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EXCHANGE RATES AND STOCK PRICES: HOW DO THEY INTERACT IN EASTERN EUROPE?

In this study, we estimate Structural Vector Error Correction (SVEC) models to analyze the effects of the exchange rate on stock prices and vice versa in the Czech Republic, Hungary, Poland and Turkey. Our empirical findings imply that for all cases, the fluctuations in exchange rates may have a considerable role in the variation in stock markets, while variations in stock prices may have macroeconomic consequences by leading to changes in real exchange rates. We also found that the relationship between real exchange rates and stock prices in these countries may be induced by the monetary policy decisions of the Fed and other domestic and foreign factors. Our results stress the importance of the derivation of the optimal economic policy framework to analyze the interaction between exchange rates and stock prices. In this respect, we suggest the use of Dynamic Stochastic General Equilibrium (DSGE) modelling with country-specific and global factors to determine the economic polices sustaining financial and economic stability for the Czech Republic, Hungary, Poland and Turkey.

Keywords: exchange rates, stock prices, SVEC model, Eastern European countries
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1. INTRODUCTION

In accordance with the process of economic liberalization, economic reforms have led to the transformation of a planned economy into a market economy in the emerging markets of Eastern European countries. The main pillars of this transformation in the 1990s were privatization, liberalization of prices, foreign trade and capital movement. During the 1990s, the banking sector in the emerging markets of Eastern European countries was restructured, recapitalized and privatized, besides that capital markets were established and the control of capital flows via government policies was abolished. The ongoing economic process in Eastern European countries and Turkey coincidences with these countries' efforts to harmonize their monetary, fiscal and exchange rate policies to adopt to the Euro area. However, fluctuations in macroeconomic and financial variables in Eastern European countries and Turkey have increased due to the budget deficits,

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current account deficits and global economic factors during the 1990s and 2000s. Among all the variables, the expected theoretical relationship between financial markets have become unpredictable as a result of the integration of financial markets and the acceleration of capital flows.

Expectations related to a country's equity market performance are important in terms of leading to exchange ratemovements. Moreover, this phenomenon has become a crucial factor for the economic agents aiming to control their currency risk and for central banks gauging the effects of the macroeconomic implications of asset market variations. According to the Uncovered Equity Parity (UEP), countries with equity markets that are expected to perform strongly will experience currency appreciation. More precisely, in expectation of this, exchange rates and equity return differentials (in local currency) are perfectly negatively correlated. Conversely, Hau and Rey (2006) state that under the assumptions of risk averse investors and incomplete hedging of foreign exchange (FX) risk, when foreign equity markets are expected to outperform domestic equity markets, the domestic currency is expected to appreciate (Cenedese et al., 2014). In this respect, Cappiello and De Santis (2005) studied the consistency of UEP by using differentials in corporate earnings' growth rates, short-term interest rate changes, annual inflation rates, and net equity flows. Cappiello and De Santis (2005) found that UEP explains a large fraction of the variability of some European currencies vis-à-vis the US dollar. Despite the fact that empirical evidence in line with the UEP condition can be found, there is no evidence that exchange rate movements can offset expected differences in equity returns across countries (Hau and Rey, 2006; Melvin and Prins, 2011; Cho et al., 2012). On the other hand, the UEP condition can be a base for the analysis of the variations in real exchange rates since this parity condition aims to examine the role of the factor leading to changes in nominal exchange rates.

In this study, we aim to analyze the interactions between real exchange rates and stock/share prices in the Czech Republic, Hungary, Poland and Turkey in a plausible econometric framework allowing the role of theoretical considerations and economic developments in the estimation process. Thus, we employ the Vector Autoregression (VAR)-type of modelling, namely the Structural Vector Error Correction (SVEC) model. Within this context, variables representing the global economic conditions, which are expedient to the aim of the study and model framework are included in the model. We also intended to incorporate the role of carry trade and plausible domestic variables that may influence the relationship between real exchange rates and

stock prices in the empirical model estimating the interactions between these variables. However, no significant data can be obtained for all the countries in terms of carry trade and cash surplus/deficit (% of GDP) covering the period we investigate (1998:Q1 to 2014:Q3). Current account balance (% of GDP) data for Poland do not also exist for the period from 1998:Q1 to 2014:Q3 and thus it cannot be included into the empirical exercise for Poland. This paper contributes to the ongoing debate by investigating the relationship between exchange rates and stock prices and thus asserts monetary policy implications and suggestions in that respect.

The remainder of the paper is organized as follows. Section II briefly reviews the previous studies while section III explains the empirical methodology we applied to test the interaction between stock prices and exchange rates. The empirical results of the study are outlined in Section IV and the final section concludes.

2. A BRIEF LITERATURE REVIEW

The interaction between stock prices and exchange rates is generally rooted to the flow-oriented and stock-oriented models of exchange rate determination. Flow oriented models explain the effect of the changes in exchange rates on stock prices, which are seen as the present values of a firm's cash flows in the future. Since exchange rates have a significant effect on a firm's cash flows through the transaction, economic and accounting outcomes mentioned below, changes in exchange rates will also be manifested in stock prices (Dornbusch and Fisher, 1980, Gavin, 1989, Homaifar 2004, Madura, 2008, Bekaert and Hodrick, 2012). This theoretical linkage between exchange rates and stock prices has relatively been strong since the rapid expansion of international capital flows, which has also introduced exchange rate risk to the trading partners. On the other hand, stock prices have an impact on the determination of exchange rates, which was theoretically formulized in stock-oriented models of exchange rate determination. One of these models, namely the portfolio balance model, states that an increase in stock prices in a country attracts foreign and domestic investors to buy these assets converting foreign exchange into domestic currency, thus leading to the appreciation of the domestic currency (Frenkel, 1976; Branson et. al., 1977; Branson, 1983; Frankel, 1983). The relationship between stock prices and exchange rates explained by the portfolio balance model has been strongly relevant since capital controls were removed and capital flows between countries were liberalized. A wide

variety of empirical studies on the interaction between exchange and stock markets have been conducted particularly since global financial integration was widely being implemented. However, different views can be found on the issue based on empirical results. One view is that there exists no significant relationship between the exchange and stock markets while an alternative view supports the classical economic theory claiming that the two markets are related to each other.

The first contribution to the literature on the interactions between stock and foreign exchange markets was conducted by Franck and Young (1972), who found no significant effect of the strong exchange rate volatility of foreign currencies on the stock prices of selected US multinational firms. Similarly, Bahmani-Oskooee and Sohrabian (1992) found no long-term links between stock and foreign exchange markets in the US using cointegration techniques and Granger causality tests. On the other hand, the study of Aggarwal (1981) indicated a long and short-term relationship between the stock and exchange markets, presenting evidence for the assumption that a devaluation or depreciation of the currency makes exports more profitable and that as most major exporters are quoted on the stock market, stock market prices would also rise. In addition, the revaluation of the US dollar is positively related to stock market returns according to Aggarwal (1981). In contrast to the findings of this study, Soenen and Hennigar (1988) exposed strong negative links between the changes of the US dollar and the changes of the stock prices of US enterprises. Attempting to investigate the relationship between US stock prices and exchange rates, Vygodina (2006) applied the Granger causality methodology over the period 1987–2005. The results of this study revealed that there was Granger causality from large-cap stocks to the exchange rates, however no causality from the small-cap stocks to the exchange rates, concluding that global integration might be confined to large multinational corporations.

In the prevalent period of financial integration, the long and short-term dynamics between stock prices and exchange rates and thus theories in that respect can also be studied for other countries by applying cointegration methodology and multivariate Granger causality tests. Investigating the issue for Sweden, Hatemi and Irandoust (2002) put forward that a short-term relationship between stock prices and exchange rates existed since empirical results indicated that Granger causality was unidirectional from stock prices to exchange rates. Hatemi and Irandoust (2002) found that the appreciation of the Swedish Krona contributed to the increase in the stock prices in Sweden. For a group of Pacific Basin countries, Phylaktis and Ravazzolo

(2005) analyzed the long and short-term dynamics between stock prices and exchange rates by applying cointegration methodology and multivariate Granger causality tests. Their empirical findings indicated that stock and foreign exchange markets were positively related, the appreciation of the home currency in real terms led to an increase in stock prices and that the stability of the US stock market was critically important for these links. For the case of Australia, Richards et al. (2009) studied the interactions between exchange rates and stock prices. They showed that Granger causality ran from stock prices to the exchange rates during the sample period. The results obtained by Richards et al. (2009) verified that two key financial variables interacted in a manner consistent with the portfolio balance model. On the other hand, Nieh and Lee (2001) showed that no long-run significant relationship between stock prices and exchange rates existed in the G-7 countries, while currency depreciation often reduced stock returns in the German financial market, but it promoted the Canadian and UK markets on the following day. Yang and Yung (2004) also studied the intertemporal interaction between stock prices and exchange rates for the G-7 countries, as well as the mean and volatility spillover effects and information transmission between two markets using the bivariate EGARCH model. Their results showed that a change in stock prices had an impact on exchange rates but changes in exchange rates had a less direct effect on stock prices. Stavarek (2004) studied the interactions between real exchange rates and stock prices and he revealed that the development of the domestic stock market could not help to improve the results of exchange rate forecasting and vice versa in Eastern European countries that are the newest members of the Euro area.

The study by Granger et al. (2000) can be accepted as one of the major contributions to the literature since the Granger causality test was proposed by Granger (1969). In an effort to test the portfolio balance effect theory in Asian countries, Granger et al. (2000) analyzed the relations between stock prices and exchange rates in Hong Kong, Indonesia, Japan, Malaysia, the Philippines, Singapore, South Korea, Taiwan and Thailand by employing the cointegration concept and Granger causality tests. They found significant linkages between exchange rates and stock prices except for Japan, Singapore and Thailand, despite the fact that during the currency crisis stock prices might have an influence on exchange rates. Pan et al. (2007) also studied the relationship between exchange rates and stock prices for seven East Asian countries (Hong Kong, Japan, Korea, Malaysia, Singapore, Taiwan and Thailand). Their results showed that there was empirical evidence for the causality running from exchange rates to stock prices for

Hong Kong, Japan, Malaysia, and Thailand before the 1997 Asian financial crisis. During the Asian crisis, Pan et al. (2007) found no significant causality from stock prices to exchange rates, while causality from exchange rates to stock prices existed for all the countries except Malaysia. Furthermore, Pan et al. (2007) showed that the depreciation of home currencies of seven East Asian countries led to a significant amount of variations in stock prices. Employing TECM Granger-Causality tests, Yau and Nieh (2009) found a long-term and asymmetric causal relationship running from TWD/USD to the stock prices of Taiwan. Lui and Wan (2012) determined no causality between stock prices and exchange rates during the period before the recent financial crisis, thus they implied that the detected connections between the stock and foreign exchange markets stemmed from the shock of the recent financial crisis. However, Lui and Wan (2012) found that unidirectional causality behaviour running from the exchange rates to the stock index existed after the financial crisis in the Shanghai financial markets. On the other hand, there exist studies in the literature revealing that empirical results are inconsistent for bivariate causality between stock prices and exchange rates in the Asian financial markets (Ramasamy and Yeung, 2002; Muhammad and Rasheed, 2002).

There are also studies in the literature studying the Asian case in terms of the relationship between exchange rates and stock prices with other econometric and time-series techniques. For the case of China, Zhao (2010) studied the relationship between real effective exchange rates and stock prices with VAR and multivariate generalized autoregressive conditional heteroscedasticity (GARCH) models. He revealed that shocks in the stock markets led to volatility in the foreign exchange market, and vice versa, thus there was not a stable long-term equilibrium relationship between real effective exchange rates and stock prices. Kubo (2012) concluded that depreciations of real exchange rates in Indonesia, Korea, and Thailand led to an increase in stock prices, interpreted by the portfolio balance approach. Employing a quantile regression model for six Asian countries (Singapore, Thailand, Malaysia, the Philippines, South Korea, and Taiwan), Tsai (2012) drew the conclusion that the negative relationship between stock prices and foreign exchange rates was more obvious when exchange rates were extremely high or low. More precisely, Tsai (2012) showed that the increase of the returns of the stock price index would cause the domestic currency to appreciate in line with the portfolio balance effect. Most recently, using panel data analysis for the ASEAN-5, Liang et al. (2013) came to the conclusion that exchange rates against the US dollar have a negative impact

on stocks via capital mobility supporting the stock-oriented approach to exchange rates.

In the process of growing economic integration process, the interactions between real exchange rates and stock prices can be under the influence of various domestic economic factors, along with global factors. Moreover, domestic and global factors can be a determinant for the linkages between real exchange rates and stock prices, and the cointegrating relationship among real exchange rates and stock prices may stem from domestic and global factors. Thus, statistical approaches incorporating the role of economic conditions on the relationship between exchange rates and stock prices have been used along with other econometric techniques. In an effort to stress this point, Michelis and Ning (2011) considered the role of macroeconomic factors on the relationship between exchange rates and stock prices for the Canadian economy. By using the Symmetrized Joe Clayton (SJC) copula function and a suitable empirical framework with one dependent variable, Michelis and Ning (2011) assumed that lagged commodity prices and energy prices influence significantly the time series properties of exchange rates and stock prices over time since Canada is an important net energy exporter and the Canadian stock market is dominated by energy companies. Michelis and Ning (2011) found significant asymmetric static and dynamic tail dependence between the real stock returns and the real exchange rate return.

Variables representing these domestic and global factors can also be included into the econometric models examining the relationship between real exchange rates and stock prices as explanatory variables. Similar to Michelis and Ning (2011), Basher et al. (2012) employed the SVAR model with short-term restrictions to analyze the effects of oil prices on exchange rates and stock prices for emerging economies. Basher et al. (2012) revealed that positive shocks to oil prices tended to depress emerging market stock prices and the US dollar exchange rates in the short-term. Pirovano (2012) also used the SVAR model with short-term restrictions and thereby they considered the role of the euro zone interest rate, the nominal exchange rate (defined as the price of foreign currency (euro) in terms of domestic currency), the industrial production index, the domestic price level, the domestic short-term interest rate, the monetary aggregate M2 and the stock market index for the Czech Republic, Hungary, Poland and Slovenia. Pirovano (2012) indicated that stock prices in these new EU member states were more sensitive to changes in the euro zone interest rate than to the domestic one. Moreover, it is found that the bulk of stock price volatility in

these countries arose from shocks related to the exchange rates and the eurozone's monetary policy. For the investigation of the effects of long-term conditions on exchange rates and stock prices, Kim (2003) extended the analysis by considering additional variables, whereupon he investigated whether there were any long-term equilibrium relationships among the aggregate stock price, industrial production, real exchange rates, interest rates, and inflation in the US with Johansen's cointegration method. Kim (2003) showed that stock prices and exchange rates expressed as the number of foreign currency units per US dollar are both negatively correlated in the long-term in the US. Lin (2012) included interest rates and foreign reserves as additional variables in the analysis of Asian emerging markets to reduce potential omitted variable bias. According to the results of the study, the co-movement between exchange rates and stock prices became stronger during crisis periods in the Asian emerging markets, consistent with contagion or spillover between asset prices, when compared with tranquil periods. On the other hand, similar to Pirovano (2012), Diamandis and Drakos (2011) stressed the long-term relationship between stock and exchange markets operating through the transmission mechanism of the US stock market in their study investigating the long-term relationships and the short-term dynamics between the two markets for Argentina, Brazil, Chile and Mexico for the period 1980-2009. According to Diamandis and Drakos (2011), the appreciation of the home currencies of Argentina, Brazil, Chile and Mexico in real terms affected the stock returns in these countries positively. For detecting the non-linear relationships between stock prices and exchange rates under the circumstances of the financial crisis, Tsagkanos and Siriopoulos (2013) included macroeconomic variables and employed the structural nonparametric cointegrating regression model for the EU and the US. They showed that there was a causal relationship from stock prices to exchange rates that was relevant in the long run in the EU and in the short run in the US. Tsagkanos and Siriopoulos (2013) also found that the Dow Jones increased as a result of the depreciation of the euro against the US dollar. Despite there being studies in the literature analyzing the relationship between exchange rates and stock prices for other countries, there are few studies regarding the interactions between real exchange rates and stock markets in the Eastern European countries, particularly in Turkey. The closest study to ours in terms of referring to the interactions between these two markets, as far as we know, is the study conducted by Ülkü and Demirci (2012). They investigated the joint dynamics of European emerging stock and foreign exchange markets assuming that this interaction is of particular significance due to large external deficits.

Ülkü and Demirci (2012) assumed that capital flows induce a strong association between the stock markets and the currency value and thus expectations of future macroeconomic conditions. In this respect they incorporated the role of future macroeconomic conditions in the relationships between exchange rates and stock prices by MSCI indexes with the Structural Vector Error Correction (SVEC) model for the emerging markets of Europe, namely Hungary, Poland, the Czech Republic, Turkey, the Russian Federation, Ukraine, Romania and Croatia. However, Ülkü and Demirci (2012) found no cointegrating relationship between the variables they included in their model, which are the log returns of the MSCI-Europe index, MSCI Emerging Market index, the exchange rate and the local stock market index for Hungary, Poland, the Czech Republic and Romania. Ülkü and Demirci (2012) adjusted all the exchange rates and stock price indices for inflation. Hence adjusted exchange rate series at a monthly frequency are neither nominal nor real exchange rates. For the theoretical explanation of derivation on real exchange rates, see Section 3.). Ülkü and Demirci (2012) used the Blanchard-Quah type of Structural Vector Autoregression (SVAR) model for Hungary, Poland, the Czech Republic and Romania, assuming that conditions in global markets have an impact on the individual local emerging stock and foreign exchange markets; however local markets are unlikely to affect world indexes. For the Czech Republic, Russia, Ukraine and Croatia, Ülkü and Demirci (2012) estimated the SVEC model without clarifying their economic assumptions determining the long-term restrictions to be imposed into their SVEC models. Ülkü and Demirci (2012) actually estimated the interaction between MSCI indices, the exchange rate and the local stock market index, not the direct relationship among exchange rates and stock prices both in the SVAR and SVEC models. Their study revealed that developed and emerging stock market returns were an important determinant of the co-movement between the stock index and currency value in Hungary, Poland, the Czech Republic, Turkey, Russia, Ukraine, Romania and Croatia. Moreover, the sign of the currency–stock market relationship was dependent on foreign capital for countries which were net receivers of foreign portfolio capital.

In this study, we consider the interactions between stock prices and real exchange rates in some Eastern European countries (the Czech Republic, Hungary, Poland) and Turkey with SVEC modelling framework since one cointegrating relationship is found. We incorporated the real exchange rates, not the nominal exchange rates since Stavarek (2004) revealed that real exchange rates were more appropriate variable to fulfil the preconditions of

both flow-oriented and stock-oriented models in Eastern European countries. Following Kim (2003), Diamandis and Drakos (2011), Michelis and Ning (2011), Lin (2012), Ülkü and Demirci (2012), Tsagkanos and Siriopoulos (2013), we firstly attempted to incorporate global and domestic variables into our empirical exercise as explanatory variables since a cointegrating relationship could well stem from global and domestic factors. As for global economic developments, the Fed's possible monetary policy change in terms of raising interest rates is expected to lead to capital outflows from the emerging markets and to fluctuations in macroeconomic aggregates by the economic agents in parallel to the implications of Kim and Roubini (2000), Kim (2001), Holman and Neumann (2002), Faust et al. (2003), Valante (2009), Scrimgeur (2010), Bluedorn and Bowdler (2011) and Barakchian (2015). More precisely, raises in the US interest rates can be accepted as the major and highest risk factor for the economies of the Czech Republic, Hungary, Poland and Turkey, which are highly dependent on capital flows. Thus, we included the US long-term (10-year) government bond yields reflecting the monetary policy stance in the US as a global variable to our SVEC models in line with Estrella and Mishkin (1998) and Diebold et al. (2006). As for domestic economic risk factors, we intended to include cash surplus/deficit (% of GDP) and trade balance (% of GDP) data of the Czech Republic, Hungary, Poland and Turkey since these variables can be important domestic economic factors leading to economic and financial fragility for these countries (for the possible role of domestic economic risk factors, see: Yilmaz, 2005; Moghadam et al., 2014; and the World Bank Regular Economic Report July, 2014). However, cash surplus/deficit (% of GDP) for the Czech Republic, Hungary, Poland and Turkey and current account balance (% of GDP) data are not available for Poland quarterly under the period we investigate.

The identification of SVEC models shows that the number of short and long-term restrictions which should be placed in the plausible matrices have to conform to the theoretical assumptions. In this respect, the classical economics approach is used to determine the assumptions and particularly the long-term restrictions imposed in SVEC models for the identification. SVEC models with more than two variables and one cointegrating relation can be theoretically studied within this framework (for the identification of the SVEC models and thus the short and long-term restrictions, see Section 3.5 and 4. and see (Breitung et al., 2007: pp. 168-169)). Since current account balance (% of GDP) data exist only for the Czech Republic, Hungary and Turkey under the period we investigate, empirical exercise for

Poland cannot be carried by the inclusion of this variable. Nevertheless, current account balance (% of GDP) variable are incorporated into the empirical exercise for the Czech Republic, Hungary and Turkey as an endogenous variable inducing the relationship among real exchange rates and stock prices. This paper also contributes to the literature by considering the interest rate policy of the Fed on the links between real exchange rates and stock prices for the Czech Republic, Hungary, Poland and Turkey and by highlighting our assumptions deriving from economic theory and incorporating them into the estimation process of our SVEC models. The aim of our study is twofold: (i) to analyze whether the US long-term (10-year) government bond yields may affect the real exchange rates and stock prices in future periods and help to improve the forecasts of the real exchange rates and stock prices with the Granger and Instantaneous Causality analysis on the basis of VEC modelling (in the literature, causality relationships among variables are generally studied within the context of VAR-type of models), (ii) to show the effects of real exchange rates and stock prices on each other and discuss the possible impacts of the US long-term (10-year) government bond yields and current account balance (% of GDP) on real exchange rates and stock prices for the following periods by estimating impulse response functions (IRFs) and forecast error variance decompositions (FEVDs). The main motivation of this paper is to test whether changes in the variables under investigation and the interactions between them should lead to changes in the monetary policy stance and implementation by the Czech Republic, Hungary, Poland and Turkey.

3. EMPIRICAL METHODOLOGY AND DATA

As for the empirical exercise, we used SVEC models allowing the role of assumptions deriving from economic theory in the estimation process. In this context, the relationship between real exchange rates and stock prices are studied for the Czech Republic, Hungary, Poland and Turkey. Empirical analysis is carried out for the period from 1998:Q1 to 2014:Q3 in an attempt to include the consequences of the Asian, Russian and the 2007-2009 financial crisis on the relations between exchange rates and stock prices (for the Czech Republic, Hungary, Poland and Turkey; dummy variables take the value 1 for the period from 1998:01 to 1999:02, while the effects of the recent 2007-2008 financial crisis are reflected by the dummy variables taking value 1 for the period from 2008:Q1 to 2014:Q3.). The period from 1998:Q1 to 2014:Q3 is also selected since the Czech Republic, Hungary,

Poland and Turkey opted for more flexible exchange rate regimes from the late 1990s. The following variables are used for the empirical exercise: the log of the real exchange rates (real exchange rates are specified as: $re_t = p_t^d - p_t^f - ne_t$, where ne_t is defined in units of home currency – the Czech Republic, Hungary, Poland and Turkey – per unit of foreign country's currency, while p_t^d and p_t^f denote the price level of the domestic country and price level of the foreign country, respectively. An increase/decrease in re_t denotes the appreciation/depreciation of the home currency, thus a fall in re_t indicates an improvement in international competitiveness. Real exchange rates series incorporated into the empirical exercise are based on manufacturing consumer price index with the base year 2010=100); $rexc_t^{cze}$, $rexc_t^{hun}$, $rexc_t^{pol}$, $rexc_t^{tur}$, the log of the share price indices (total share prices indices include all shares and they are from base year 2010=100); $shpr_t^{cze}$, $shpr_t^{hun}$, $shpr_t^{pol}$, $shpr_t^{tur}$, long-term (10-year) government bond yields of the USA; $lyie_t^{usa}$, current account balance (% of GDP); cur_t^{cze}, cur_t^{hun}, cur_t^{tur}. All series are in levels and derived with plausible techniques using the database of the Federal Reserve Bank of St. Louis and databases of the Central Banks of the Czech Republic, Hungary, Poland and Turkey.

3.1. Unit root tests for the time series

In order to determine whether the series included in our empirical exercise are stationary or not we employed the most widely used test in the econometric literature, namely the Augmented Dickey-Fuller (ADF) test based on the estimation of a regression model. Since critical values for the ADF test depend on the deterministic terms which have to be included, we followed the Pantula principle proposed by Pantula (1989). According to Pantula principle, if a linear trend term is necessary in the ADF test for the time series y_t, only a constant term should be included in the test for the Δy_t; whereas if only a constant is needed in the ADF test, the test for Δy_t is to be carried with no deterministic term to find the appropriate type of regression model (Lütkepohl, 2007a: p. 55).

Within the context of the Pantula principle, ADF tests are carried out with an intercept term or trend term for the series included in our empirical exercise. As shown in Table 2, all the series in the form of levels are non-stationary, whereas all series are stationary in first differences at the

Table 1

Augmented Dickey-Fuller tests

Variables	ADF Test Statistic	Number of Lagged Differences
$rexc_t^{cze}$ (c,t)	-1.10	1
$\Delta rexc_t^{cze}$ (c)	-6.04	0
$shpr_t^{cze}$ (c,t)	-1.68	1
$\Delta shpr_t^{cze}$ (c)	-0.53	1
$rexc_t^{hun}$ (c,t)	-1.01	2
$\Delta rexc_t^{hun}$ (c)	-7.41	1
$shpr_t^{hun}$ (c,t)	-2.06	1
$\Delta shpr_t^{hun}$ (c)	-5.52	0
$rexc_t^{pol}$ (c)	-2.45	1
$\Delta rexc_t^{pol}$	-5.83	1
$shpr_t^{pol}$ (c,t)	-2.40	1
$\Delta shpr_t^{pol}$ (c)	-5.61	0
$rexc_t^{tur}$ (c)	-2.58	0
$\Delta rexc_t^{tur}$	-5.94	3
$shpr_t^{tur}$ (c,t)	-3.50	1
$\Delta shpr_t^{tur}$ (c)	-6.07	0
cur_t^{cze} (c)	-2.60	1
Δcur_t^{cze}	-8.75	1
cur_t^{hun} (c)	-0.99	0
Δcur_t^{hun}	-8.73	0
cur_t^{tur} (c)	-2.24	0
Δcur_t^{tur}	-7.91	0
$lyie_t^{usa}$ (c)	-3.69	3
$\Delta lyie_t^{usa}$	-4.34	2

Notes: 1% critical values for the ADF test with constant and trend (c,t) , constant (c) terms and no deterministic terms are -3.96, -3.43, -2.56, respectively. Critical values of the ADF test are from Davidson and McKinnon (1993). The lag orders used in the ADF tests are selected by the Akaike Information Criteria (AIC).

Source: authors' estimation

1 percent significance level. Thus we explored the possibility of cointegration relationships among the series corresponding to the same country. As shown in Table 2, we found one cointegrating relation using the Johansen cointegration model with structural breaks (structural breaks are in line with crisis periods as reflected by the dummy variables included in the models).

Table 2

Test for cointegration

Series: $rexc_t^{cze}$, $shpr_t^{cze}$, $lyie_t^{usa}$, cur_t^{cze} **No of Included Lags (Levels):** 1			**Series:** $rexc_t^{hun}$, $shpr_t^{hun}$, $lyie_t^{usa}$, cur_t^{hun} **No of Included Lags (Levels):** 2		
Null Hypothesis	**Test Value**	**95% Critical Value**	**Null Hypothesis**	**Test Value**	**95% Critical Value**
$r = 0$	71.70	59.75	$r = 0$	63.31	59.75
$r = 1$	33.95	40.09	$r = 1$	20.85	40.09
$r = 2$	20.15	24.34	$r = 2$	12.24	24.34
Series: $rexc_t^{pol}$, $shpr_t^{pol}$, $lyie_t^{usa}$ **No of Included Lags (Levels):** 1			**Series:** $rexc_t^{tur}$, $shpr_t^{tur}$, $lyie_t^{usa}$, cur_t^{tur} **No of Included Lags (Levels):** 1		
Null Hypothesis	**Test Value**	**95% Critical Value**	**Null Hypothesis**	**Test Value**	**95% Critical Value**
$r = 0$	67.90	66.88	$r = 0$	79.55	59.75
$r = 1$	36.57	42.71	$r = 1$	29.36	40.09
$r = 2$	12.51	21.91	$r = 2$	16.24	24.34

Note: Optimal lag lengths of the two models with constant and trend terms are determined by the AIC, Hannan-Quinn Criterion (HQ) and Schwarz Criterion (SC).

Source: authors' estimation

According to Table 2, there exists one cointegrating relation among the variables in the vectors. Thus, VEC models are used to analyze the interactions between real exchange rates and stock prices for the Czech Republic, Hungary, Poland and Turkey.

3.2. The case for the economies under investigation and relevant data

Despite a full transformation process towards integration to the dynamics of a market economy and convergence with the EU, the former socialist countries of Eastern Europe were also exposed to significant competitive disadvantage compared to the EU during the transition process from a planned economy to a free market economy. Similarly to the Eastern

European countries we investigated, Turkey also had current account deficits due to its rapid liberalization process during the 1990s. Thus, policies maintaining capital inflows have become critically important to finance the current account deficits and sustain economic growth in these countries. Expansionary macroeconomic policies were implemented for overcoming the unemployment problem and promoting economic activity; however this led to an increase in the debt level of economic agents (see: Yilmaz, 2005; Moghadam et al., 2014; the World Bank Regular Economic Report July, 2014). All these economic developments can be accepted as factors increasing the financial fragilities in the Czech Republic, Hungary, Poland and Turkey, and thus may lead to changes in the relationship between exchange rates and stock prices. On the other hand, Eastern European countries and Turkey then went through the process of accession to the European Union (EU) and the European Monetary Union (EMU) which require the convergence of inflation, interest rates, exchange rates and government deficits to the average levels of the EU countries. Accordingly, candidate countries implemented a number of reform programs in order to capture the extensive benefits from catching up with the developed EU countries. However, during the catching up and adaptation process, Eastern

Table 3

Economic indicators of the Czech Republic, Hungary, Poland and Turkey

	The Czech Republic	**Hungary**	**Poland**	**Turkey**
Total population (million)**	10,5	9,8	38,5	74,9
Unemployment (% of total labour force)**	6.9	10.1	10.3	10
GDP per capita (current USD)**	14,637	11,429	10,781	8,722
GDP growth (annual %)**	-0.7	1.5	1.6	4.1
Inflation (annual consumer prices %)**	1.4	1.7	1	7.4
Cash surplus/deficit (% of GDP)***	-2.3	-2.5	-3.5	-0.5
Current account balance (% of GDP)**	-1.3	4.1	-1.3	-7.9
FDI (net inflows, % of GDP)**	2.3	-3.2	-0.8	1.5
Portfolio Investment, net (BoP, million current USD)**	-4.676	-4.028	-473	-23.7
Real exchange rates based on manufacturing labour costs (2010=1)*	0.94	0.91	0.92	0.94
Total Share Prices (2010=1)*	0.84	0.79	1.22	1.28

* *Include 2014 data.*
** *Include 2013 data.*
*** *Include 2012 data.*

Source: The World Bank, Federal Reserve Bank of St. Louis

European countries and Turkey were expected to face fluctuations and macroeconomic shocks which could be severe in less developed countries and also lead to disparities in growth performances and income equality.

According to Table 3, Poland and Turkey have the highest population and the highest rate of unemployment when compared to the Czech Republic and Hungary. Moreover, Poland and Turkey have a lower GDP per capita than the Czech Republic and Hungary. In this respect, these phenomena can be considered as a factor leading to pressures on the economic policy of the authorities in terms of implementing policies that may promote economic activity. The role of expansionary polices on economic activity is reflected by the highest GDP growth, inflation and current account deficit rates in Turkey. Along with Turkey, the Czech Republic and Poland have also current account deficits accompanied by cash deficits that can lead to financial fragility. On the other hand, the positive current account balance in Hungary cannot be regarded as a positive factor in terms of financial stability when the negative value of FDI is considered. The high amount of net portfolio outflows, except Poland and particularly Turkey, is also another risk factor that may lead to speculative attacks and financial crisis. Moreover, the increased role of foreign investor participation in local bond markets and foreign institutional investors, the reliance on a relatively few common creditors and the sharp tightening of external financial conditions can be accepted as factors hindering economic growth and deteriorating financial stability in the future. In this respect, we can assert that the role of risks arising from external financing requirements may depreciate the home currencies and lead to a fall in stock prices in the Czech Republic, Hungary, Poland and Turkey.

3.3. VEC model

The general framework of the SVEC model is based on a VEC(p) model specified as;

$$\Delta y_t = \Pi y_{t-1} + \Gamma_1 \Delta y_{t-1} + \ldots + \Gamma_{p-1} \Delta y_{t-p+1} + u_t \qquad (1)$$

where the long-term part Πy_{t-1} is $I(0)$ and it includes $I(1)$ variables since Δy_t does not contain stochastic trends assuming that all variables can be at most $I(1)$. Π is a product of $(K \times r)$ matrices, α and β with $\mathrm{rk}(\alpha) = \mathrm{rk}(\beta) = r$; $\Pi = \alpha\beta'$ if it is supposed as, $\mathrm{rk}(\Pi) = r$. $\beta' y_{t-1}$ is

obtained by premultiplying $\Pi y_{t-1} = \alpha\beta' y_{t-1}(\alpha'\alpha)^{-1}\alpha'$, thus there are $r = \text{rk}(\Pi)$ linearly independent cointegrating relations exist among the components of y_t. The rank of Π is the cointegrating rank of the system, while β is a cointegration matrix. The weights attached to the cointegrating relations in the equations of the model are included in α-loading matrix. In this study, the cointegrating rank of the system is determined using the Johansen cointegration test as represented below;

$$y_t = D_t + x_t \tag{2}$$

where y_t is a K-dimensional vector containing observable variables. $D_t = \mu_0 + \mu_1 t$ refers to the deterministic part with a linear trend term, while x_t is a stochastic process having a Vector Autoregression (VAR) representation. Within the framework of (2), the pair of hypothesis below is tested for determining the cointegrating rank of the model or the appropriate type of the model.

$$\text{H}_0(r_0)\text{: rk}(\Pi) = r_0 \text{ versus } \text{H}_1(r_0)\text{: rk}(\Pi) > r_0,\ r_0 = 0,...,K-1 \tag{3}$$

3.4. Causality analysis

Causality tests are important to analyze the relationship between two time series since they help to determine whether one time series is useful for forecasting another. According to the Granger Causality analysis, y_{2t} is to be causal for a time series variable y_{1t} if the former helps to improve the forecasts of the latter. Thus, a bivariate VEC(p) process of the form below may be considered (Lütkepohl, 2007b: p. 146).

$$\begin{bmatrix} y_{1t} \\ y_{2t} \end{bmatrix} = \alpha\beta' \begin{bmatrix} y_{1,t-1} \\ y_{2,t-1} \end{bmatrix} + \sum_{i=1}^{p-1} \begin{bmatrix} \gamma_{11,i} & \gamma_{12,i} \\ \gamma_{21,i} & \gamma_{22,i} \end{bmatrix} \begin{bmatrix} \Delta y_{1,t-i} \\ \Delta y_{2,t-i} \end{bmatrix} + u_t \tag{4}$$

In a bivariate situation, the cointegrating rank r can only be 0, 1, or 2, and if $r = 1$, there must be Granger-causality in at least one direction. According to the instantaneous causality concept, y_{2t} is instantaneously causal for y_{1t} if knowing the value of y_{2t} in the forecast period helps to improve the forecasts of y_{1t}. The concept as such does not specify a causal direction; y_{2t} is instantaneously causal for y_{1t} and y_{1t} is instantaneously causal for y_{2t} provided that u_{1t} and u_{2t} are correlated.

Table 4
Granger causality tests

H_0 : $lyie_t^{usa}$ **does not Granger-cause** $rexc_t^{cze}$, $shpr_t^{cze}$ and cur_t^{cze}		H_0 : $lyie_t^{usa}$ **does not Granger-cause** $rexc_t^{hun}$, $shpr_t^{hun}$ and cur_t^{hun}	
Test Statistic	**p-value-*F***	**Test Statistic**	**p-value-*F***
7.36	0.00	4.95	0.00
H_0 : $lyie_t^{usa}$ **does not Granger-cause** $rexc_t^{pol}$ and $shpr_t^{pol}$		H_0 : $lyie_t^{usa}$ **does not Granger-cause** $rexc_t^{tur}$, $shpr_t^{tur}$ and cur_t^{tur}	
Test Statistic	**p-value-*F***	**Test Statistic**	**p-value-*F***
2.29	0.00	7.96	0.00

Source: authors' estimation

The interest rate policy of the Fed may have a major role in the cointegrating relationship among real exchange rates and stock prices and also may influence the dynamics of this relationship in the future. Thus the possible impact of the US interest rates on real exchange rates and stock prices can be studied within the causality analysis framework for the Czech Republic, Hungary, Poland and Turkey. According to Table 4, the hypothesis that long-term government bond yields does not Granger-cause real exchange rates and stock prices can be rejected at the 5% significance level for the Czech Republic, Hungary, Poland and Turkey since p-values of the tests for all cases are smaller than 0.05. This implies that monetary policy changes in the US may have an effect on the future values of real exchange rates and stock prices in the Czech Republic, Hungary, Poland and Turkey.

Table 5
Instantaneous Causality Tests

H_0 : **No instantaneous causality between** $lyie_t^{usa}$, $rexc_t^{cze}$, $shpr_t^{cze}$ and cur_t^{cze}		H_0 : **No instantaneous causality between** $lyie_t^{usa}$, $rexc_t^{hun}$, $shpr_t^{hun}$ and cur_t^{hun}	
Test Statistic	**p-value-*F***	**Test Statistic**	**p-value-*F***
10.97	0.00	16.69	0.00
H_0 : **No instantaneous causality between** $lyie_t^{usa}$, $rexc_t^{pol}$ and $shpr_t^{pol}$		H_0 : **No instantaneous causality between** $lyie_t^{usa}$, $rexc_t^{tur}$, $shpr_t^{tur}$ and cur_t^{tur}	
Test Statistic	**p-value-*F***	**Test Statistic**	**p-value-*F***
15.25	0.00	10.87	0.00

Source: authors' estimation

The instantaneous causality tests results in Table 4 show that there may be a relationship between interest rates in the US and real exchange rates and stock prices for the following periods in the Czech Republic, Hungary, Poland and Turkey in the short run, similar to the results of the studies by Yau and Nieh (2009) and Liu and Wan (2012). Our Granger and instantaneous causality tests provide empirical evidence for the fact that it is critically important to analyze the direction of the relationship between real exchange rates, stock prices and current account/GDP ratio of the Czech Republic, Hungary and Poland and Turkey and the US long-term government bond yields of the USA to determine the dynamics of the real exchange rates and stock prices in the countries we investigate.

3.5. SVEC model

The SVEC models are used to consider the contemporaneous and long-term shocks to be traced in an impulse response analysis of a VEC model. Thus, restrictions on the matrix of the long-term effects of shocks and the matrix B of contemporaneous effects of the shocks are specified. SVEC can be represented as

$$\mathrm{A}\Delta y_t = \Pi^* y_{t-1} + \Gamma_1^* \Delta y_{t-1} + ... + \Gamma_{p-1}^* \Delta y_{t-p+1} + \mathrm{B}\varepsilon_t \tag{5}$$

The Π^* and $\Gamma_j^* (j = 1,..., p-1),$ are structural form parameter matrices, while K is the number of variables included in the model and $(K \times K)$ matrix A allows modelling instantaneous relations among the variables in y_t. SVEC also has an MA representation as below:

$$y_t = \Xi \sum_{i=1}^{t} u_i + \Xi^*(L) u_t + y_0^* \tag{6}$$

In (6), Ξ represents the long-term effects of forecast error impulse responses and Ξ has rank $K - r$, provided that the cointegrating rank of system is r, while $\Xi^*(L) = \Sigma_{j=0}^{\infty} \Xi_j^* L^j$ is an infinite-order polynomial in the lag operator with coefficient matrices Ξ_j^* and the Ξ_j^* contain transitory effects. The orthogonalized short-term impulse responses may be obtained as $\Xi_j^* \mathrm{A}^{-1}\mathrm{B}$ when u_t is replaced by $\mathrm{A}^{-1}\mathrm{B}\varepsilon_t$, while the long-term effects of ε shocks are given by $\Xi \mathrm{A}^{-1}\mathrm{B}$. There are $K - r$ permanent shocks and given

the reduced rank of the matrix $K - r(K - r - 1)/2$, additional restrictions are imposed for identifying the permanent shocks, whereas $r(r-1)/2$ additional contemporaneous restrictions are needed for identifying the transitory shocks (Breitung et al. 2007, pp. 168-169). In addition, we show the proportion of the movements in the dependent variables that are due to their own shocks versus shocks to the other variables by computing forecast error variance decompositions. FEVDs are related to IRFs and specifically show the proportion of the movements in the dependent variables that are due to their own shocks, versus shocks to the other variables. (For details of the derivation of FEVDs see Breitung et al., 2007, pp. 159-195.) More precisely, FEVDs determine how much of the *h*-step-ahead forecast error variance of a given variable is explained by shocks to the other variables (Brooks, 2008, pp. 299-300).

4. IDENTIFICATION OF THE SVEC MODELS AND EMPRICAL RESULTS

In this study, four SVEC(10) models (the lag lengths of the models are suggested by the AIC) are employed depending on the VEC modelling framework with constant and trend terms to analyze the relationship between stock prices and exchange rates. Within this framework, plausible restrictions are to be imposed to identify the structural shocks of the SVEC models. Our approach uses a vector containing three variables that can be specified as: $y_t = (rexc_t, shpr_t, lyie_t^{usa})'$, whereas a vector containing four variables is denoted by $y_t = (rexc_t, shpr_t, lyie_t^{usa}, cur_t)'$; thus $K = 3$ and $K = 4$, respectively. On the other hand, $r = 1$, since we found one cointegrating relation for all cases. In this respect, there are two permanent shocks in the model with three variables, while $0.5\left[K - r(K - r - 1)\right] = 1$ additional restrictions are needed to identify the permanent shocks and additional $0.5r(r-1) = 0$ contemporaneous restrictions are required for the identification of transitory shocks. Accordingly, three additional restrictions are needed to identify the permanent shocks in SVEC models with four variables. In order to identify permanent shocks for both type of models, we assume that (i) nominal shocks attributed to the shocks to stock prices have no long-term effects on the variables included in the SVEC model, (ii) shocks in the US long-term (10-year) government bond yields have long-term effects on real exchange rates and stock prices despite it being a nominal variable. For both type of models we imposed one extra restriction

needed to identify the permanent shocks assuming that the real exchange rates do not influence the US long-term (10-year) government bond yields. Additional restrictions of the SVEC model with four variables are based on the assumptions that current accounts do not influence the US long-term (10-year) government bond yields and real exchange rates. Therefore the matrix B of the contemporaneous effects of the shocks and the matrix Ξ B of the long-term effects of the shocks in three-variable SVEC model are represented as $B=\begin{pmatrix} * & * & * \\ * & * & * \\ * & * & * \end{pmatrix}$ and $\Xi B=\begin{pmatrix} * & 0 & * \\ * & 0 & * \\ 0 & 0 & * \end{pmatrix}$, respectively. On the other hand, the matrix B and the matrix Ξ B refers to $B=\begin{pmatrix} * & * & * & * \\ * & * & * & * \\ * & * & * & * \\ * & * & * & * \end{pmatrix}$ and $\Xi B=\begin{pmatrix} * & 0 & * & 0 \\ * & 0 & * & * \\ 0 & 0 & * & 0 \\ * & 0 & * & * \end{pmatrix}$, respectively.

4.1. Impulse response analysis results

Stock prices can be defined as the present value of the future cash flows of companies, and stock prices are related to the changes in real output. Market conditions and the state of the real economic activity of a country are reflected in the changes in stock market prices. For the Czech Republic, Hungary and Turkey, Figure 1 shows that following a one standard deviation shock in the real exchange rates, share prices may rise, thereby a positive relationship between the real exchange rate appreciation and stock prices are implied in line with the studies conducted by Nieh and Lee (2001), Phylaktis and Ravazzolo (2005), Diamandis and Drakos (2011), Ülkü and Demirci (2012) and Liang et al. (2013). The Czech Republic, Hungary and Turkey are capital-importing economies and thus it is revealed that real exchange rate appreciation may be a crucial factor promoting imports of highly-efficient intermediate and capital goods in the Czech Republic, Hungary and Turkey, which in turn may lead to an increase in output and affect firms' value and stock prices positively. In addition, the results of the impulse

response analysis show that the appreciation of the home currency in the Czech Republic, Hungary and Turkey may lead to an improvement of the balance sheet items (assets and liabilities) of firms in these countries due to a fall in the exchange rate risk (firms in the Eastern European countries and Turkey may be exposed to exchange rate risk due to their currency positions; see Moghadam et al., 2014; and the World Bank Regular Economic Report July, 2014). Therefore we can also interpret for the Czech Republic, Hungary and Turkey that the appreciation of the home currency may lead to a flow of foreign funds into domestic financial markets which in turn may affect stock prices positively and reinforce the expectation of the local currency's further appreciation. Conversely, the response of stock prices to real exchange rate appreciation is not significant for Poland, in line with Wu (2001), Stavarek (2004), Basher et al. (2012), Pirovano (2012), Wu et al. (2012), and Ülkü and Demirci (2012), thus we cannot arrive at a decision whether Poland may benefit from the real exchange rate appreciation despite changes in real exchange rates which may lead to fluctuations in the Polish stock market in the future. On the other hand, our assertion for Poland may arise from the fact that the empirical model for Poland does not consider trade flows due to data unavailability. Within this context, it can also be assumed that an improvement in foreign trade accounts affect firm values positively due to an increase in real economic activity. According to the IRFs, foreign trade flows may lead to variations in stock prices for the Czech Republic, Hungary and Turkey. More precisely, stock prices may fall in these countries following a positive shock in current accounts that indicates an improvement in the external balance. Hence the importance of the increase in imports for sustaining economic growth is stressed for the Czech Republic and Turkey.

On the other hand, in line with expectations, our IRFs show for the Czech Republic that rises in the US long-term bond yields may lead to capital outflows and thus a fall in the stock prices of the Czech Republic, in line with Ehrmann and Fratzscher (2006), Kim and Nguyen (2009), Wongswan (2009), Pirovano (2012), and Mollick and Assefa (2013), as shown in Figure 1. More precisely, it can be interpreted that the US high-yield bonds are considered a buying opportunity by the financial market players, who also invest in the stock market of the Czech Republic. However, IRFs detect that stock prices may fluctuate and indeed may increase due to the rises in the US long-term bond yields in other cases. We can interpret that the domestic financial market players of Hungary, Poland and Turkey may assess the rising interest rates in the US as the cause of the relative decrease in the bond

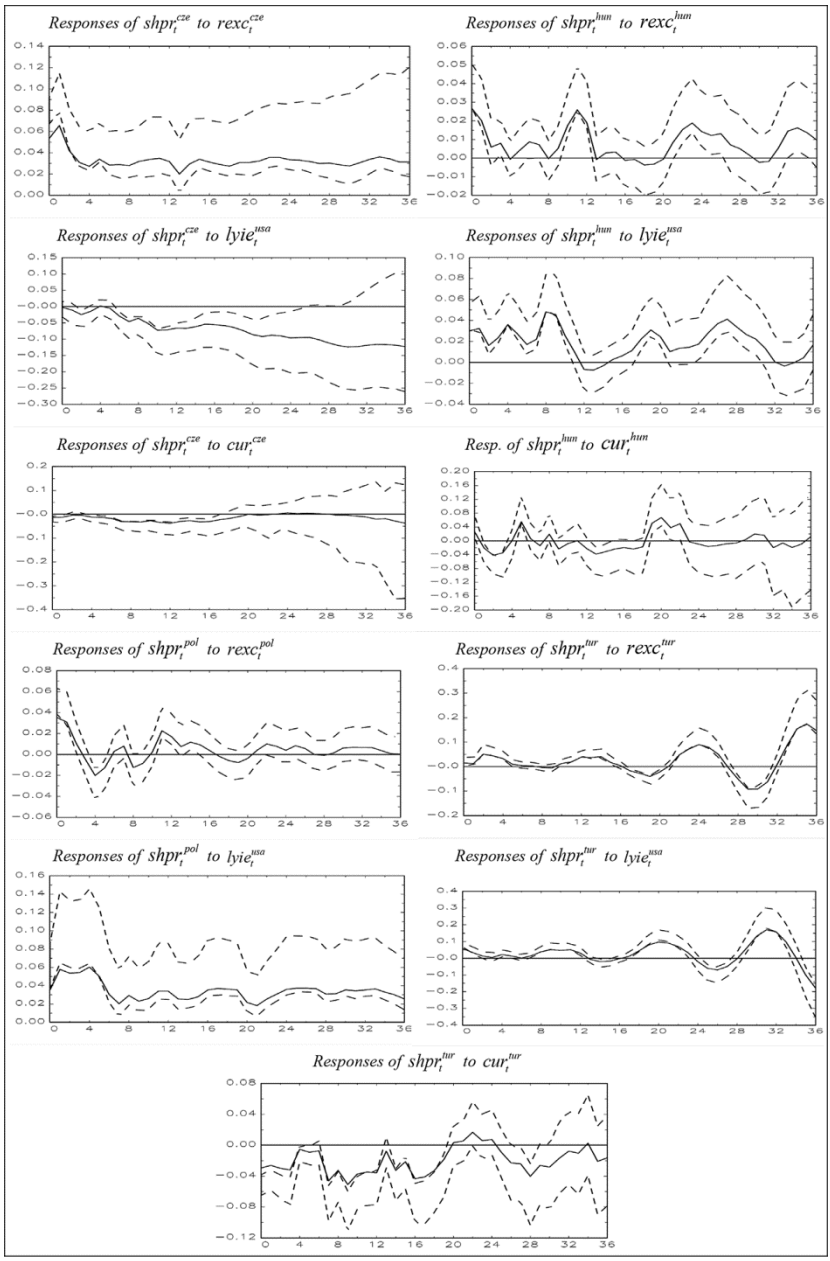

Figure 1. Responses of Stock Prices to Real Exchange Rate, Foreign Interest Rate and Current Account Balance (% of GDP) Shocks

Source: authors' estimation

yields of these countries when compared to the US bond yields. Our interpretation is in contrast to Valante (2009), Bluedorn and Bowdler (2011) and Scrimgeour (2010), who found that foreign monetary policy authorities follow the federal funds rate increases. However, our findings can be proven upon the policy change of the Fed in terms of interest rates rising when the external financial requirements of the Czech Republic Hungary, Poland and Turkey are present.

Lin (2012) suggests that the co-movement between exchange rates and stock prices may be driven by capital account balance rather than trade balance. When the consequences of the financial crisis of 2007–2009 are considered, stock market performance has become a key factor for maintaining macroeconomic stability since financial fragilities can have negative effects. According to the monetarist models of exchange rate determination and portfolio-balance models, equities, as a part of wealth, may affect the behaviour of exchange rates. Furthermore, changes in stock prices can be considered as a confidence indicator about the macroeconomic situation and may lead to changes in money demand. Figure 2 shows that as a result of a one standard deviation shock in stock prices, the real exchange rates of the Czech Republic, Hungary, Poland and Turkey fluctuate in the following periods and thus no significant impact of stock prices on real exchange rates are detected. We can assert that in the Czech Republic, Hungary, Poland and Turkey, the real exchange rate may appreciate or depreciate in the short-term in relation to changes in stock prices, whereas there is no long-term impact on the real exchange rates, in line with Stavarek (2004) and Ülkü and Demirci (2012), but in contrast to Kubo (2009), Zhao (2010), Diamandis and Drakos (2011), and Tsai (2012). This finding reveals that changes in stock prices may not be regarded as an important factor affecting the money demand in Hungary, Poland and Turkey over the long term, in contrast to the recent studies conducted by Baharumshah et al. (2009), Zuo and Park (2011) and De Santis et al. (2013). Therefore, we can assert that the development and liberalization of the capital market of the Czech Republic, Hungary, Poland and Turkey may not be regarded as a factor leading to current account surpluses or deficits and promoting economic development. IRFs show that the share prices of the Czech Republic, Hungary, Poland and Turkey do not have a sufficient amount of impact on nominal exchange rates and domestic inflation that lead to a change in the real exchange rates in a significant direction.

Similarly, we detect by IRFs that increases in the US long-term bond yields may lead to fluctuations in the real exchange rates of Hungary, Poland

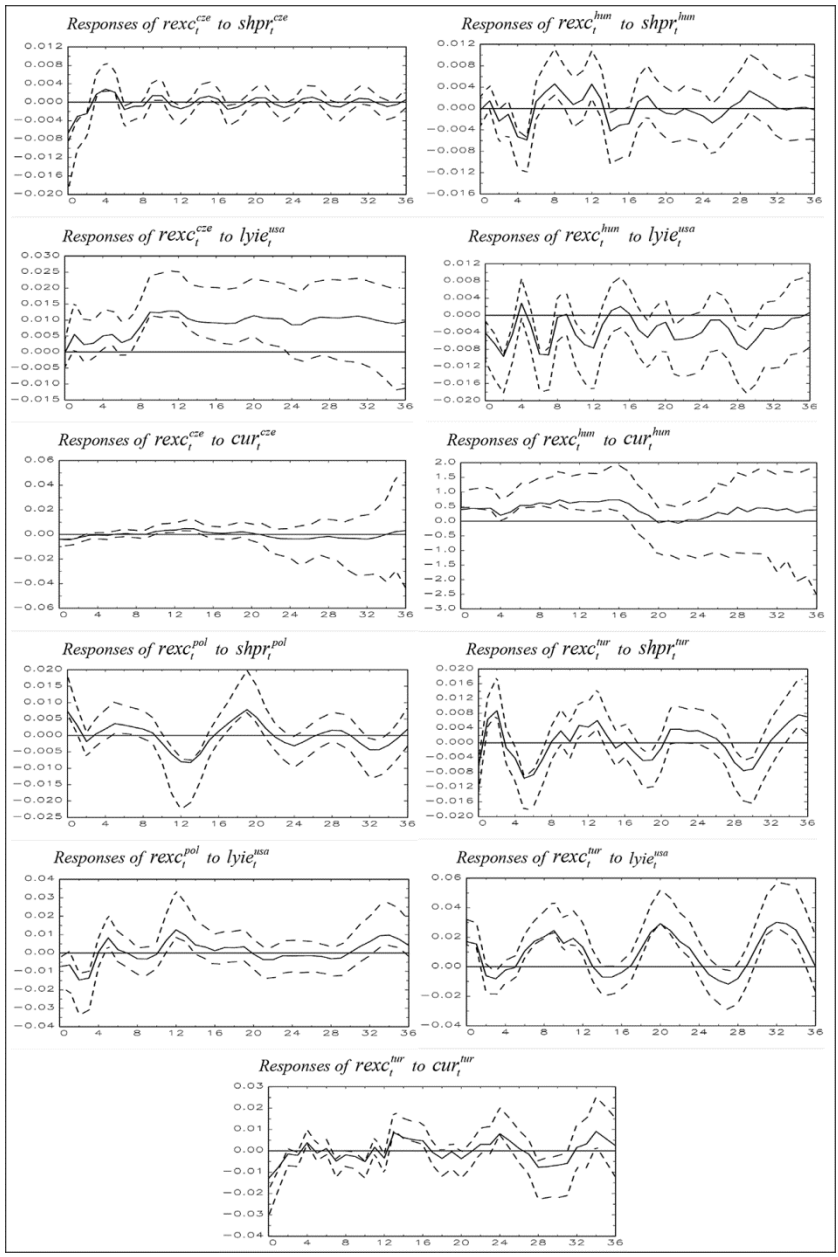

Figure 2. Responses of Real Exchange Rates to Stock Price, Foreign Interest Rate and Current Account Balance (% of GDP) Shocks

Source: authors' estimation

and Turkey, whereas the real exchange rates of the Czech Republic and Turkey may appreciate as a result of a positive shock in the US long-term bond yields, in line with Holman and Neumann (2002). This finding, related to the Czech Republic and Turkey, is in contrast to the expectations that increases in the US interest rates will lead to a depreciation of the home currencies in emerging markets. When our IRF related to the real exchange rates is considered with the result of the IRF showing the response of share price to the shocks in the US interest rate, we can assert that capital outflows from the Czech Republic and Turkey may erode economic activity and may cause a fall in inflation that can appreciate the home currency, in line with Kim and Roubini (2000), Faust et al. (2003), Barakchian (2015). Within this context, the current account balance can also be accepted as a factor for the variations in real exchange rates since changes in trade flows may have an impact in terms of appreciation or depreciation of the home currency in the following periods. Only in the case of Hungary, IRFs indicate that an improvement of current account balance relative to GDP may lead to real exchange rate appreciation and thus a deterioration in the external balance in future periods.

4.2. Forecast error variance decomposition results

Table 6 shows that the real exchange rates have an important explanatory power over the variation of stock prices for all cases, similarly to the studies of Kim (2003), Pan et al. (2007) and Pirovano (2012), but in contrast to Ülkü and Demirci (2012). The real exchange rates account for nearly 50, 30, 10 and 10 percent of the 36-step forecast error variance of stock prices in the Czech Republic, Hungary, Poland and Turkey, respectively. Our FEVDs also show that shocks in current account/GDP ratio are also a key factor for the variations in stock prices in the Czech Republic, Hungary and Turkey. For all cases, it is revealed that changes in the real exchange rates and current account dynamics may have a key role for analyzing the changes in company values and variations in stock markets. Therefore our finding implies that changes in stock prices may be sensitive to the nominal exchange rates and domestic and foreign prices and GDP, thus supporting the results of the study of Maysami and Koh (2000). In this respect, the channels through which the nominal exchange rates, domestic prices and foreign economic activity affect stock prices in the Czech Republic, Hungary, Poland and Turkey should be clarified by their monetary policy authorities aiming to maintain financial stability.

On the other hand, FEVD results point out that in the following 36th quarter, $shpr_t^{hun}$ and $shpr_t^{tur}$ can only explain a maximum of approximately 15 percent of the variation in themselves, implying that stock prices are not mainly driven by their own shocks and technical dynamics of stocks in the countries we investigate in contrast to Ülkü and Demirci (2012). Moreover, FEVDs reveal that the US long-term bond yields may lead to a high level of impact on the variations in share prices in the following periods, especially in the Czech Republic and Poland, when the values of capital flows are concerned. Hence it can be asserted that the past values of nominal exchange rates, domestic and foreign inflation and monetary policy shocks in the US may cause a considerable amount of fluctuations in stock prices that affect financial stability negatively. Along with the analysis of all these domestic and foreign factors in one theoretical framework, the political factors and expectations influencing investment decisions in the stock market should also be taken into consideration by the policy makers and market players of the financial markets of these countries (particularly in Hungary and Turkey) to explain the movements in stock prices, consistent with Leigh et al. (2005) and Wu et al. (2012).

Table 6

FEVDs of the share prices

	FEVD of $shpr_t^{cze}$				**FEVD of** $shpr_t^{hun}$			
Forecast Horizon	$rexc_t^{cze}$	$shpr_t^{cze}$	$lyie_t^{usa}$	cur_t^{cze}	$rexc_t^{hun}$	$shpr_t^{hun}$	$lyie_t^{usa}$	cur_t^{hun}
1	0.90	0.01	0.05	0.04	0.11	0.04	0.02	0.83
6	0.85	0.01	0.12	0.02	0.15	0.05	0.54	0.26
12	0.50	0.03	0.40	0.07	0.34	0.08	0.36	0.22
18	0.42	0.03	0.41	0.14	0.35	0.16	0.26	0.23
24	0.44	0.03	0.37	0.16	0.32	0.15	0.30	0.23
30	0.50	0.03	0.33	0.14	0.31	0.15	0.28	0.26
36	0.52	0.03	0.34	0.11	0.30	0.15	0.26	0.29
	FEVD of $shpr_t^{pol}$				**FEVD of** $shpr_t^{tur}$			
Forecast Horizon	$rexc_t^{pol}$	$shpr_t^{pol}$	$lyie_t^{usa}$		$rexc_t^{tur}$	$shpr_t^{tur}$	$lyie_t^{usa}$	cur_t^{tur}
1	0.46	0.08	0.46		0.54	0.03	0.01	0.42
6	0.15	0.01	0.84		0.34	0.13	0.21	0.32
12	0.15	0.01	0.84		0.15	0.11	0.48	0.26
18	0.14	0.01	0.85		0.11	0.11	0.56	0.22
24	0.12	0.02	0.86		0.14	0.11	0.54	0.21
30	0.11	0.02	0.87		0.14	0.11	0.51	0.24
36	0.09	0.02	0.88		0.13	0.11	0.50	0.26

Source: authors' estimation

According to Table 7, the real exchange rates explain a high amount of the 36-step forecast error variance of itself in the Czech Republic, Hungary and Turkey in line with the findings of Pan et al. (2007) and Wu et al. (2012). Conversely, a small amount of the variations in the real exchange rates are attributable to its own shocks in Poland in contrast to Ülkü and Demirci (2012). On the other hand, the importance of stock prices for the variation in the real exchange rates in Poland is the highest among all cases; $shpr_t^{pol}$ explain nearly 30 percent of the variation in $rexc_t^{pol}$ up to 36 quarters. Thus we can assert that this phenomenon may arise from the fact that the empirical model for Poland does not consider current account balance. Moreover, FEVDs demonstrate that changes in the monetary policy stance of the Fed may lead to variations of the real exchange rates in terms of appreciation and depreciation for all cases. FEVDs generally do not provide evidence for the consistency of purchasing power parity in the Czech Republic, Hungary and Turkey over a long time, in contrast to the recent studies (Alba and Papell, 2007; Ahmad and Craighead 2011; Chang and Tzeng, 2011 and Chang et al., 2011). Hence we can infer that, along

Table 7

FEVDs of the real exchange rates

	FEVD of $rexc_t^{cze}$				**FEVD of** $rexc_t^{hun}$			
Forecast Horizon	$rexc_t^{cze}$	$shpr_t^{cze}$	$lyie_t^{usa}$	cur_t^{cze}	$rexc_t^{hun}$	$shpr_t^{hun}$	$lyie_t^{usa}$	cur_t^{hun}
1	0.07	0.27	0.40	0.26	0.69	0.16	0.13	0.02
6	0.25	0.06	0.48	0.21	0.34	0.14	0.21	0.31
12	0.51	0.03	0.29	0.17	0.29	0.17	0.28	0.26
18	0.46	0.02	0.36	0.16	0.26	0.15	0.25	0.34
24	0.37	0.02	0.45	0.16	0.26	0.16	0.14	0.44
30	0.33	0.02	0.48	0.17	0.28	0.14	0.11	0.47
36	0.33	0.02	0.46	0.19	0.31	0.14	0.11	0.44
	FEVD of $rexc_t^{pol}$				**FEVD of** $rexc_t^{tur}$			
Forecast Horizon	$rexc_t^{pol}$	$shpr_t^{pol}$	$lyie_t^{usa}$		$rexc_t^{tur}$	$shpr_t^{tur}$	$lyie_t^{usa}$	cur_t^{tur}
1	0.01	0.64	0.35		0.74	0.02	0.12	0.12
6	0.01	0.53	0.46		0.68	0.01	0.15	0.16
12	0.01	0.46	0.53		0.63	0.01	0.16	0.20
18	0.02	0.42	0.56		0.61	0.02	0.15	0.22
24	0.03	0.38	0.59		0.58	0.02	0.15	0.25
30	0.03	0.35	0.62		0.56	0.02	0.15	0.27
36	0.04	0.32	0.64		0.53	0.01	0.16	0.30

Source: authors' estimation

with changes in domestic stock prices, changes in the interest rates in the US may seriously affect variations in foreign competitiveness, current account balance and real economic activity in the Czech Republic, Hungary, Poland and Turkey.

CONCLUSION

In this study, we employed SVEC models to determine the relationship between exchange rates and stock prices via Granger and Instantaneous Causality analysis, IRFs and FEVDs in the Czech Republic, Hungary, Poland and Turkey.

The results of the Granger causality analysis indicate that interactions between foreign exchange rate and stock markets in the Czech Republic, Hungary, Poland and Turkey can be under the influence of the Fed's decisions. If this is the case, the monetary policy authorities of these countries aiming to maintain financial stability should consider the channels through which foreign interest rates may influence the real exchange rates and stock prices more seriously. The results of instantaneous causality tests reveal that there may be a relationship between the US long-term interest rates and the real exchange rates, and the stock prices in the Czech Republic, Hungary, Poland and Turkey in the short term. In this respect, determining the direction of impact of the US long-term interest rates on the real exchange rates and stock prices is stressed when the high external financing requirement of the Czech Republic, Hungary, Poland and Turkey is concerned.

According to the FEVDs, the real exchange rates are important sources of the fluctuations in stock prices for all cases. IRFs are generally in line with the FEVDs, showing that stock prices may be positively affected in the Czech Republic, Hungary and Turkey as a result of the real exchange rate appreciations. Our empirical exercise also show that current account dynamics impact on stock price changes in the Czech Republic, Hungary and Turkey, indicating that improvements in external balance may lead to a fall in stock prices in the Czech Republic and Turkey. Therefore we can infer that an increase in imports of relatively high-efficient intermediate and capital goods may positively affect total factor productivity, real output and firm values in the Czech Republic, Hungary and Turkey. Thus, we suggest that open-economy Dynamic Stochastic General Equilibrium (DSGE) modelling framework can be adopted in order to clarify the channels through which imports may influence the real economic activity in the Czech

Republic, Hungary and Turkey. In this respect, the open-economy DSGE modelling framework adopted by the policy-makers and researchers can be enriched by the inclusion of exchange rates, foreign inflation and GDP and terms of trade shocks. FEVDs also imply that the monetary policy stance in the US can cause a high amount of variations in the stock markets of the Czech Republic, Hungary, Poland and Turkey. More precisely, IRFs show that share prices in the Czech Republic may decrease as a result of the increase in the US long-term bond yields in line with expectations. Accordingly, we can interpret that financial market players who invest in the stock market of the Czech Republic, may consider the US high-yield bonds as a buying opportunity.

On the other hand, IRFs and FEVDs demonstrate that real exchange rates of the Czech Republic, Hungary, Poland and Turkey fluctuated in the following periods due to the changes in stock prices. Moreover, IRFs do not detect any impact on the real exchange rates in the long-run. Thus, we can infer that the development and liberalization of the capital market of the Czech Republic, Hungary and Turkey may not be regarded as an indirect factor leading to current account surpluses or deficits and promoting economic development. Conversely, we detect that variations in the stock market may have a considerable amount of influence on the real exchange rate in Poland. Accordingly, we can infer that the empirical approaches not considering foreign factors may lead to overestimating the results in terms of the impacts of stock markets on macroeconomic variables. According to our empirical exercise, improvements in current account balance are an important source of the variations in real exchange rates in the Czech Republic, Hungary and Turkey, leading to currency appreciation in Hungary. IRFs and FEVDs also reveal that the monetary policy decisions of the Fed may lead to a high number of fluctuations in terms of the real exchange rate appreciation and depreciation in the Czech Republic, Hungary, Poland and Turkey. When the possible effects of domestic stock prices and monetary policy changes in the US are considered, we suggest that the monetary policy rule of the Czech Republic, Hungary, Poland and Turkey - that is the element of the DSGE modelling framework in each country - should also include stock prices along with the interest rates shocks arising from the Fed, considering the external financing requirement. Consequently, our study highlights the importance of the derivation of the optimal economic policy framework within DSGE modelling, considering the country-specific and global factors to sustain financial and economic stability for the Czech Republic, Hungary, Poland and Turkey.

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