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RELATIONSHIP BETWEEN MACROECONOMIC FUNDAMENTALS AND STOCK MARKET INDICES IN SELECTED CEE COUNTRIES

The aim of this paper is to test for the presence of informational inefficiencies on stock markets of selected CEE countries (Croatia, Czech Republic, Hungary, Poland and Slovenia) analyzing the relationship between stock market indices and macroeconomic variables. In order to test for bilateral long run equilibrium relationships between stock market index and set of macroeconomic variables, including inflation rate, broad money supply, money market interest rate and foreign currency reserves, we use Johansen cointegration method. To gain more information about market efficiency Granger causality test is employed. Results point to established long run relationship between stock market indices and macroeconomic variables, especially in case of Poland and Czech Republic. The results of Granger (non) causality reveal that (a) there is no causal linkage between any macroeconomic variable and stock market index in Croatia, Hungary and Poland; (b) money supply and foreign exchange lead stock index in Czech Republic, while inflation rate and money market interest rate lead Slovene stock index (c) none of stock market indices might be used as a leading indicator of inflation rate (d) stock market index leads money market interest rate in Hungary and Czech Republic, foreign exchange reserves in Slovenia and money supply in Poland.

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1. Introduction

Analysis of relationships between macroeconomic variables and stock returns is object of ongoing interest of academics, investors and policymakers. First interest group is particularly motivated to reveal existing interrelationships between proxies of real economic activities and changes in stock returns. While stock prices should reflect expectations about future corporate performance, corporate profits on the other hand should reflect the level of country's economic activities. In case of stock prices reflecting the underlying fundamentals, it is possible to employ stock prices as a leading indicator of future economic activity and vice versa. Therefore, information about dynamics and direction of relationship between macroeconomic variables and stock prices is crucial for policymakers as it facilitates formulation of nation's macroeconomic policy.

Moreover, relationship between macroeconomic variables and stock returns can be observed in terms of market efficiency. The degree of stock market efficiency depends on the speed and accuracy with which information are built into stock prices. Informational efficiency is attributed to well functioning equity market. By definition, a financial market informational efficiency represents the security prices capacity to instantly and fully reflect all relevant available information affecting them. According to Fama (1970), depending on completeness and speed of information incorporation in securities prices, there are three levels of informational efficiency: (a) the weak form, (b) the semi-strong form, and (c) the strong form.[1] In that vein, in case of macroeconomic activity affecting stock prices, an efficient equity market instantaneously incorporates all available information about economic variables. On the other hand, absence of informational efficiency would allow market participants to develop profitable trading rule and thereto gain above average returns.

Information on changes in macroeconomic variables is widely and frequently available and investors incorporate them in their estimates of the future stock returns. Since the changes in macroeconomic variables arrive randomly, the consequence of the efficient market reaction to the news would appear as a relation-

[1] Weak form tests use an information set that includes only past prices, semi-strong tests of market efficiency augment the information on past prices with all other publicly available information, and strong-form tests include all information (public and private) in the information set.

ship between stock market index and macroeconomic variable. Nevertheless, one should keep in mind that the stock market is affected by economic activity to the extent that this affects general earnings, but stocks are also dependent on specific company and industry fundamentals.

Although literature provides evidence on strong linkages between fundamental economic activities and stock market returns in developed countries and Asian emerging markets, it has remained unclear whether such relationship exists for CEE emerging stock markets. In case of not being tied to economic fundamentals, stock prices on those emerging markets could be more exposed to speculative activities of irrational investors. Therefore, this paper aims to explore the relationship between stock market index and selected set of macroeconomic variables (inflation rate, broad money supply, money market interest rate and foreign currency reserves) in Croatia, Slovenia, Czech Republic, Poland and Hungary. Analysis is performed on emerging Central and Eastern European equity markets that represent congenial sample, because those markets are closely geographically and economically linked. Literature suggests existence of strong multilateral integration between these CEE equity markets as well as growing bilateral and multilateral integration of the selected CEE equity markets and proxies of developed European equity markets (Gilmore, Lucey and Mcmanus, 2005; Voronkova, 2004; Vizek and Dadic, 2006). Moreover, Poland, Czech Republic, Slovenia and Hungary are members of EU while Croatia is preparing its economy for such membership. Finally, it should be noted that all selected equity markets have similar attributes in terms of liquidity, level of development and short history of organized share trading. However, Polish equity market is the biggest one in absolute terms.

Aiming to explore potential informational inefficiencies on selected CEE equity markets, we test for existence of any long run equilibrium relationships and a short-run dynamics between stock markets and real economic activity. In order to test for bilateral long run equilibrium relationships between stock market index and set of macroeconomic variables, including inflation rate, broad money supply, money market interest rate and foreign currency reserves, we use Johansen cointegration method. To gain more information about market efficiency Granger causality test is employed. Additionally, results of Granger causality test should reveal some information about transmission mechanism of shocks from macroeconomic environment to analyzed stock markets. We hypothesize that the presence of a cointegrating relationship between macroeconomic variables and stock index brings the conclusions of the efficient market hypothesis. The rationale is straightforward: if long run relationship between macroeconomic variables and stock market index exists, macroeconomic variables are significantly and consistently priced in stock market returns. i.e. stock prices reflect available macroeconomic data. The hypothesis of our paper leans on Malkiel's (2003) broader definition of

efficient markets arguing that efficient financial markets "…do not allow investors to earn above-average returns without accepting above-average risks".[2]

Finally, this paper fills the gap of existing literature that deals with relationships between macroeconomic variables and stock prices in selected CEE equity markets. As it has been already mentioned, results of this study should provide useful guidelines for investors and portfolio managers on the one side and policy-maker on the other.

The rest of the paper is organized as follows. After reviewing some of the literature on the relationship between stock market indices and macroeconomic variables in section 2, in section 3 data and methodology employed are presented. Last two sections, 4 and 5, offer discussion of results of the paper and concluding remarks.

2. Literature review

Literature that deals with relationship between macroeconomic and financial effects on equity markets can be presented from three different aspects. Namely, literature differs in terms of selected financial and macroeconomic variables, methodology employed, and level of equity market development. Oberuc (2004) recognized term spread, default spread, dividend yield, interest rate, industrial production, inflation, exchange rates, money supply, GNP or GDP, previous stock returns and unemployment as most commonly used variables. As far as methodology is concerned, following approaches can be derived from the literature: arbitrage pricing theory (APT), discount cash flow model and cointegration approach. In line with the main purpose of this paper, emphasis is put on studies that deal with long run comovements and short run dynamics of macroeconomic variables and equity market indices on emerging markets.

There is extensive evidence on significant relationship between equity market returns and financial and macroeconomic variables for developed countries (Fama, 1981, 1990; Chen, Roll and Ross, 1986; Fama and French, 1989; Schwert, 1990; Dumas, Harvey and Ruiz, 2003). Being conducted for developed countries in different time periods, aforementioned studies link changes in stock market

[2] Alternative approach was adopted by Granger (1986), Hakkio and Rush (1989) and Baillie and Bollerslev (1989). They argued that if two variables are cointegrated then this implies that one price can be used to forecast another which violates the principle of efficient markets. However, Sephton and Larsen (1991), Dwyer and Wallace (1992), Baffes (1994), Crowder (1994) and Engel (1996) point to serious lack of equivalence between markets inefficiency and cointegration.

returns and different proxies of financial and macroeconomic activity through arbitrage pricing theory by allowing asset returns to be explained with multiple risk factors. In other words, APT models a short run relationship between macroeconomic variables and the stock price in terms of first differences, assuming trend stationarity.

Fama (1981) showed a strong positive relationship between equity returns and real economic activities such as industrial production, capital expenditures and GNP. Moreover, same researcher proved a significant positive relationship between current and expected future output growth on the one side and stock market returns on the other (Fama, 1990). While adding a proxy of industrial production, Schwert (1990) confirmed Fama's results and pointed out three explanations for the strong link between stock prices and real economic activity. "First, information about future real activity may be reflected in stock prices well before it occurs—this is essentially the notion that stock prices are a leading indicator for the well-being of the economy. Second, changes in discount rates may affect stock prices and real investment similarly, but the output from real investment doesn't appear for some time after it is made. Third, changes in stock prices are changes in wealth, and this can affect the demand for consumption and investment goods" (Schwert, 1990, p. 1237).

Chen, Roll and Ross (1986) proved strong relationship between the equity market returns and industrial production, the money supply, inflation, and interest rate and exchange rate. Fama and French (1989) found expected returns on common stocks and long-term bonds to contain a term or maturity premium and a risk premium that is related to longer-term aspects of business conditions. Therefore, expected returns tend to be lower when economic conditions are strong and higher when conditions are weak. Moreover, Dumas, Harvey and Ruiz (2003) presented statistical evidence that correlations in output growth rates and correlations in stock market returns exhibit a positive and significant relationship. Pearce and Roley (1985) also found that unexpected announcements in monetary policy had a significant influence on stock prices while Jain (1988) noted that announcements about money supply and consumer price index are significantly associated with stock price changes.

Alternatively, long run relationships between stock prices and macroeconomic variables can be analyzed with discounted cash flows approach. This approach is based on assumption that macroeconomic factors have an influence on the stock prices by affecting future expected cash flows or the discount rate. Aforementioned assumption was confirmed by Shiller (1981), Flannery and Protopapadakis (2002) and Campbell and Shiller (1988). Results of latter analysis suggested that long term moving average of earnings predicted by dividends and the ratio of earnings to current stock price was powerful in predicting stock returns over several years.

While analyzing equity index returns of 16 OECD countries, Patro *et al*. (2002) showed that imports, exports, inflation, market capitalization, dividend yields and price-to-book ratios significantly affected a country's exposure to world market risk.

Long-run relationships between the stock market index and various macroeconomic variables have been examined using cointegration techniques. Such approach has been followed in number of studies. Having used monthly data over 40 years, Humpe and Macmillan (2007) demonstrated that US stock prices were positively influenced by industrial production and negatively by inflation and the long interest rate, while money supply had an insignificant influence over the US stock prices.

Nasseh and Strauss (2000) found a strong relationship between stock prices and domestic and international macroeconomic variables in France, Germany, Italy, Netherlands, Switzerland and the UK. Their findings suggest that stock prices are grounded in economic fundamentals since they are influenced by production, interest rates, business expectations and the CPI. Moreover, variance decomposition methods showed that domestic and international activity could forecast from 37% to 82% of stock prices after four years, depending on which European economy is viewed.

Errunza and Hogan (1998) estimated VAR models for European stock returns for 1959-1993. Results of the study suggested that for many European equity markets return volatility predictions could be enhanced by incorporating information about the macroeconomic conditions. Moreover, results imply that lagged money supply growth rates Granger cause stock market return volatility in Germany and France. On the other hand, return volatility for Italy and the Netherlands were more responsive to real economic uncertainty than monetary uncertainty. However, evidence that past macroeconomic variables affect equity returns in the United Kingdom, Switzerland and Belgium, was not found.

Although literature offers prominent evidence on relationship between macroeconomic fundamentals and developed stock markets, research of emerging markets is scarce, especially in case of Central and Eastern European equity markets.

Harvey (1995) examined returns of 20 emerging stock markets over the period 1976-1992. He found return predictability to be greater in the emerging markets than in developed ones. Results suggested that over half of the predictable variance in the emerging market returns could be traced to local information. This conclusion was supported by a more recent study that discovered that a mix of local (GDP, inflation, money and interest rates) and world (industrial production and inflation) economic variables could only explain up to 14.6 per cent of the variance of monthly returns for a sample of 13 emerging stock markets (Fifield *et al*., 2002).

Mahmood and Dinniah (2009) used the Engle-Granger test and Johansen and Juselius maximum likehood procedure to test relationship between stock price and three macroeconomics variables which consist of inflation, output and exchange rates of six countries in Asian-Pacific region. The study provides evidence of long-run relationship between these variables in all countries, thus support the cointegration hypothesis with exception of Malaysia. Analysis rejected existence of short-run relationship between all variables in all selected countries except between foreign exchange rates and stock price in Hong Kong and between real output and stock price in Thailand. The latter equity market was subject of interest of Brahmasrene and Jiranyakul (2007). They showed that money supply had a positive impact on the Thai stock market index while the industrial production index, the exchange rate and oil prices had a negative impact. Moreover, results of the Granger causality test indicated money supply was the only variable positively affecting the stock market returns.

Same methodology was employed by Karamustafa and Kucukkale (2003) on Turkish equity market. Results of the study showed that money supply, exchange rate of USD, trade balance, and the industrial production index were cointegrated with stock returns. However, the macroeconomic variables were not the leading indicators for the stock returns, while stock returns was the leading indicator for the macroeconomic performance.

3. Data and methodology

3.1. Data

In this study we used stock indices and selected macroeconomic variables monthly data of Croatia, Czech Republic, Hungary, Poland and Slovenia for the period from January 1998 to January 2010.[3] All series used in the analysis are transformed into natural logarithms. Data was collected from Bloomberg, Eurostat and Reuters database. Stock prices are the end-of-period closing share price indices. To proxy for Croatian, Czech, Hungarian, Polish and Slovenian stock market, we employed CROBEX, PX, BUX, WIG and SVSM indices, respectively.

The selection of the macroeconomic variables for inclusion in the analysis was governed by the time series that are commonly included in studies of stock

[3] The period before 1998 was not taken in consideration in order to avoid breaks in data series due to both infrequent trading on selected stock markets and relatively inconsistent macroeconomic variables as a result of macroeconomic stabilization programs in early 1990-ies.

return predictability. It is assumed that stock market behavior is related to macroeconomic conditions, and hence variables which might be able to capture both current and future direction in the broad economy are used in the analysis. Since it would be almost impossible to incorporate every potential aspect of macroeconomic activity to explain the stock market behavior, this study is limited to following macroeconomic variables: broad money supply (M3), foreign exchange reserves (FXR), money market interest rates (MMIR) and harmonized index of consumer prices (HICP). The money supply is related to the stock market in several ways. Money supply represented by M3 provides a measure of liquidity in the economy and any change in money supply should therefore have an impact on the investment decisions of the individual investors. Increased nominal money supply leads to a portfolio rebalancing toward other real assets, resulting in upward pressure on stock prices. On the other hand, purely nominal increases in money supply might be regarded as a leading indicator of future inflation, which in turn affects stock returns. Furthermore, increase in money supply leads to a falling in real interest rates. It implies that firms are faced with lower discount rates against future cash flows, and also respond to increasing income by adjusting their investments so as to generate greater sales and profits resulting in higher future cash flows and higher stock prices. The above economic rationale supporting the linkage between stock returns and money supply is sufficient to include money supply as a relevant economic force that can impact stock returns. In our analysis M3 was used for all countries except in case of Croatia which uses M4 as measure of broad money, and Czech Republic, for which M2 was used due to data unavailability of aggregate M3 for the entire period. The rise (fall) in inflation, beside its impact on interest rates, directly reduces (increases) the purchasing power of investors and thus should have an impact on equity investment decisions of local investors. An increase in foreign exchange reserves helps an economy by increasing the "cushion" it has against excessive variations of the exchange rate. This is particularly important for fixed exchange regimes where it is vital for an economy to keep its exchange rate constant and hence maintain macroeconomic stability. Short-term nominal interest rates are assumed to contain information about future economic conditions and to capture the state of investment opportunities.

3.2. Methodology

Firstly, we test each series for the presence of unit roots, which will show whether the series are nonstationary. Nonstationarity is a precondition for cointegration and all the series must be integrated of the same order. Augmented Dickey-Fuller procedure (ADF) will be used to test for existence of unit roots in both

levels and first differences of stock market indices CROBEX, SVSM, PX, WIG and BUX as well as inflation rate, broad money supply, money market interest rate and foreign currency reserves[4] (Dickey and Fuller, 1979). The test for a unit root has the null hypothesis that $\gamma = 0$. Optimal number of time lags is to be determined by Modified Akaike Information Criteria (MAIC).

In order to test for bilateral long run equilibrium relationships between stock market index and set of macroeconomic variables, including inflation rate, broad money supply, money market interest rate and foreign currency reserves, Johansen cointegration method will be employed (Johansen, 1991). Cointegration analyses consider a setting where time series of individual variables "can wander extensively and yet some pairs of series may be expected to move so they do not drift too far apart" (Engle and Granger, 1987). In different words, when two time series are cointegrated, they move together over time maintaining long term equilibrium, although short term disturbances are allowed.

The Johansen method applies the maximum likelihood procedure to determine the presence of cointegrating vectors in non-stationary time series as a vector autoregressive (VAR). Consider a VAR of order *p*

$$Y_t = A_1 Y_{t-1} + A_2 Y_{t-2} + \ldots\ldots + A_p Y_{t-p} + BX_t + \varepsilon_t \tag{1}$$

where Y_t is a k-vector of non-stationary I(1) variables, X_t is a d-vector of deterministic variables, and ε_t is a vector of innovations. Alternatively, VAR can be written as:

$$\begin{aligned} \Delta Y_t &= \Pi Z_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta Y_{t-i} + BX_t + \varepsilon_t \\ \Pi &= \sum_{i=1}^{p} A_i - I \quad \text{and} \quad \Gamma_i = -\sum_{j=i+1}^{p} A_j \end{aligned}, \tag{2}$$

where Y_t is a vector of nonstationary variables, indicating the log return on stock market index (CROBEX, SVSM, PX, WIG and BUX) and X_t is log of macroeconomic variable (inflation rate, broad money supply, money market interest rate and foreign currency reserves). The information on the coefficient matrix between the levels of the series Π is decomposed as $\Pi = \alpha\beta'$ where the relevant elements of the α matrix are adjustment coefficients and the β matrix contains the cointegrating vectors.

[4] Since it is the case that log values will be cointegrated when the actual values are cointegrated it is standard, but not necessary, to perform the cointegration analysis on log values in order to eliminate possible exponential behavior of time series.

If variables are I(1) and cointegration vector(s) between n variables are found, VAR should be transformed into VECM in following way:

$$\Delta y_t = \Pi y_{t-k} + \Gamma_1 \Delta y_{t-1} + \Gamma \Delta y_{t-2} + ... + \Gamma_{k-1} \Delta y_{t-(k-1)} + u_t \quad (3)$$

The VEC specification restricts the long-run behavior of the endogenous variables to converge to their cointegrating relationships while allowing a wide range of short-run dynamics. The cointegration term is known as the error correction term since the deviation from long-run equilibrium is corrected gradually through a series of partial short-run adjustments.

Johansen and Juselius (1990) specify two likelihood ratio test statistics to test for the number of cointegrating vectors. The first likelihood ratio statistics for the null of exactly *r* cointegrating vectors against the alternative of *r+1* vectors are the maximum eigenvalue statistic. The second statistic for the hypothesis of at most *r* cointegrating vectors against the alternative is the trace statistic. Critical values for both test statistics are tabulated in Johansen and Juselius (1990). The number of lags applied in the cointegration tests is based on the information provided by the multivariate generalization of the AIC.

Finally, we employ Granger causality test to determine the direction of short-run dynamics i.e. interdependences between all the equity markets in our sample (Granger, 1988). In accordance with statistical properties of selected time series we re-parameterized Granger causality test by augmenting it for error correction term when evidence of bilateral cointegration between equity markets was found. This is done because conventional Granger test is made for series that are integrated of order 0. Such Granger test specifies a bivariate vector autoregressive model with a lag length set as p and has a following form:

$$Yt = c_1 + \sum_{i=1}^{p} \alpha_i Y_{t-i} + \sum_{i=1}^{p} \beta_i X_{t-i} + u_t \quad (4)$$

$$H_0 : \beta_1 = \beta_2 = ... = \beta_p = 0$$

The Granger causality is examined by testing whether all β_i are equal to zero using a standard F-test, also called Wald test. If we can reject the null hypothesis in equation (4) X is said to Granger-cause Y. The above equations are, however, only valid for series that are stationary - that is I(0). Since most time-series in macroeconomics are found to be non-stationary - that is I(1)- we have to apply differencing and thus convert series into an I(0) to which the Granger causality tests could be applied:

$$\Delta Yt = c_1 + \sum_{i=1}^{p} \alpha_i \Delta Y_{t-i} + \sum_{i=1}^{p} \beta_i \Delta X_{t-i} + u_t$$
$$H_0 : \beta_1 = \beta_2 = ... = \beta_p = 0 \quad (5)$$

However, later research showed that this procedure is only correct if the two series are not cointegrated. Engle and Granger (1987) and Granger (1988) argue that in the presence of cointegration, causality tests, which ignore the error correction term (ECT) derived from the cointegration relationship are mis-specified and suggest to re-parameterize the model in the equivalent error correction model form. Therefore, in cases when cointegration between variables is found, Granger causality test is re-parameterized with VECM.

4. Results

The results of the empirical analysis are reported in tables 1-5. Table 1 shows results of unit root tests in levels and first differences for logarithmic transformations of CROBEX, PX, BUX, WIG and SVSM indices as well as for the inflation rate, broad money supply, money market interest rate and foreign currency reserves. Closer look at the results confirms that indeed all time series exhibit nonstationarity in levels and stationary in first differences and are integrated of order 1, i.e. I(1).

Table 1.

RESULTS OF UNIT ROOT TESTS

Variable	Time period (mm.yy)	ADF in levels		ADF in first differences	
		t-value (trend and intercept)	p-value for Z(t)	t-value (intercept)	p-value for Z(t)
Croatia					
CROBEX	01/98 – 01/10	-1.7917 (0)	0.7039	-2.2770 (12)	0.0225
FXR	01/98 – 01/10	-1.1486 (1)	0.9162	-2.6592 (11)*	0.0840
HICP	01/98 – 01/10	-2.2232 (0)	0.4728	-7.3815 (1)	0.0000
M4	01/98 – 01/10	-1.2656 (4)	0.8920	-1.6864 (10)*	0.0867
MMIR	01/99 – 01/10	-2.6058 (2)	0.2786	-13.6161 (0)	0.0000

Variable	Time period (mm.yy)	ADF in levels		ADF in first differences	
		t-value (trend and intercept)	p-value for Z(t)	t-value (intercept)	p-value for Z(t)
Czech Republic					
PX	01/98 – 01/10	-1.4547 (0)	0.8404	-4.3075 (4)	0.0006
FXR	01/98 – 01/10	-1.8522 (0)	0.6740	-3.4228 (6)	0.0118
HICP	01/98 – 01/10	-0.9722 (13)	0.7618	-4.2079 (5)	0.0009
M2	01/98 – 01/10	-2.5889 (13)	0.2861	-14.5895 (0)	0.0000
MMIR	01/98 – 01/10	-2.3293 (3)	0.4151	-1.9498 (10)	0.0493
Hungary					
BUX	01/98 – 01/10	-1.9617 (0)	0.6167	-4.1207 (6)	0.0013
FXR	01/98 – 01/10	-1.4965 (0)	0.8266	-3.2869 (9)	0.0174
HICP	01/98 – 01/10	-3.0798 (13)	0.1155	-5.0878 (3)	0.0003
M3	01/98 – 01/10	0.4529 (12)	0.9991	-5.4014 (3)	0.0000
MMIR	01/98 – 01/10	-2.3851 (2)	0.3857	-5.6267 (2)	0.0000
Poland					
WIG	01/98 – 09/09	-1.6972 (0)	0.7476	-3.7956 (6)	0.0038
FXR	01/98 – 01/10	-2.2024 (4)	0.4842	-5.6573 (2)	0.0000
HICP	01/98 – 01/10	-2.7617 (6)	0.2141	-2.7168 (7)*	0.0738
M3	01/98 – 01/10	-2.0794 (7)	0.5522	-1.8845 (6)	0.0570
MMIR	01/98 – 01/10	-1.6538 (1)	0.7674	-3.3318 (5)	0.0153
Slovenia					
SVSM	01/98 – 01/10	-1.0126 (1)	0.9381	-3.5029 (4)	0.0093
SLO_FX	01/98 – 01/10	-2.2024 (4)	0.4842	-5.6573 (2)	0.0000
SLO_HICP	01/98 – 01/10	-0.5521 (1)	0.9800	-9.2589 (0)	0.0000
SLO_M3	12/04 – 01/10	-2.4514 (1)	0.3502	-3.7731 (2)	0.0055
SLO_MMIR	01/98 – 01/10	-1.6106 (2)	0.7839	-1.7778 (7)*	0.0717

Note: optimal number of time lags determined with Modified Akaike Information Criterion (MAIC) and is presented in parenthesis; * null hypothesis about existence of unit root rejected at 10 percent level

Results of bivariate Johansen cointegration procedure are summarised in Table 2. The number of significant cointegration vectors are tested by using the maximum likelihood based λ_{max} and λ_{trace} statistics introduced by Johansen (1988, 1991) and Johansen and Juselius (1990).

Table 2.

RESULTS OF JOHANSEN COINTEGRATION PROCEDURE
FOR PAIRS OF VARIABLES

	Stock market index (SMI)	SMI - FXR	SMI - HICP	SMI - M3	SMI - MMIR
Croatia	CROBEX	Yes	Yes	Yes	No
Czech Republic	PX	Yes	Yes	Yes	Yes
Hungary	BUX	No	Yes	Yes	No
Poland	WIG	Yes	Yes	Yes	Yes
Slovenia	SVSM	Yes	Yes	No	Yes

Note: null hypothesis rejected at 5% level

In case of Hungarian stock market, we found one cointegration vector between BUX index and inflation rate and two cointegration vectors between BUX and money supply. For Croatian stock market we found one cointegration vector in all bilateral cases except in case of CROBEX and money market interest rate where no cointegration was detected. One cointegration vector was found in all tested bilateral relationships between stock market index and selected macroeconomic variable in case of both Czech Republic and Poland, except when testing long run relationship between PX index and Czech money market interest rate, where we found two cointegration vectors. In case of Slovene market we found one cointegration vector for all bilateral combinations except in case of SVSM and money supply. However, we do not give much credit to the latter result due to shorter time span of the M3 data employed in the analysis.

In Table 3 we present the results of λ_{max} and λ_{trace} statistics for pairs of national stock market indices and selected macroeconomic variables where cointegration was found.

Table 3.

RESULTS OF Λ_{MAX} AND Λ_{TRACE} STATISTICS FOR PAIRS OF NATIONAL STOCK MARKET INDICES AND SELECTED MACROECONOMIC VARIABLES WHERE COINTEGRATION WAS FOUND

		Hypothesized no. of CE(s)	Eigen value	λtrace	5 % critical value	λmax	5 % critical value
Croatia	CROBEX - FXR	None*	0.11373	18.59464	12.3209	17.26451	11.2248
		At most 1	0.00926	1.330123	4.12991	1.330123	4.12991
	CROBEX – HICP	None*	0.20162	35.14197	20.2618	32.20050	15.8921
		At most 1	0.02036	2.941464	9.16455	2.941464	9.16455
	CROBEX – M4	None*	0.13816	25.46379	20.2618	21.26210	15.8921
		At most 1	0.02896	4.201689	9.16454	4.201689	9.16455
Czech Republic	PX –FXR	None*	0.10962	17.12774	12.3209	16.60333	11.2248
		At most 1	0.00366	0.524413	4.12991	0.524413	4.12991
	PX –HICP	None*	0.10362	17.22351	12.3209	15.64308	11.2248
		At most 1	0.01099	1.580428	4.12991	1.580428	4.12991
	PX –M2	None*	0.27447	47.11605	12.3209	45.88220	11.2248
		At most 1	0.00859	1.233852	4.12991	1.233852	4.12991
	PX –MMIR	None*	0.08007	18.14099	15.4947	11.93493	14.2646
		At most 1*	0.04247	6.206059	3.84147	6.206059	3.84147
Hungary	BUX –HICP	None*	0.19378	36.21744	12.3209	30.80216	11.2248
		At most 1*	0.03716	5.415284	4.12991	5.415284	4.12991
	BUX –M3	None*	0.29456	51.43810	12.3209	49.89847	11.2248
		At most 1	0.01071	1.539623	4.12991	1.539623	4.12991
Poland	WIG –FX	None*	0.09959	16.22764	12.3209	14.58290	11.2248
		At most 1	0.01176	1.644740	4.12991	1.644740	4.12991
	WIG –HICP	None*	0.10699	17.86646	12.3209	15.72971	11.2248
		At most 1	0.01526	2.136749	4.12991	2.136749	4.12991
	WIG –M3	None*	0.13698	20.66435	15.4947	20.47668	14.2646
		At most 1	0.00135	0.187670	3.84147	0.187670	3.84147
	WIG –MMIR	None*	0.13698	26.74076	20.2618	20.47677	15.8921
		At most 1	0.04406	6.263991	9.16455	6.263991	9.16455
Slovenia	SVSM –FX	None*	0.08801	15.26699	12.3209	13.17473	11.2248
		At most 1	0.01452	2.092260	4.12991	2.092260	4.12991
	SVSM –HICP	None*	0.14999	25.37814	12.3209	23.23901	11.2248
		At most 1	0.01485	2.139134	4.12991	2.139134	4.12991
	SVSM –MMIR	None*	0.10845	29.15578	25.8721	15.61162	19.3870
		At most 1*	0.09479	13.54416	12.5179	13.54416	12.5179

* denotes rejection of hypothesis at the 5% level

Note: optimal number of time lags selected using AIC obtained after VAR estimation of all endogenous variables

The results of Granger causality tests are summarized in Table 4. Results provide limited support for the argument that the lagged values of changes in macroeconomic variables Granger cause variations in the stock market indices. At 5% level of significance inflation rate and money market interest rate in Slovenia were found to Granger cause SVSM index. In addition, money supply and foreign exchange reserves in Czech Republic were found to Granger cause PX index on Czech stock market. Therefore, market informational efficiency hypothesis can be rejected for SVSM with respect to the rate of inflation and money market interest rate and for PX with respect to rate of money supply and foreign exchange reserves (detailed statistics provided in Table 5).

Table 4.

CAUSAL RELATIONS BETWEEN STOCK MARKET INDEX (SMI) AND MACROECONOMIC VARIABLE

	FXR → SMI	**HICP → SMI**	**M3 → SMI**	**MMIR → SMI**
Croatia	No	No	No	No
Czech Republic	Yes***	No	Yes*	No
Hungary	No	No	No	No
Poland	No	No	No	No
Slovenia	No	Yes**	No	Yes**
	SMI → FXR	**SMI → HICP**	**SMI → M3**	**SMI → MMIR**
Croatia	No	No	No	No
Czech Republic	No	No	No	Yes***
Hungary	No	No	No	Yes**
Poland	No	No	Yes*	No
Slovenia	Yes***	No	No	No

Note: → represents the direction of Granger causality, * null hypothesis rejected at 1% level; ** null hypothesis rejected at 5% level; *** null hypothesis rejected at 10% level

Table 5.

RESULTS OF GRANGER CAUSALITY TEST

Dependent variable / Independent variable	ΔFXR	ΔHICP	ΔM3	ΔMMIR	ΔBUX	ΔCROBEX	ΔPX	ΔWIG	ΔSVSM
	chi^2 - value	chi^2 - value	chi^2 - value	chi^2 - value	chi^2 - value	chi^2 - value	chi^2 - value	chi^2 - value	chi^2 - value
ΔBUX	0.576193 [0.7497]	0.252987 [0.6150]	0.216819 [0.6415]	5.422301** [0.0199]	-	-	-	-	-
ΔCROBEX	0.211939 [0.6453]	1.762285 [0.1843]	0.300920 [0.5833]	4.652243 [0.5891]	-	-	-	-	-
ΔPX	0.627613 [0.4282]	0.929102 [0.3351]	2.272322 [0.3210]	2.799739*** [0.0943]	-	-	-	-	-
ΔWIG	1.396846 [0.2373]	0.002008 [0.9643]	12.76646* [0.0004]	0.418567 [0.5177]	-	-	-	-	-
ΔSVSM	2.953135*** [0.0857]	1.639124 [0.2004]	0.650201 [0.4200]	1.048444 [0.3059]	-	-	-	-	-
ΔFXR	-	-	-	-	0.935306 [0.6265]	1.924915 [0.1653]	3.083393*** [0.0791]	0.508631 [0.4757]	0.598981 [0.4390]
ΔHICP	-	-	-	-	0.043470 [0.8348]	0.011276 [0.9154]	1.454529 [0.2278]	0.264771 [0.6069]	4.912524** [0.0267]
ΔM3	-	-	-	-	0.545718 [0.4601]	0.374460 [0.5406]	9.459045* [0.0088]	0.586712 [0.4437]	2.295617 [0.1297]
ΔMMIR	-	-	-	-	0.987794 [0.3203]	9.285337 [0.1582]	1.233778 [0.2667]	0.502864 [0.4782]	5.378641** [0.0204]

Note: number of lags is determined by Hannah-Quinn information criteria; p-value in brackets;

* null hypothesis rejected at 1% level; ** null hypothesis rejected at 5% level; *** null hypothesis rejected at 10% level

However, we also found some evidence of Granger causality between the lagged values of changes in stock prices and macroeconomic variables. Finding causality from lagged values of stock prices to an economic aggregate does not violate informational efficiency and is equivalent to the existence of causality from current values of stock prices to future levels of the economic variable (Bhattacharya and Mukherjee, 2006). This implies that stock index might be used as an leading indicator for future developments in macroeconomic variables. BUX index is found to Granger cause money market interest rate in Hungary, while WIG index is found to Granger cause money supply in Poland. At 10% level of significance, we found Granger causality between PX and money market interest rate and SVSM and foreign exchange reserves. This would suggest that BUX and PX indices lead money market interest rate, while WIG and SVSM might be used as the leading indicators money supply and foreign exchange reserves, respectively. Therefore, these stock markets make rational forecasts of the real sector. In cases when changes in the economic variable neither influenced nor are influenced by stock price fluctuations, the two series are independent of each other and the market is informationally efficient.

5. Conclusion

This paper is aimed to determine the nature of relationships between stock markets and selected macroeconomic variables in Croatia, Czech Republic, Hungary, Poland and Slovenia. We wanted to explore market efficiency with respect to information about macroeconomic indicators: inflation rate, money supply, foreign exchange reserves and money market interest rate. Evidence of market inefficiencies has important implications both at micro and macro levels. At the micro level, this implies that the individual investor is able to build profitable trading rule and hence earn above average returns. At the macro level, it raises serious doubts on the ability of the market to perform its fundamental role to allocate funds to the most productive sectors of the economy. Results of Johansen bivariate cointegration procedure are rather expected and point to established long run relationship between stock market indices and macroeconomic variables, especially in case of Poland and Czech Republic. Having in mind our adoption of aforementioned Malkiel's view that efficient market hypothesis is confirmed by the presence of cointegration relationship between macroeconomic variables and stock index, it has brought us to the conclusions that the most prominent predictor of the long run developments on Croatian and Hungarian stock market is money market interest rate. The results of Granger (non) causality reveal that (a) there is no causal linkage between any macroeconomic variable and stock market index in

Croatia, Hungary and Poland; (b) money supply and foreign exchange lead stock index in Czech Republic, while inflation rate and money market interest rate lead Slovene stock index (c) none of stock market indices might be used as a leading indicator of inflation rate (d) stock market index leads money market interest rate in Hungary and Czech Republic, foreign exchange reserves in Slovenia and money supply in Poland. Results point to conclusion that in the short run investors in Croatia, Hungary and Poland are not able to gain above average profits by using information on changes in macroeconomic fundamentals. Thereto, these markets could be perceived efficient. In that vein, some inefficiency was found on Czech and Slovene stock market. However, there is a great possibility that market participant are not in position to use profitably market inefficiencies because of high transaction costs, trading and reporting delays, higher cost of new information as well as pronounced uncertainty that are usually inherent to emerging markets. Finally, conclusions above possibility of earning above average returns should be made with prudence, as no profitable trading rule was built in this paper.

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POVEZANOST IZMEĐU MAKROEKONOMSKIH VARIJABLI I BURZOVNIH INDEKSA U ODABRANIM ZEMLJAMA SREDNJE I ISTOČNE EUROPE

Sažetak

U ovom se radu testira postojanje informacijske (ne)efikasnosti na tržištima kapitala odabranih zemalja Srednje i Istočne Europe. Na primjerima hrvatskog, češkog, mađarskog, poljskog i slovenskog tržišta kapitala, analizira se veza između burzovnih indeksa i makroekonomskih varijabli koje uključuju inflaciju, novčanu ponudu, kamatnu stopu na tržištu novca i devizne pričuve. Postojanje dugoročne bilateralne ravnotežne veze između burzovnog indeksa, s jedne strane, i makroekonomskih varijabli s druge strane, ispitano je korištenjem Johansenove kointegracijske metode. Za dobivanje detaljnijih informacija o tržišnoj efikasnosti korišten je Grangerov test uzročnosti. Rezultati kointegracijske analize upućuju na postojanje dugoročnih veza između burzovnih indeksa i makroekonomskih varijabli u slučaju Poljske i Češke. Rezultati Grangerovog testa uzročnosti pokazuju da (a) ne postoji uzročna veza između nijedne makroekonomske varijable i burzovnog indeksa u Hrvatskoj, Mađarskoj i Poljskoj, (b) novčana ponuda i devizne pričuve vode burzovni indeks u Češkoj, a inflacija i kamatna stopa na tržištu novca u Sloveniji, (c) burzovni indeks ne navješta inflaciju na nijednom promatranom tržištu, (d) burzovni indeks vodi kamatnu stopu na novčanom tržištu u Mađarskoj i Češkoj, devizne pričuve u Sloveniji, i novčanu ponudu u Poljskoj.

Ključne riječi: Tržište kapitala, makroekonomski pokazatelji, efikasnost, kointegracija, Grangerov test uzročnosti