1	8.6820	31.1538	6.1048	23.9753	No
	At most 2	2.5771	16.5538	5.5771	16.5538	No
Summary	Test	None No Intercept No Trend	None Intercept No Trend	Linear Intercept No Trend	Linear Intercept Trend	Quadratic Intercept Trend
Variables	Trace	0	0	0	0	0
	Max-Eig	0	0	0	0	0

TABLE 10: JOHANSEN COINTEGRATION TEST: CZECH REPUBLIC AND GERMANY

Type of Test		JOHANSEN COINTEGRATION TEST				
Models	**No. of CE(s)**	**Trace Statistic**	**1% CV**	**Max-Eigen St**	**1% CV**	**Cointegration**
Model 2	None	26.8349	41.1950	17.4609	27.0678	No
	At most 1	9.3739	25.0781	6.7948	20.1612	No
	At most 2	2.5791	12.7607	2.5791	12.7607	No
Model 3	None	17.1658	35.4581	11.1516	25.8612	No
	At most 1	6.0141	19.9371	4.9325	18.5200	No
	At most 2	1.0816	6.6348	1.0816	6.6348	No
Model 4	None	39.7184	49.3627	25.1734	30.8339	No
	At most 1	14.5450	31.1538	10.0550	23.9753	No
	At most 2	4.4900	16.5538	4.4900	16.5538	No
Summary	Test	None No Intercept No Trend	None Intercept No Trend	Linear Intercept No Trend	Linear Intercept Trend	Quadratic Intercept Trend
Variables	Trace	0	0	0	0	0
	Max-Eig	0	0	0	0	0

TABLE 11: JOHANSEN COINTEGRATION TEST: CZECH REPUBLIC AND UNITED KINGDOM

Type of Test		JOHANSEN COINTEGRATION TEST				
Models	**No. of CE(s)**	**Trace Statistic**	**1% CV**	**Max-Eigen St**	**1% CV**	**Cointegration**
Model 2	None	24.9688	41.1950	16.2239	27.0678	No
	At most 1	8.7449	25.0781	6.2398	20.1612	No
	At most 2	2.5050	12.7607	2.5050	12.7607	No
Model 3	None	18.6901	35.4581	15.7208	25.8612	No
	At most 1	2.9693	19.9371	2.9318	18.5200	No
	At most 2	0.0374	6.6348	0.0374	6.6348	No
Model 4	None	37.7443	49.3627	20.7188	30.8339	No
	At most 1	17.0254	31.1538	14.3495	23.9753	No
	At most 2	2.6759	16.5538	2.6759	16.5538	No
Summary	Test	None No Intercept No Trend	None Intercept No Trend	Linear Intercept No Trend	Linear Intercept Trend	Quadratic Intercept Trend
Variables	Trace	0	0	0	0	0
	Max-Eig	0	0	0	0	0

TABLE 12: JOHANSEN COINTEGRATION TEST: CZECH REPUBLIC AND UNITED STATES

Type of Test		JOHANSEN COINTEGRATION TEST				
Models	**No. of CE(s)**	**Trace Statistic**	**1% CV**	**Max-Eigen St**	**1% CV**	**Cointegration**
Model 2	None	34.2738	41.1950	25.6250	27.0678	No
	At most 1	8.6487	25.0781	6.1148	20.1611	No
	At most 2	2.5338	12.7607	2.5338	12.7607	No
Model 3	None	28.5452	35.4581	25.5131	25.8612	No
	At most 1	3.0321	19.9371	2.5977	18.5200	No
	At most 2	0.4344	6.6348	0.4344	6.6348	No
Model 4	None	42.0915	49.3627	25.7546	30.8339	No
	At most 1	16.3368	31.1538	14.2822	23.9753	No
	At most 2	2.0545	16.5538	2.0545	16.5538	No
Summary	Test	None No Intercept No Trend	None Intercept No Trend	Linear Intercept No Trend	Linear Intercept Trend	Quadratic Intercept Trend
Variables	Trace	1	0	0	0	0
	Max-Eig	1	0	0	0	0

TABLE 13: JOHANSEN COINTEGRATION TEST: SLOVAKIA AND GERMANY

Type of Test		JOHANSEN COINTEGRATION TEST				
Models	**No. of CE(s)**	**Trace Statistic**	**1% CV**	**Max-Eigen St**	**1% CV**	**Cointegration**
Model 2	None	2522.219*	41.1950	1316.005*	27.0678	Yes
	At most 1	1206.214*	25.0781	1204.421*	20.1612	Yes
	At most 2	1.7930	12.7607	1.7930	12.7607	No
Model 3	None	2522.199*	35.4581	1316.005*	25.8612	Yes
	At most 1	1206.195*	19.9371	1204.421*	18.5200	Yes
	At most 2	1.7743	6.6348	1.7743	6.6348	No
Model 4	None	2525.190*	49.3627	1316.321*	30.8339	Yes
	At most 1	1208.869*	31.1538	1205.382*	23.9753	Yes
	At most 2	3.4868	16.5538	3.4868	16.5538	No
Summary	Test	None No Intercept No Trend	None Intercept No Trend	Linear Intercept No Trend	Linear Intercept Trend	Quadratic Intercept Trend
Variables	Trace	2	2	2	2	2
	Max-Eig	2	2	2	2	2

* indicates rejection of the null hypothesis (r=0, r=1 etc) at 1% significance level.

TABLE 14: JOHANSEN COINTEGRATION TEST:SLOVAKIA AND UNITED KINGDOM

Type of Test		JOHANSEN COINTEGRATION TEST				
Models	**No. of CE(s)**	**Trace Statistic**	**1% CV**	**Max-Eigen St**	**1% CV**	**Cointegration**
Model 2	None	27.5694	41.1950	16.6757	27.0678	No
	At most 1	10.8937	25.0781	8.9405	20.1612	No
	At most 2	1.9532	12.7607	1.9532	12.7607	No
Model 3	None	21.6854	35.4581	13.7613	25.8612	No
	At most 1	7.9240	19.9371	7.0108	18.5200	No
	At most 2	0.9132	6.6348	0.9132	6.6348	No
Model 4	None	35.2696	49.3627	23.4495	30.8339	No
	At most 1	11.8201	31.1538	7.0114	23.9753	No
	At most 2	4.8087	16.5538	4.8087	16.5538	No
Summary	Test	None No Intercept No Trend	None Intercept No Trend	Linear Intercept No Trend	Linear Intercept Trend	Quadratic Intercept Trend
Variables	Trace	0	0	0	0	0
	Max-Eig	0	0	0	0	0

TABLE 15: JOHANSEN COINTEGRATION TEST: SLOVAKIA AND UNITED STATES

Type of Test		JOHANSEN COINTEGRATION TEST				
Models	**No. of CE(s)**	**Trace Statistic**	**1% CV**	**Max-Eigen St**	**1% CV**	**Cointegration**
Model 2	None	28.1544	41.1950	16.3803	27.0678	No
	At most 1	11.7741	25.0781	8.9689	20.1612	No
	At most 2	2.8052	12.7607	2.8052	12.7607	No
Model 3	None	22.2139	35.4581	13.5824	25.8612	No
	At most 1	8.6314	19.9371	8.6050	18.5200	No
	At most 2	0.0264	6.6348	0.0264	6.6348	No
Model 4	None	35.7784	49.3627	20.9366	30.8339	No
	At most 1	14.8417	31.1538	10.1222	23.9753	No
	At most 2	4.7195	16.5538	4.7195	16.5538	No
Summary	Test	None No Intercept No Trend	None Intercept No Trend	Linear Intercept No Trend	Linear Intercept Trend	Quadratic Intercept Trend
Variables	Trace	0	0	0	0	0
	Max-Eig	0	0	0	0	0

We have implemented the Granger Causality Test (1981), using two different lag selection criteria, the Akaike's Information Criterion (AIC) and the Hannan-Quinn Information Criterion (HQ). The results from the causality test, together with the optimal number of lags are outlined in Tables 16-18, with Germany, the UK and US respectively included as the additional explanatory variable.

We fail to reject the null hypothesis of no causality from the Hungarian exchange rate to Hungarian stock prices, in all three models. We find no other causal relationships from the international financial proxies to Hungarian exchange rates or stock prices, or from Hungarian stock prices to Hungarian exchange rates.

In the case of Poland we fail to reject the hypothesis of no causality from the Polish exchange rate to Polish stock prices in all three models; furthermore, we find evidence of causality from UK stock prices to Polish stock prices, as well as from US stock prices to Polish stock prices and also the Polish exchange rate.

For the Czech Republic the causality tests show causality from the Czech exchange rate to Czech stock prices in all three models, as well from US stock prices to Czech stock prices.

Finally, in the case of Slovakia the results indicate that we find no causal relationships between the stock price and exchange rate in all three models, as well as no causality between any of the international financial markets and Slovakian stock prices or exchange rates. Given that we found evidence of cointegration between stock prices and the exchange rate for Slovakia when

Germany was included as a proxy for the international financial environment, we included the error correction term in the causality tests. Results indicated that the ECM is significant at 1% significance level, thus there is also a short run dynamic relationship between the stock prices of the German market and the exchange rate and stock prices in Slovakia.

The fact that we find different causal relationships in the four Eastern European markets indicates that the relationship between stock prices and exchange rates, as well as between the international financial markets and stock prices and exchange rates in each market are not uniform across these emerging markets.

TABLE 16: GRANGER CAUSALITY TEST: TRIVARIATE MODEL WITH GERMANY

Type of Test		AIC			HQ		
Countries	Variables	No. of lags	F-stat	p-value	No. of lags	F-stat	p-value
Hungary	DHGE⇒DHGI	8	8.8924	5.02E-12*	2	30.7212	7.3E-14*
	DHGI⇒DHGE		1.7869	0.0751		1.4436	0.2363
	DGE⇒DHGI		1.0674	0.3831		1.0777	0.3405
	DGE⇒DHGE		1.1138	0.3504		0.4653	0.6280
Poland	DPOE⇒DPOI	3	31.4354	7.7E-20*	2	46.3932	2.1E-20*
	DPOI⇒DPOE		2.3643	0.0693		2.0603	0.1276
	DGE⇒DPOI		0.4410	0.7236		0.5942	0.5520
	DGE⇒DPOE		2.0706	0.1021		1.5683	0.2086
Czech Republic	DCZE⇒DCZI	2	8.9009	0.0001*	1	16.9571	4.0E-05*
	DCZI⇒DCZE		1.0899	0.3364		1.6113	0.2044
	DGE⇒DCZI		1.9374	0.1443		0.1093	0.7409
	DGE⇒DCZE		2.1796	0.1133		4.3715	0.0366
Slovakia	DSLE⇒DSLI	5	2.2379	0.0481	1	0.0213	0.8838
	DSLI⇒DSLE		0.7379	0.5949		0.5789	0.4468
	DGE⇒DSLI		1.2556	0.2805		1.0222	0.3121
	DGE⇒DSLE		1.0329	0.3964		0.0694	0.7921

*Reject the null hypothesis. Ho: Y does not cause X. In our case the Stock Prices cause the Exchange Rates or Vice versa.. D:Variable in first differences.DCZE:Czech Republic Exchange Rate, DCZI: Czech Republic Stock Prices, DHGE: Hungary Exchange Rates,D HGI:Hungary Stock Prices, DPOE: Poland Exchange Rates,D POI:Poland Stock Prices, DSLE: Slovakia Exchange Rate, DSLI: Slovakia Stock Prices, DGE:Germany Stock Prices, DUK:United Kingdom Stock Prices, DUS:United States Stock Prices

TABLE 17: GRANGER CAUSALITY TEST: TRIVARIATE MODEL WITH UK

Type of Test		AIC			HQ		
Countries	Variables	No. of lags	F-stat	p-value	No. of lags	F-stat	p-value
Hungary	DHGE⇒DHGI	9	6.93055	6.9E-10*	2	30.7212	7.3E-14*
	DHGI⇒DHGE		1.5042	0.1406		1.4436	0.2363
	DUK⇒DHGI		1.5758	0.1168		3.57403	0.0282
	DUK⇒DHGE		0.4479	0.9091		0.4492	0.6381
Poland	DPOE⇒DPOI	4	23.6292	4.2E-19*	3	31.4354	7.7E-20*
	DPOI⇒DPOE		2.4260	0.0460		23.6432	0.06933
	DUK⇒DPOI		8.2227	1.4E-06*		10.3958	8.7E-07*
	DUK⇒DPOE		0.7203	0.5779		0.6521	0.5816
Czech Republic	DCZE⇒DCZI	2	8.9009	0.0001*	2	8.9009	0.0001*
	DCZI⇒DCZE		1.0899	0.3364		1.0899	0.3364
	DUK⇒DCZI		0.4500	0.6376		0.4500	0.6376
	DUK⇒DCZE		2.2525	0.1054		2.2525	0.1054
Slovakia	DSLE⇒DSLI	6	1.8685	0.0826	1	0.0213	0.8838
	DSLI⇒DSLE		0.9124	0.4848		0.5789	0.4468
	DUK⇒DSLI		1.0851	0.3689		1.6165	0.2037
	DUK⇒DSLE		0.6490	0.6910		0.9094	0.3403

*Reject the null hypothesis. Ho: Y does not cause X. In our case the Stock Prices cause the Exchange Rates or Vice versa.. D:Variable in first differences.DCZE:Czech Republic Exchange Rate, DCZI: Czech Republic Stock Prices, DHGE: Hungary Exchange Rates,D HGI:Hungary Stock Prices, DPOE: Poland Exchange Rates,D POI:Poland Stock Prices, DSLE: Slovakia Exchange Rate, DSLI: Slovakia Stock Prices, DGE:Germany Stock Prices, DUK:United Kingdom Stock Prices, DUS:United States Stock Prices

TABLE 18: GRANGER CAUSALITY TEST: TRIVARIATE MODEL WITH UNITED STATES

Type of Test		AIC			HQ		
Countries	Variables	No. of lags	F-stat	p-value	No. of lags	F-stat	p-value
Hungary	DHGE ⇒ DHGI	3	22.0793	4.6E-14*	3	22.0793	4.6E-14*
	DHGI ⇒ DHGE		0.9498	0.4156		0.9498	0.4156
	DUS ⇒ DHGI		3.0363	0.0281		3.0363	0.0281
	DUS ⇒ DHGE		0.3716	0.7735		0.3716	0.7735
Poland	DPOE ⇒ DPOI	3	31.4354	7.7E-20*	3	31.4354	7.7E-20*
	DPOI ⇒ DPOE		2.3643	0.0693		2.3643	0.0693
	DUS ⇒ DPOI		58.7405	2.4E-36*		58.7405	2.4E-36*
	DUS ⇒ DPOE		6.2810	0.0003*		6.2810	0.0003*
Czech Republic	DCZE ⇒ DCZI	3	5.9475	0.0004*	3	5.9475	0.0004*
	DCZI ⇒ DCZE		1.2655	0.2845		1.2655	0.2845
	DUS ⇒ DCZI		30.6942	2.2E-19*		30.6942	2.2E-19*
	DUS ⇒ DCZE		1.2210	0.3005		1.2210	0.3005
Slovakia	DSLE ⇒ DSLI	1	1.8668	0.0826	6	0.0213	0.8838
	DSLI ⇒ DSLE		0.9124	0.4848		0.5789	0.4468
	DUS ⇒ DSLI		1.1182	0.3489		2.1792	0.1400
	DUS ⇒ DSLE		1.5813	0.1485		2.8888	0.0893

*Reject the null hypothesis. Ho: Y does not cause X. In our case the Stock Prices cause the Exchange Rates or Vice versa.. D:Variable in first differences.DCZE:Czech Republic Exchange Rate, DCZI: Czech Republic Stock Prices, DHGE: Hungary Exchange Rates,D HGI:Hungary Stock Prices, DPOE: Poland Exchange Rates,D POI:Poland Stock Prices, DSLE: Slovakia Exchange Rate, DSLI: Slovakia Stock Prices, DGE:Germany Stock Prices, DUK:United Kingdom Stock Prices, DUS:United States Stock Prices

5. Conclusions

This paper set out to investigate the relationship between stock prices and exchange rates in four emerging transition economies. The results from our cointegration tests indicated that in most of the cases the null hypothesis of no cointegration could not be rejected indicating that there is no long run relationship between exchange rates and stock markets; the exception to this was the Slovakian market where exchange rates and stock prices where cointegrated when Germany was included as an additional explanatory variable reflecting the international financial environment. The significance of the error correction mechanism for Slovakia also indicated that a short-run relationship existed between Slovakian stock prices and exchange rates, and German stock prices. Our findings are thus consistent with the results of Smyth and Nandha (2003), Nieh and Lee (2001) and Bahamani-Oskooee and Sohrabian (1992), who did not find any significant evidence of a long run relationship between stock prices and exchange rates. While Grambovas (2003), found evidence of a cointegrating relationship between the Hungarian and German stock markets as well as between the Czech Republic market and the German market; the fact that our results here differ can partly be explained by the different period of analysis. Given that his analysis focused on the 1994-2000 period, our results indicate that for the 1999-2006 period, the influence of the German market on stock markets in Hungary and the Czech Republic appears to have declined.

The results from the causality tests indicate that for Hungary, Poland and the Czech Republic, that movements in the exchange rate causes movements in stock prices; thus causality is unidirectional with no evidence of bidirectional causality between exchange rates and stock markets in any of the countries. Furthermore, what happens on international stock markets can also affect domestic stock market and exchange rate movements, as reflected in the significant causal relationship from the UK stock market to the Polish stock market, and from the US stock market to the Polish and Czech stock markets. The lack of international stock market influence on the Slovakian and Hungarian stock exchanges indicates that these markets are not as integrated with world financial markets as the Polish and Czech stock markets; the significant influence of world markets on the Polish and Czech markets may also reflect significant foreign participation in these stock markets. The results indicate that for example, a fall in the US stock market would have a negative effect on the Czech and Polish stock markets, which in turn would cause a capital outflow which would create depreciation pressures for the Czech and Polish exchange rates; conversely, a boom in the US stock market would have a positive effect on Czech or Polish stock markets and would lead to increased demand for the currencies and so appreciation of the exchange rate. Awareness of these linkages is likely to provide important information for more effective policy formulation on exchange rate issues, as well as for fund managers in terms of devising more effective portfolio hedging and diversification strategies.

6. References

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