THE HYPOTHESIS OF EFFICIENT CAPITAL MARKETS: THE CASE OF THE CENTRAL AND EASTERN EUROPEAN STATES

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Abstract: *This paper investigates whether institutional or regulatory changes determine changes in information efficiency within Central and Eastern European states. To test the implications of the institutional and regulatory resort to a series of tests: autocorrelation, binary cycle type, unit root, dispersions and a test report BDS for profitability but also on an auto regression model. All tests are applied to three different samples: complete sample, ante-code of governance and post-codes of governance. Our results indicate that Central and Eastern European capital markets are not informative enough in any analyzed sample. In fact, we are witnessing partial information efficiency for Slovakia for the entire sample and for the ante codes, while for the post code period Hungary, Slovakia, Romania and the Czech Republic are partly informational efficient. In addition to the samples post codes witnessing an improvement in information efficiency in the markets analyzed, but the result is a combination of several factors: changes in legislation, European integration and the recent financial crisis. Our results indicate that for Central and Eastern European Capital Markets, forecasts can be made about the price evolution of an action based on historical data.*

1. INTRODUCTION

The hypothesis of efficient EHM is one of the foundations of modern financial and portfolio management theory. Theoretically, a market is considered to be informational efficient if the price of traded instruments reflects all the information available at one time (Fama, 1970). Within an informative efficient capital market, forecasting of stock price developments is impossible. That is why, in an efficient capital market, the price formation mechanism is able to channel the resources available from financiers to efficient investments that lead to better capital allocation and faster capital market development (Nurumambi, 2012). In the case of emerging countries, information efficiency as well as informal inefficiency pose controversial issues, raising new questions about price capacities to objectively reflect the value of an asset. The characteristics and particularities of emerging countries can be both factors that improve information efficiency and inhibit it. Therefore, in the case of emerging countries, we are talking about a "partial efficiency" (Lim & Brooks, 2011) which is confirmed and challenged by empirical results, depending on the period and the methodology used (Nurumambi, 2012). In the case of Central and Eastern European countries the results are even more contradictory (Dragotă, & Țilică, 2014).

The lack of information efficiency in emerging countries can be attributed to a whole series of factors, but especially to: the different degrees of financial system development (Kim, Shamsuddin, 2008), the degree of liquidity of financial markets (Chorinda et al. 2008), and the disturbing effects of external exogenous shocks that can destabilize information efficiency in other states (Bekaert, Harvey, 1995). Therefore, the introduction of legislative and institutional changes could increase efficiency in emerging countries (Hung, 2009), because lack of an effective monitoring and control system can inhibit information efficiency (Firmduc et al., 2013).

The purpose of this article is to examine whether regulatory and institutional changes can lead to an increase in information efficiency in emerging countries. In our opinion, the choice of the Central and Eastern European countries is all the more appropriate because these countries act on a whole range of new factors influencing the information efficiency such as the lack of a developed financial system (Pele & Voineagu, 2008) (Dragotă et al., 2009) and the recent financial crisis (Smith, 2012). Therefore, testing information efficiency in the Central and Eastern European countries can highlight the ability of investors to adapt to a new economic climate in which European integration and regulatory changes can be beneficial.

Highlighting the role played by regulatory changes in information efficiency is achieved through an extensive set of autocorrelation tests, binary cycles, unit root, dispersion ratio, and a BDS test for cost-effectiveness but also an autoregressive pattern . All tests are applied to three different samples: complete sample, ante-code of governance and post-codes of governance, in order to highlight the impact of institutional and regulatory changes on information efficiency.

Our results indicate that no analyzed capital market is informational efficient, but we see partial efficiency or partial inefficiency characteristic of all emerging countries (Lim & Brooks, 2011). Additionally, we can see that with institutional modernization in the Central and Eastern European countries we are also witnessing an improvement in information efficiency, but the result is rather a accumulation of several factors. In fact, the increase in information efficiency can be attributed both to regulatory and institutional changes and to the process of European integration as well as to the recent financial crisis. The rest of the article is organized as follows: Section 2 describes the state of knowledge, section 3 data, section 4 of the methodology, section 5 empirical results, and section 6 study findings.

2. THE STATE OF KNOWLEDGE

From a theoretical point of view, reducing information efficiency leads to an increase in the probability of predicting the evolution of a financial asset. In Fama's (1970) vision, a market is informally efficient if all market prices reflect all the amount of information at a time. Consequently, in an information-efficient market, price changes are a direct response to new market information. Because information is in a random manner in the market, asset prices fluctuate randomly as "random walk" as investors react actively to the new information available. The random evolution of financial instruments prices suggests that price developments cannot be predicted on the basis of historical

information, and subsequent successive changes are independent of previous developments. Therefore, the random model assumes that asset prices will be in constant balance, while lack of randomization implies an inappropriate level of capital and risk assumed (Nurunnabi, 2012). In this context, the existence of information efficiency is a factor as direct implications on capital allocation and economic development. Generally, the random walk pattern can be written as (1):

$$P_t = \mu + P_{t-1} + \varepsilon_t \quad (1)$$

Where: P_t- price of the action at the moment; μ - the degree of change expected; P_ (t-1) - the price of the action t-1; e_t is the random standard error that has a zero average and a constant variance.

$$\begin{cases} E[\varepsilon_t] = 0, \forall t \\ Var[\varepsilon_t] = \sigma^2, \forall t \\ \varepsilon_t \text{ și } \varepsilon_{t+k} \text{sunt variabile independente}, \forall k \neq 0 \end{cases} \quad (2)$$

Fama (1970) classifies the information efficiency of a market according to its ability to react to the new information available in three distinct categories of information efficiency: a weak form of information efficiency, a semi-solid form and a strong form. If the weak form implies the impossibility of forecasting based on historic prices, and the semi-hard form refers both to historical prices and to all public information, in the form of strong information efficiency, asset prices fully reflect both public and private information. Consequently, the technical analysis is inefficient in the weak form while the fundamental analysis in the semi-strong form (Dragotă, et al., 2009).

2.2 Factors influencing information efficiency in emerging countries

In the case of emerging countries, information efficiency or, more precisely, the lack of information efficiency are two topics analyzed by economic literature in the context of globalization, the growth of foreign direct investment flows that make up the major emerging markets emerging markets (Nurunnabi, 2012). In general, the main factors limiting the information efficiency of emerging markets are: the different degrees of financial system development (Kim, Shamsuddin, 2008), the degree of financial market liquidity (Chorinda, et al., 2008) and the disruptive effects of some external exogenous shocks that can destabilize information efficiency in other states (Bekaert, Harvey, 1995).

In parallel with the general factors, which exert influence on information efficiency in emerging states, they are also vectors of influence depending on the specificity of each state. Some authors attribute the lack of information efficiency to the transition from the planned economy to the market economy, requiring a restructuring of the entire financial system that requires a period of modernization (Pele, Voineagu, 2008), the socio-cultural specificity of the investors a country that can encourage speculative behavior without taking into account the true value of financial assets (Dragotă, et al., 2009), the arbitrary limits imposed on foreign capital inflows that may temporarily increase information efficiency in emerging countries (Graham, (Smith, 2012), the accession of the country to an economic union such as the European Union (Borges, 2010) or in a monetary union such as the EURO zone (Urquhart, 2014).

The institutional and governance system is a pillar on which the proper functioning of capital markets and ultimately the efficiency of capital markets are based. Along with the development and upgrading of the institutional and governance system from a capital market, investors' ability to correctly evaluate their shares increases, and the number of inward transactions decreases (Firmduc, et al., 2006). In addition, the existence of a more rigid governance system leads to a more virulent and timely response to domestic transactions with stricter government systems (Firmduc, et al., 2013) while adopting a golden parachute in a company leads to a reduction in the returns obtained by the company as an adverse reaction of the market to the establishment of a protection mechanism against mergers (Bebchuk, et al., 2014). In this context, the adoption of new codes of corporate governance within emerging capital markets can be another factor contributing to increasing the functioning of capital markets (European Commission, 2009), perhaps even increasing information efficiency.

Changing the regulatory system may lead to an increase in information efficiency in a capital market, especially in the case of emerging countries. Some of the most important studies have shown that: in the case of Turkey, the modification of the capital market regulation system in 1989 has led to an increase in the information efficiency of the Turkish market since 1991 (Antoniou, et al., 1997) the change in the Chinese banks' regulatory system has led to a reduction in information efficiency after their exclusion from the listing between 1 July 1996 and 31 December 1999 and the increase in efficiency after the readmission to the listing from 1 January 2000 to 29 March 2001 (Groenewold et al., 2004), the change in the status of B-rated companies in China on February 19, 2001 led to the informational growth of the entire capital market (Lu, et al., 2007, Fifield, Jetty, 2008, Hung, 2009).

2.3 Empirical Outcomes on Market Efficiency in Central and Eastern Europe

A whole series of controversies in the economic literature, which converge around two conflicting trends, appear around the efficient markets hypothesis. First of all, they are supporters of market efficiency, who believe that there is no systematic way of predicting market developments consistently (Fama, 1970). At the same time, they are the opponents of the hypothesis because it is contrary to economic reality, being refuted by a series of empirical tests (Summers 1986; Fama, French 1988; Lo MacKilay, 1988).
In the case of emerging capital markets, due to the economic, social and historical specifics of each state, the results of the information efficiency tests offer mixed results, depending on the methodology used, the time period and the context in which it is realized, as globalization, foreign investment as well as the process of European integration can be beneficial or disruptive vectors for informational efficiency. A detailed study on information efficiency in emerging countries is presented in Nurunnabi (2012), and for Central and Eastern European Countries (Dragotă, Țilică, 2014) gives an overview of the main studies, methodologies and results obtained in the studies aimed at this region.

Some of the relevant findings in this direction may be: (Gilmore, McManus, 2003) states that the Czech, Hungarian and Polish capital markets between 1995 and

2000 were not effective in a weak form for weekly series based on unit root tests, dispersions, autocorrelation, ARIMA, GARCH while Grangner tests confirmed random walk. In a study on capital markets in the Czech Republic, Hungary, Poland and Russia, (Hassan, et al., 2006) noted that no country complied with the Random Chance hypothesis between December 1988 and August 2002 on the basis of ARMA, GARCH , dispersion ratio, autocorrelation and rally. In a similar study of all Baltic states between 2002-2009 (Akatan, et al., 2010), none of the analyzed indices complied with the random walk hypothesis, making it possible to make predictions based on ARMA models.

(Heininen, Puttonen, 2008) in a study on the testing of information efficiency based on weekend-type tests, the effect of January for January 1997-February 2008, notes that only Bulgaria and Slovakia respect the random walk hypothesis while the Czech Republic , Croatia, Estonia, Hungary, Latvia, Lithuania, Poland, Russia, Slovenia are not effective in poor form. Similarly (Dragotă, Ţilică, 2014) tests the informational efficiency of the Central and Eastern European markets and observes that in the case of: Bosnia Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Lithuania, Latvia, Macedonia, Poland, Romania, Russia , Serbia, Slovakia and Slovenia, and notes that each market is effective at least once in a variety of tests: unit roots, rally tests, filter tests and the January effect. The two authors consider that the results show that only the market in Bosnia and Herzegovina is informational and the others are partially effective or partially ineffective (Lim, Brooks, 2011). Regarding the information efficiency in Romania, the results reveal that initially the Romanian capital market was not efficient in a weak form due to the lack of liquidity and the lack of a risk-free rate to which the investors would relate (Dragotă, et al., 2004) , then the tests revealed an increase in the efficiency of information (Pele, Voineagu, 2008, Dragotă, et al., 2004) and later at least a temporary reduction in the context of the financial crisis (Dragotă, Ţilică, 2014).

The image reflected by the literature provides the necessary framework for our first hypothesis:

H_1: Capital markets in the Central and Eastern European countries are informational efficient in poor form.

Our first hypothesis takes into account his statement (Lim, Brooks, 2011) that he considers that in the case of emerging countries we are talking about a degree of information efficiency depending on time and time and on the whole we can speak of a partially or partially partial market ineffective. That is why we expect the results of our tests to provide clues to information efficiency but also to challenge it for other test categories. Since changes to the institutional and regulatory system can induce an increase in the functional efficiency of a capital market, we will alternatively test whether the adoption of corporate governance codes along with other external factors has allowed information growth in a capital market. In this context, we deduce the second hypothesis of our study:

H_1: Regulatory changes determine the growth of capital markets.

The alternative to our second hypothesis is that despite the adoption of codes of corporate governance, information efficiency does not change significantly post code adoption due to general external factors or due to the specificities of each socio-economic climate in emerging countries.

3. DATA

The data used in this analysis is the daily values of the main stock indices in Bulgaria, the Czech Republic, Poland, Romania, Slovakia and Hungary. The analyzed indices are the most representative for each of the capital markets in the respective countries: SOFIX for Bulgaria, PX for the Czech Republic, TIG for Poland, BET - Romania, SAX-Slovakia and BUX for Hungary. The analysis period for each index is the first day of calculating (trading) the index by 30 October 2015. The source of the data used is represented by the analyzed capital markets sites.

Table 1. Moments of adoption of codes of governance in the analyzed countries

Country	Index	Date of adoption	Code Nr. Last	Last Modified Code Changes
Bulgaria	SOFIX	10.10.2007	2	15.02.2012
Czech Republic	PX	09.09.2002	2	31.12.2004
Poland	WIG	15.06.2002	5	21.11.2012
Romania	BET	22.01.2009	2	11.09.2015
Slovakia	SAX	16.09.2002	2	21.05.2008
Hungary	BUX	26.08.2004	4	12.11.2012

Source: Authorized processing based on ECGI data and the European Commission (2009)

With increasing global competition for funding sources, emerging markets are experiencing the need to improve capital market functionality. Therefore, adopting codes of governance within regulated markets appears to be a natural reaction to the new economic context and, in the case of the States under consideration, this process implied the adoption of different codes of governance in different stages. In table no. 1 shows the date on which the first corporate governance code was developed in each analyzed country, the number of changes made but also the date when the change was made. It can be observed that each analyzed state chose different moments from the adoption of a code of governance and the process involved at least one change in each state. In terms of time, Poland was the first country to develop the first corporate governance code on 15.06.2002, while in Romania the first code of governance emerged within the capital markets according to generally accepted criteria was 22.01.2009 (European Commission, 2009).

Table 2. Structure of the analyzed sample

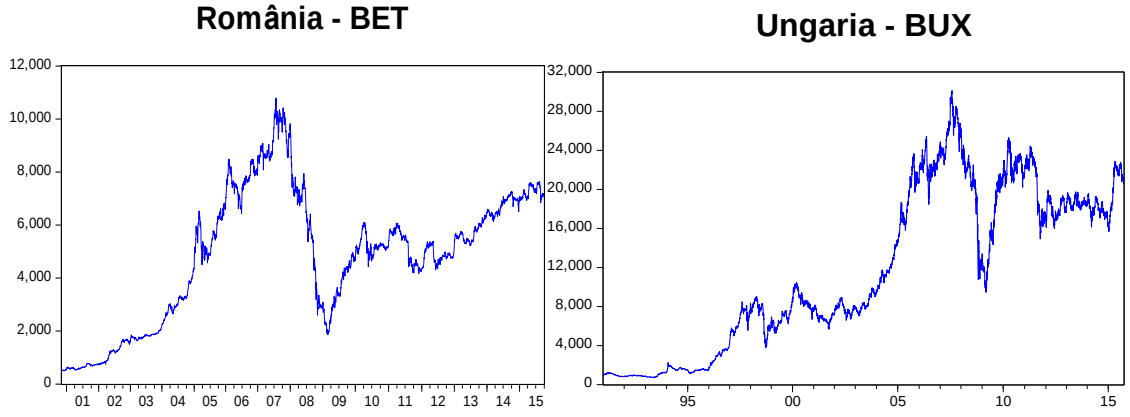
Country	Index	Initial date	Number of records	Last day
Panel A: all period				
Bulgaria	SOFIX	26.11.2001	3408	30.09.2015
Czech	PX	07.09.1993	5372	30.09.2015
Poland	WIG	16.04.1991	5669	30.09.2015
Romania	BET	31.10.2000	3706	30.09.2015

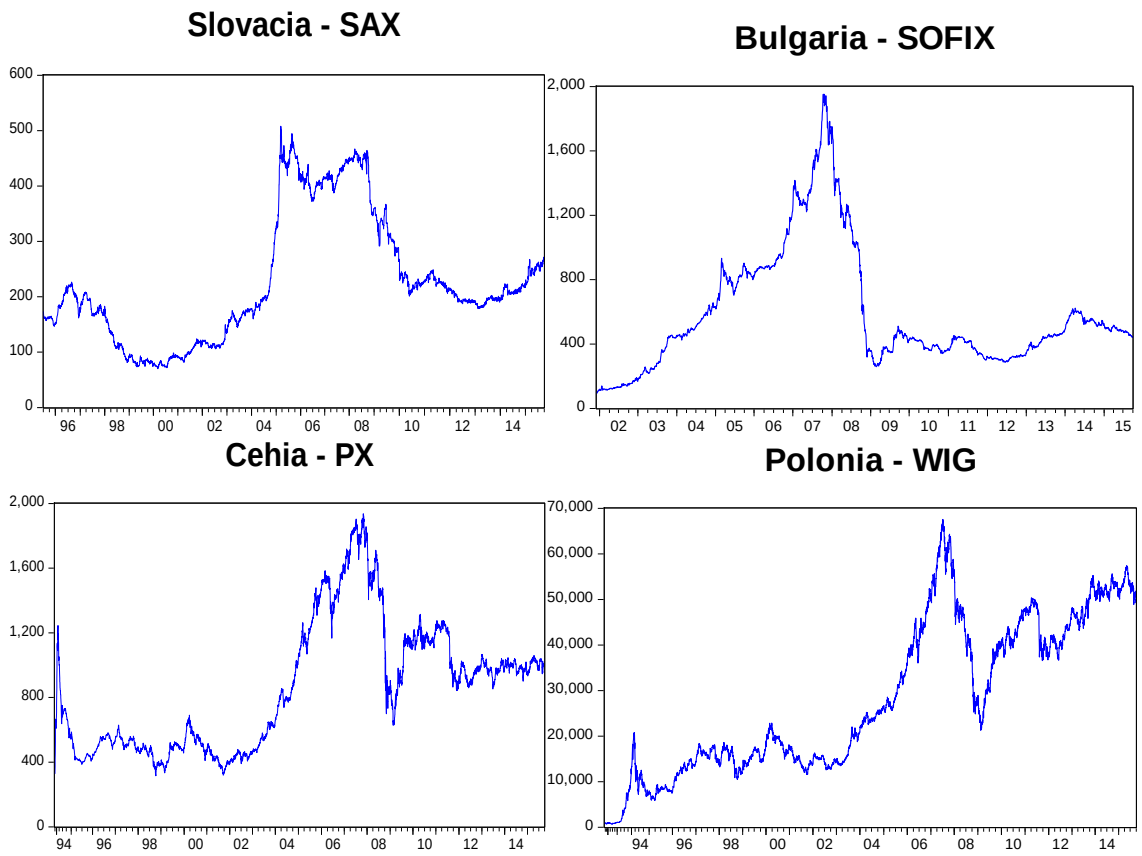
Slovakia	SAX	30.07.1995	4956	30.09.2015
Hungary	BUX	02.01.1991	6182	30.09.2015
Panel B: before Governance Code				
Bulgaria	SOFIX	26.11.2001	1377	10.10.2007
Czech	PX	07.09.1993	2092	09.09.2002
Poland	WIG	16.04.1991	2335	15.06.2002
Romania	BET	31.10.2000	2018	22.01.2009
Slovakia	SAX	30.07.1995	1748	16.09.2002
Hungary	BUX	02.01.1991	3365	26.08.2004
Panel C: after Governance Code				
Bulgaria	SOFIX	10.10.2007	2030	30.09.2015
Czech	PX	09.09.2002	3279	30.09.2015
Poland	WIG	15.06.2002	3333	30.09.2015
Romania	BET	22.01.2009	1687	30.09.2015
Slovakia	SAX	16.09.2002	3207	30.09.2015
Hungary	BUX	26.08.2004	2816	30.09.2015

Source: Author calculations

The alternative purpose of our analysis is to observe whether there is an ante and post-adoption of a code of governance in accordance with table no. 2 where the analysis periods used for each of the three different samples are presented in detail: Panel A full sample Panel B Before the Code of Governance and Panel C post Codes of Governance. The evolution of the indices analyzed for the whole period of analysis reveals that the 2000-2008 period represented an upward trend for all analyzed countries, registering the highest values of the indicators at that time. Of all the analyzed capital markets, only Poland, Hungary and Romania tend to the values obtained before the crisis, while in Bulgaria and the Czech Republic the values of the analyzed indices are well below the level previously achieved in the peak period at the end of 2008.

Figure 1. Evolution of Stock Market Indices in the analyzed period





Source: Author's processing

Testing the efficiency of capital markets is based on the daily returns of stock indices that are calculated using the natural logarithm according to the formula:

$$R_t = \ln\left(\frac{P_t}{P_{t-1}}\right) \qquad (2)$$

Where: R_t - the Price Index of the Index;
P_t and P_ (t-1) - index prices at time t and $t-1$.

Table 3 Statistical Description of Variables

Index	BET	BUX	PX	SAX	SOFIX	WIG
Panel A: all period						
N	3706	6182	5372	4956	3408	5669
Medie	0,000696	0,000492	0,000198	0,000085	0,000449	0,000689
Mediană	0,000526	0,000461	0,000315	0,000000	0,000502	0,000577
Maxim	0,145765	0,136157	0,153905	0,118803	0,083878	0,147831
Minim	-0,119018	-0,180331	-0,161855	-0,148101	-0,113600	-0,113472
Abaterea st.	0,016143	0,016496	0,014598	0,012793	0,013445	0,018686
Boltire	-0,176603	-0,506104	0,293763	-0,745045	-0,453438	-0,064271

Asimetrie	12,57549	14,29324	17,57729	16,05637	11,66708	9,822255
Jarque-Bera	14177,72	33115,38	47641,25	35660,31	10783,58	10997,79
Prob.	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000
Panel B: before Governance Code						
N	2018	3365	2092	1748	1377	2335
Medie	0,000767	0,000725	0,000138	-0,000270	0,002007	0,001164
Mediană	0,000588	0,000478	-0,000216	0,000000	0,001183	0,000552
Maxim	0,145765	0,136157	0,153905	0,095738	0,083878	0,147831
Minim	-0,119018	-0,180331	-0,075664	-0,114839	-0,082380	-0,113472
Abaterea st.	0,017618	0,016630	0,015037	0,014242	0,013254	0,024961
Boltire	-0,139473	-0,828724	1,457975	-0,510100	0,258261	-0,030305
Asimetrie	11,94442	17,94236	16,89379	9,818918	10,04216	6,896196
Jarque-Bera	6733,439	31690,07	17567,59	3462,384	2860,650	1477,278
Prob.	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000
Panel C: after Governance Code						
N	1687	2816	3279	3207	2030	3333
Medie	0,000617	0,000213	0,000237	0,000282	-0,000610	0,000356
Mediană	0,000506	0,000425	0,000756	0,000000	-0,000033	0,000619
Maxim	0,086226	0,131769	0,123641	0,118803	0,72924	0,060834
Minim	-0,110125	-0,126489	-0,161855	-0,148101	-0,113600	-0,082888
Abaterea st.	0,014188	0,016335	0,014315	0,011930	0,013478	0,012541
Boltire	-0,262822	-0,101345	-0,566819	-0,926153	-0,915053	-0,429712
Asimetrie	12,35334	9,658161	18,05479	21,95580	12,58499	6,518928
Jarque-Bera	6168,886	5206,338	31141,19	48472,93	8054,133	1822,243
Prob.	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000

Source: Author calculations

The statistical description of the variables used in the analysis is shown in table no. 3. In the case of the entire sample of the average profitability, all six analyzed capital markets are positive and the shape of the curve described by the profitability of the analyzed indices is leptokurtic with left asymmetry. The only index, showing a different structure in terms of the shape of the yield curve, is PX, its curve being a plasticity one. A key aspect indicated by the statistical description of the variables is that none of the analyzed samples is normally distributed according to Jarque-Bera normality tests. The lack of a normally distributed distribution of the returns of the analyzed indices can be considered a sign that markets are informational inefficient, but not necessarily, so careful treatment of unit root and autocorrelation tests is necessary, which are very sensitive to the lack of a normal distribution.

4. METHODOLOGY

From the methodological point of view for testing, random walk theory can be used a whole series of specific statistical tests as well as a series of tests aimed at identifying the degree of profitability of buying and selling techniques based on the evolution of the markets. In addition to the two main test categories, stochastic test models such as ARMA, GARCH, EGARH as well as other derived tests can be used. Due to the high degree of difficulty in incorporating transaction costs related to the buying and selling techniques, respectively the predictive character of the stochastic tests in the analysis of the information efficiency, we will use a series of specific statistical tests. The main test categories analyzed are: autocorrelation testing, a binary test (rally test), unit root testing, dispersion-based tests and the BDS test.

5. EMPIRICAL RESULTS

5.1 Results of the autocorrelation test

The first method of testing the efficiency of capital markets in the weak form is represented by autocorrelation tests for a number of 20 lags. The results obtained from the test are summarized in Table 4, the values for lag 1-5, 10 and 20 respectively are detailed. Based on the obtained results, we can say that only the Slovak capital market (SAX index) complies with the random run hypothesis over time with the rest of the capital markets not being informally efficient. In case of the sample efficiency analysis for the pre-adoption period of the codes of governance it reveals that only Slovakia presents a random run only in the case of the first lag and the 20th lag, respectively, the rest of the lagoons do not observe the random walk. Similarly, all the other markets analyzed do not respect the hypothesis of efficient financial markets due to self-correlation. Contrary to the results obtained for the other analyzed periods, for the post-code governance period, the informational efficiency of the analyzed markets is changing for Romania (BET), which becomes informational efficient on the basis of autocorrelation tests. However, it can be noticed that in the case of Slovakia (SAX), the information efficiency is no longer confirmed for the post-governance period, the market becoming inefficient in poor form. The analysis of the statistical coefficients of the Q-statistical Ljung-Box test shows contradictory developments between the ante and post code of corporate governance, with a reduction in the degree of self-correlation in Romania, Hungary, the Czech Republic and Poland, while for Slovakia and Bulgaria the degree of autocorrelation for the post code period.

5.2 Results of binary cycle tests

In the case of series that are not normally distributed as for the analyzed returns, the binary (or rally) type tests shown in table no. 6 are considered more appropriate than autocorrelation tests. The results of the rally type tests on the whole sample show that based on a 90% probability, the capital market in Slovakia exemplified by the SAX index is the only one that is informally efficient because the estimates of the Z function indicate the impossibility of forecasting based on historical data through binary cycle tests. In the case of Romania, Hungary, the Czech Republic, Bulgaria and Poland, they are informally

inefficient. Repeating the analysis for the ante-codes of governance indicates a 1% assumed risk that no index respects information efficiency, even if the sign of the Z function for SAX is positive but insignificantly different from zero.

Table 5 Results of autocorrelation test

Lag	BET			BUX			PX			SAX			SOFIX			WIG		
	ACF	Q-Stat	Prob.	ACF	Q-Stat	Prob.	ACF	Q-Stat	Prob.	ACF	Q-Stat	Prob.	ACF	Q-Stat	Prob.	ACF	Q-Stat	Prob.
Panel A: All period																		
1	0,104	40,454	0,000	0,084	43,516	0,000	0,181	175,61	0,000	-0,040	7,9532	0,005	0,131	58,692	0,000	0,246	342,33	0,000
2	-0,022	42,324	0,000	-0,007	43,803	0,000	0,052	190,36	0,000	-0,009	8,3215	0,016	0,119	106,74	0,000	-0,008	342,67	0,000
3	-0,015	43,121	0,000	-0,036	51,863	0,000	0,036	197,25	0,000	-0,003	8,3768	0,039	0,046	114,07	0,000	0,017	344,30	0,000
4	0,008	43,350	0,000	0,040	61,636	0,000	0,060	216,51	0,000	0,008	8,7045	0,069	0,084	138,29	0,000	0,046	356,39	0,000
5	0,012	43,855	0,000	0,009	62,192	0,000	0,021	218,85	0,000	0,005	8,8362	0,116	-0,003	138,32	0,000	0,025	359,89	0,000
10	0,019	56,964	0,000	0,050	100,22	0,000	0,047	232,19	0,000	0,024	24,024	0,008	0,053	168,75	0,000	0,017	376,32	0,000
20	0,019	93,716	0,000	-0,014	121,27	0,000	0,005	336,73	0,000	-0,023	33,957	0,026	-0,010	258,79	0,000	0,006	398,47	0,000
Panel B: before Governance Code																		
1	0,140	39,592	0,000	0,103	35,547	0,000	0,352	259,58	0,000	-0,019	0,6410	0,423	0,111	17,082	0,000	0,303	214,31	0,000
2	-0,027	41,080	0,000	0,040	40,926	0,000	0,227	367,48	0,000	-0,069	8,8947	0,012	0,092	28,749	0,000	-0,002	214,31	0,000
3	-0,001	41,084	0,000	-0,035	45,117	0,000	0,151	415,51	0,000	0,014	9,2389	0,026	-0,016	29,107	0,000	0,015	214,85	0,000
4	-0,006	41,163	0,000	0,018	46,164	0,000	0,099	436,14	0,000	0,038	11,713	0,020	0,035	30,841	0,000	0,061	223,49	0,000
5	0,006	41,225	0,000	-0,009	46,457	0,000	-0,008	436,26	0,000	0,003	11,725	0,039	-0,050	34,289	0,000	0,031	225,69	0,000

10	0,002	46,666	0,000	0,080	81,909	0,000	0,080	451,48	0,000	-0,002	21,363	0,019	-0,000	41,149	0,000	0,017	238,68	0,000
20	0,044	78,130	0,000	-0,008	117,33	0,000	0,046	613,48	0,000	-0,033	26,503	0,150	-0,042	57,683	0,000	0,018	254,32	0,000
Panel C: after Governance Code																		
1	0,036	2,2469	0,134	0,060	10,160	0,001	0,060	11,957	0,000	-0,057	10,468	0,001	0,131	34,813	0,000	0,086	24,714	0,000
2	-0,023	3,1063	0,212	-0,065	22,206	0,000	-0,071	28,344	0,000	0,037	14,903	0,001	0,122	65,307	0,000	-0,026	26,955	0,000
3	-0,049	7,1574	0,067	-0,038	26,212	0,000	-0,046	35,257	0,000	-0,018	15,899	0,001	0,073	76,027	0,000	0,020	28,226	0,000
4	0,031	8,8370	0,065	0,066	38,643	0,000	0,033	38,748	0,000	-0,016	16,684	0,002	0,103	97,516	0,000	0,004	28,267	0,000
5	0,021	9,6005	0,087	0,032	41,570	0,000	0,041	44,281	0,000	0,007	16,823	0,005	0,013	97,874	0,000	0,008	28,460	0,000
10	0,050	32,731	0,000	0,012	66,588	0,000	0,025	48,044	0,000	0,044	29,303	0,001	0,076	129,30	0,000	0,016	31,306	0,001
20	-0,045	48,200	0,000	-0,021	84,601	0,000	-0,022	79,200	0,000	-0,016	38,264	0,008	0,003	223,86	0,000	-0,030	42,421	0,002

Source: Author calculations

The results for post code codes of governance show a clear change in the indices and the analyzed capital markets. Based on the SAX-Slovakia estimates, it indicates a random run for a 95% risk, while WIG - Poland indicates a random move, but the Z function is insignificantly different from zero. In the case of the other analyzed markets it is observed that Romania and Bulgaria do not observe the random move, and for Hungary and the Czech Republic, the coefficient is insignificantly different from zero, rejecting the information efficiency. Overall, we can see that in the case of post code samples of governance we are seeing an improvement of the information efficiency for all the indices analyzed in relation to the ante-codes period. Because none of the analyzed distributions is normally distributed, the results of the rally tests are more enlightening than the autocorrelation tests mentioned above.

Table 6. Test results of "rally"

Coefficient	BET	BUX	PX	SAX	SOFIX	WIG
Panel A: All period						
Test value	3706	6182	5372	4956	3408	5669
Returns	1853	3091	2686	2048	1704	2834

< median						
Returns > median	1853	3091	2686	2908	1704	2835
Nr. teste Real	1681	2922	2438	2468	1553	2716
Z-Statistic	-5,684	-4,325	-6,795	1,864	-5,208	-3,175
Prob.	0,000***	0,000***	0,000**	0,062*	0,000***	0,002***
Panel B: before Governance Code						
Test value	2018	3365	2092	1748	1377	2335
Returns < median	1009	1682	1046	828	688	1167
Returns > median	1009	1683	1046	920	689	1168
Nr. teste Real	891	1517	826	888	624	1009
Z-Statistic	-5,299	-5,741	-9,666	0,740	-3,532	-6,603
Prob.	0,000***	0,000***	0,000***	0,459	0,000***	0,000***
Panel C: after Governance Code						
Test value	1687	2816	3279	3207	2030	3333
Returns < median	843	1408	1639	1220	1015	1666
Returns > median	844	1408	1640	1987	1015	1667
Nr. teste Real	787	1400	1619	1580	930	1698
Z-Statistic	-2,801	-0,339	-0,751	2,518	-3,818	1,057
Prob.	0,005***	0,734	0,453	0,012**	0,000***	0,291
Note: *, **, *** is statistically significant for 1%, 5% and respectively 10%						

Source: Author calculations

The results of unit root tests

In unit root testing, we used the ADF test, which requires comparison of the results by testing with the results in a critical value table, corresponding to the number of observations. If ADF test values are higher than the appropriate critical values then the random run hypothesis is rejected. The test results ADF pattern of constant trend and a maximum of 20 lags presented in Table 7 indicates that all pointers In the analysis unit root, stationary, so the hypothesis random walk is rejected for all the countries analyzed, regardless of the period analysis: complete sample, ante-codes, post-codes. ADF test reveals a potential improvement not being present mixed results ante codes are indices that increase their efficiency and BUX and SOFIX and indices that reduce their effectiveness as BET, PX, SAX or TIG. However the lack of a normal distribution for samples can induce errors in test results obtained under ADF, so one interpretation must be reserved as ADF test results may reject incorrectly random walk in certain circumstances.

Table 7. Results of unit root tests

TEST ADF	Panel A: All period		Panel B: before Governance Code		Panel C: after Governance Code
	Critical Values 1% = -		Critical Values 1% = -		Critical Values 1% = -

	3,4328; 5% = 2,8625; 10% = -2,5673			3,4328; 5% = 2,8625; 10% = -2,5673			3,4328; 5% = 2,8625; 10% = -2,5673	
	T-statistic	Prob.		T-statistic	Prob.		T-statistic	Prob.
BET	-54,7926	0,0000		-38,8513	0,0000		-39,6681	0,0000
BUX	-72,2145	0,0001		-52,2195	0,0001		-38,9525	0,0000
PX	-61,0344	0,0001		-31,6286	0,0000		-42,2566	0,0000
SAX	-73,2608	0,0001		-32,0131	0,0000		-59,9083	0,0001
SOFIX	-24,3959	0,0000		-22,1746	0,0000		-18,1235	0,0000
WIG	-33,9678	0,0000		-31,5452	0,0000		-52.8985	0,0001

Source: Author calculations

Test results based on dispersion ratio

Estimates of the information efficiency of the indicators analyzed on the basis of dispersion test reports presented in table no. 8 reveals a series of outcomes in the information efficiency of the indices and the analyzed capital markets. If, for previous tests, the evolution of the SAX index indicates a general trend of randomity, results based on the dispersion ratio no longer confirm this regardless of the estimation method used. For the SAX index, the Lo and Mackinley test scores for lag periods of up to 4 days are no longer statistically significant, whereas in case of longer periods of detention of 8, 16 or more days, the walking hypothesis is respected random. However, on the basis of both Chow-Dening CD2 significance and significance tests based on the Adams (2000) significance JS1 and JR1, respectively, indicates the rejection of the random run hypothesis for the entire sample. Overall, the obtained results no longer confirm the random run hypothesis for Slovakia for the whole analyzed sample. Noteworthy is that for the BET index, results show increased efficiency for holding periods of over 8 days, but these are challenged for all three significance tests. A result that is inconsistent with previous estimates is the JR1 rank signification test for the Czech Republic confirming information efficiency, but this is not corroborated by the other tests. In the case of the ante-governance analysis, the partial performance of the information is weak in the case of Slovakia based on VR tests and on the basis of the Chow-Dening CD2 test but these results are contradicted by the results obtained on the basis of non-parametric tests on the JS1 signs and the ranks JR1 indicating the possibility of making forecasts based on historical data in the case of SAX.

Table 8. Test results based on dispersion ratios

Lag	Test Dispersie	BET	BUX	PX	SAX	SOFIX	WIG
Panel A: All period							
Lag 2	LoM	1,080***	1,083***	1,180***	0,959***	1,131***	1,245***
		(6,635)	(6.594)	(13,23)	(-2,821)	(7,647)	(18,47)
Lag 4	LoM	1,138**	1,113***	1,404***	0,928***	1,338***	1,368***
		(2,066)	(3,245)	(13,52)	(-2,704)	(10,54)	(14.81)
Lag 8	LoM	1,176*	1,139***	1,494***	0,924*	1,567***	1,503***
		(1,801)	(3.245)	(10,73)	(-1.786)	(11,19)	(12.82)
Lag 16	LoM	1,351***	1,323***	1,669***	1,023	1,898	1,680***

		(2,580)	(5,115)	(9.876)	(0,380)	(11,92)	(11,63)
Critical Values test	LoM	6,635***	6,594***	13,52***	2,821**	11,92***	18,47***
		(70,63)	(80,53)	(227.24)	(19,78)	(159,6)***	(367,2)
	CD2	3,513***	2,876***	4,743***	2,299**	6,226	7,865***
	JS1	5,190***	6,085***	8,580***	8,437***	9,687***	3,413***
		(49.06)	(50,73)	(88,33)	(115,8)	(95,61)	(15,66)
	JR1	6,825***	6,211)***	8,909	4,363**	10,98***	10,55***
		(65,40)	(67,62	(115,32)	(49,39)	(134,2)	(123,4)
Panel B: before Governance Code							
Lag 2	LoM	1,139***	1,102***	1,351***	0,980	1,110***	1,302***
		(6,212)	(5,958)	(16,05)	(-0,805)	(4,100)	(14,60)
Lag 4	LoM	1,178**	1,190***	1,995***	0,906**	1,248***	1,457***
		(2,031)	(5,053)	(20,77)	(-2,095)	(4,929)	(11,82)
Lag 8	LoM	1,237*	1,237***	2,199***	0,920	1,299***	1,625***
		(1,854)	(4,088)	(16,24)	(-1,129)	(3,757)	(10,21)
Lag 16	LoM	1,476***	1,550***	2,519)***	1,004	1,238***	1,841***
		(2,663)	(6,419)	(13,98	(0,041)	(2,011)	(9,242)
Critical Values test	LoM	6,212***	6,419***	20,77***	2,095	4,929***	14,60***
		(56.31)	(93,60)	(471,41)	(11,51)	(27,21)	(228,9)
	CD2	3,535***	3,383***	6,755***	1,732	3,075***	7,270***
	JS1	4,452***	8,115***	11,62***	2,745**	6,768***	6,394***
		(33,55)	(80,86)	(164,10)	(16,40)	(49,25)	(44,38)
	JR1	6,407***	8,444***	11,74***	2,631**	7,201***	11,27***
		(54,12)	(102,58)	(190,88)	(19.15)	(58,14)	(145,8)
Panel C: after Governance Code							
Lag 2	LoM	1,031	1,059***	1,060***	0,942***	1,130***	1,085***
		(1,306)	(3,181)	(3,448)	(-3.234)	(5,892)	(4,960)
Lag 4	LoM	0,995	1,013	0,987	0,942*	1,354***	1,112***
		(-0,087)	(0,334)	(-0,318)	(-1,738)	(8,545)	(3,465)
Lag 8	LoM	1,013	1,010	0,997	0,922	1,641***	1,150**
		(0,169)	(0.172)	(-0,038)	(-1,484)	(9,770)	(2,939)
Lag 16	LoM	1,142	1,032	1,068	1,026	2,120***	1,188***
		(0,238)	(0,731)	(0,791)	(0,346)	(11,46)	(2,469)
Critical Values test	LoM	1,306	3,181***	3,448***	3,234***	11,46***	4,960***
		(9,230)	(19,80)	(35,18)	(25,89)	(140,3)	(26,71)
	CD2	0,804	1,622	1,293	2,445	5,473***	3,897***
	JS1	2,751***	0,584	1,692	8,313***	6,717***	1,740
		(16.79)	(0,869)	(5,054)	(113,1)	(46,63)	(4,471)
	JR1	2,623***	1,651	2,317**	4,676***	7,896***	2,438**
		(10,74)	(6,750)	(14,60)	(37,25)	(68,82)	(9,700)

Source: Author calculations

For the other markets analyzed, the information efficiency hypothesis is rejected on the basis of all the tests performed, so it is possible to make forecasts on the evolution of share prices based on historical data. The analysis of information efficiency post-codes of governance indicates a change in the degree of information efficiency of the analyzed markets. In Slovakia, similarly to the ante-code period, the results of observation of the

random walk in the VR tests or the Chow-Dening CD2 test are observed, while the results of the non-parametric tests on the JS1 and JR1 marks invalidate the information efficiency. Similarly for Romania - BET, VR estimates or the Chow-Dening CD2 test confirm the random run hypothesis while the JS1 and JR1 mark tests invalidate random walk. As far as Hungary is concerned, the results attest to informational efficiency in poor form for all tests, less VR tests with a maximum holding period of 2 days. Similarly, the Czech Republic - PX is informally efficient according to all tests less the significance test based on rankings, which may indicate the presence of heteroscedasticity. The information efficiency in Poland is only confirmed by a single JS1 significance test which is a confirmation of the high degree of autocorrelation previously observed for the TIG index.

Mutations in the case of information efficiency following governance codes reveal a possible link between changing the regulatory system and market efficiency, but this should not necessarily be attributed to this issue, being a cumulative effect of a series of factors such as : European integration, joining the euro area (Slovakia only), accelerating globalization and increasing the volume of foreign direct investment, including the disruptive effects of the recent financial crisis.

5.4 Result of BDS tests

The effectiveness of the BDS test in detecting the presence of a random-action effect may provide a new insight into the financial efficiency of a financial instrument as the BDS test proved more effective in detecting self-correlation within a series of returns. The results of the BDS on Profitability test presented in Table 9 show that none of the analyzed capital markets is informative enough for both the whole sample and the ante and post codes of governance. Consequently, in the capital markets analyzed in the three different samples, they were either marked by chaos phenomena or an indication of a possible adaptive information efficiency hypothesis. In the case of the tests performed on the residues of the AR (n) type autoregressive models in Table 10, it rejects the information efficiency hypothesis for all analyzed capital markets. On the other hand, it can be noticed that in all the markets with less Bulgaria, the post-code rates of governance the degree of autocorrelation is much lower, which again indicates an increase in the degree of compliance of the evolution of the analyzed indices against a random-type model. In spite of the "improvement" of post code information efficiency, highlighted by all our results, we do not consider our result to be a defining one, because at the same time a whole series of other related phenomena have been manifested that could increase information efficiency: European integration, the recent economic crisis and changes in institutional and regulatory bills. The results obtained are in fact the cumulative effect of several factors.

Table 9. Results of the BDS for the return on equity

Dimension	BET	BUX	PX	SAX	SOFIX	WIG
Panel A: All period						
m=2	0,037***	0,025***	0,028***	0,009***	0,043***	0,042***
	(22,59)	(21,91)	(22,67)	(3,619)	(23,66)	(30,92)

m=3	0,070***	0,049***	0,056***	0,022***	0,080***	0,074***
	(26,68)	(26,08)	(28,03)	(5.584)	(27,36)	(34,63)
m=4	0,094***	0,065***	0,075***	0,031***	0,102***	0,097***
	(29,87)	(29,30)	(31,56)	(6,700)	(29,40)	(37,83)
m=5	0,108***	0,075***	0,086***	0,036***	0,114***	0,110***
	(32,79)	(32,33)	(34,79)	(7,366)	(31,49)	(41,18)
Panel B: before Governance Code						
m=2	0,036***	0,031***	0,032***	0,015***	0,039***	0,056***
	(17,31)	(18,37)	(16,13)	(7,447)	(13,42)	(26,76)
m=3	0,064***	0,057***	0,061***	0,030***	0,073***	0,099***
	(19,03)	(21,46)	(19,25)	(9,162)	(15,74)	(29,87)
m=4	0,081***	0,076***	0,083***	0,040***	0,094***	0,126***
	(20,38)	(23,73)	(21,86)	(10,33)	(16,88)	(31,88)
m=5	0,091***	0,086***	0,096***	0,045***	0,105***	0,141***
	(21,79)	(25,84)	(24,24)	(11,09)	(18,11)	(34,24)
Panel C: after Governance Code						
m=2	0,036***	0,019***	0,025***	0,015***	0.045***	0,012***
	(14,22)	(12,25)	(15,73)	(7,447)	(19,45)	(7,889)
m=3	0,073***	0,038***	0,050***	0,030***	0,083***	0,026***
	(17,93)	(14,97)	(19,81)	(9,162)	(22,46)	(10,54)
m=4	0,100***	0,052***	0,066***	0,040***	0,107***	0,038***
	(20,57)	(17,17)	(22,05)	(10,33)	(24,16)	(13,04)
m=5	0,115***	0,061***	0,075***	0,045***	0,119***	0,046***
	(22,67)	(19,24)	(23,92)	(11,09)	(25,76)	(15,19)

Source: Author calculations

Table 10. Results of the BDS test for the Ar(n)

Dimension	BET	BUX	PX	SAX	SOFIX	WIG
Panel A: All period						
m=2	0,036***	0,025***	0,026***	0,009***	0,043***	0,042***
	(21,98)	(21,89)	(21,58)	(3,619)	(23,66)	(30,92)
m=3	0,069***	0,048***	0,053***	0,022***	0,080***	0,074***
	(26,35)	(26,10)	(27,12)	(5.584)	(27,36)	(34,63)
m=4	0,092***	0,064***	0,072***	0,031***	0,102***	0,097***
	(29,40)	(29,34)	(30,87)	(6,700)	(29,40)	(37,83)
m=5	0,106***	0,074***	0,083***	0,036***	0,114***	0,110***
	(32,29)	(32,28)	(34,20)	(7,366)	(31,49)	(41,18)
AR (n)	9	10	10	1	11	7
Panel B: before Governance Code						
m=2	0,035***	0,031***	0,032***	0,015***	0,039***	0,056***
	(16,60)	(18,51)	(16,13)	(7,447)	(13,42)	(26,76)

m=3	0,063***	0,058***	0,061***	0,030***	0,073***	0,099***
	(18,81)	(21,92)	(19,25)	(9,162)	(15,74)	(29,87)
m=4	0,080***	0,077***	0,083***	0,040***	0,094***	0,126***
	(20,23)	(24,25)	(21,86)	(10,33)	(16,88)	(31,88)
m=5	0,090***	0,087***	0,096***	0,045***	0,105***	0,141***
	(21,74)	(26,30)	(24,24)	(11,09)	(18,11)	(34,24)
AR (n)	6	10	9	1	1	4
Panel C: after Governance Code						
m=2	0,035***	0,019***	0,025***	0,015***	0.045***	0,012***
	(13,78)	(12,30)	(15,73)	(7,447)	(19,45)	(7,889)
m=3	0,070***	0,037***	0,050***	0,030***	0,083***	0,026***
	(17,34)	(14,85)	(19,81)	(9,162)	(22,46)	(10,54)
m=4	0,096***	0,051***	0,066***	0,040***	0,107***	0,038***
	(19,88)	(16,94)	(22,05)	(10,33)	(24,16)	(13,04)
m=5	0,110***	0,059***	0,075***	0,045***	0,119***	0,046***
	(21,97)	(18,96)	(23,92)	(11,09)	(25,76)	(15,19)
AR (n)	7	5	5	1	11	3

Source: Author calculations

6. CONCLUSIONS AND DISCUSSIONS

The purpose of this article was to analyze information efficiency for six Central and Eastern European countries: Bulgaria, the Czech Republic, Poland, Romania, Slovakia and Hungary, based on a series of specific tests covering all available data for each of the markets analyzed between the years 1991 and September 30, 2015. The entire sample and the two additional ante and post code codes of governance pointed out the presence of informational inefficiencies in the analyzed countries. Autocorrelation tests such as rally, unit roots, dispersion ratios, and BDS test revealed the obvious autocorrelation of the yields of the analyzed indices.

Our results indicate different degrees of efficiency, depending on the country or period under review, and Table 11 gives an overview of the information efficiency of the analyzed capital markets. Based on the data in Panel A, it can be seen that Slovakia's SAX index reveals the presence of information efficiency in 2 of the eight tests, while the Czech market was informational efficient on the basis of a single test. These results reveal that Romania, Hungary, Bulgaria and Poland are informally inefficient, considering the entire period of existence of the most significant stock market indices in that country.

For the ante-codes of governance sample, our results indicate that only the evolution of the SAX index followed a random trend based on autocorrelation tests and tests based on sign and rank dispersion ratios. Overall, the efficiency of the Slovak capital market is rejected due to the large number of unsatisfied tests. For the other capital markets, we can see that the ante-code of corporate governance has been characterized by the lack of informational efficiency in poor form. Our results are in line with other studies

targeting our countries for the period 1990-2002 as (Gilmore, McManus, 2003) for the Czech Republic, Poland and Hungary or (Dragotă, et al., 2004) for Romania. Testing of information efficiency for the post-code sample of governance reveals a generalized increase in information efficiency for all analyzed capital markets. In the case of the post-code sample of governance, the evolution of the Hungarian capital market is the closest to a random move, even if it is effective only for dispersion-type tests. Significant signs of increasing information efficiency are evident in the capital markets in Romania and the Czech Republic, while for the Slovak capital market we can see a similar degree of information efficiency. Among all the analyzed countries is Bulgaria, which cannot be considered as an informational efficient in any of the tests that concern both the entire analysis period and the ante and post codes of governance.

Table 11. Summary of the obtained results

Test	Romania	Hungary	Czech	Slovakia	Bulgaria	Poland
Panel A: all period						
AC	I	I	I	E	I	I
Raliu	I	I	I	E	I	I
Răd. unitară	I	I	I	I	I	I
VR	I	I	I	I	I	I
CD	I	I	I	I	I	I
JS	I	I	I	I	I	I
JR	I	I	E	I	I	I
BDS	I	I	I	I	I	I
Număr	0	0	1	2	0	0
Rang	3	3	2	1	3	3
Panel B: before Code of Governance						
AC	I	I	I	E	I	I
Raliu	I	I	I	I	I	I
Răd. unitară	I	I	I	I	I	I
VR	I	I	I	E	I	I
CD	I	I	I	E	I	I
JS	I	I	I	I	I	I
JR	I	I	I	I	I	I
BDS	I	I	I	I	I	I
Număr	0	0	0	3	0	0
Rang	2	2	2	1	2	2
Panel C: after Code of Governance						
AC	E	I	I	I	I	I
Raliu	I	I	I	E	I	I
Răd. unitară	I	I	I	I	I	I

VR	E	E	E	E	I	I
CD	E	E	E	E	I	I
JS	I	E	E	I	I	E
JR	I	E	I	I	I	I
BDS	I	I	I	I	I	I
Număr	3	4	3	3	0	1
Rang	2	1	2	2	6	5

Source: Author calculations

Informational inefficiency in the analyzed markets highlights the possibility of forecasting the future price evolution of an action, which implies that financial analysts can anticipate the evolution of stock prices. Therefore, the degree of capital allocation efficiency is lower for Central and Eastern European countries. Even if our tests reveal an improvement in post-governance information efficiency, we can not only attribute the results to the improvement of the regulatory system because the results obtained are rather the cumulative effect of the European integration process, the effects of financial globalization, the increase in foreign direct investment flows in the analyzed countries as well as the destabilizing effects of the recent financial crisis. In conclusion, our results reveal rather an overall improvement in information efficiency in emerging markets than an improvement that can only be attributed to new regulations in the financial system.

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