Stock market speculative bubbles: the case of Visegrad countries

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Abstract: Conventional theory of speculative bubbles describes stock bubbles as stock prices that exceed their fundamental value because current owners believe that the stocks can be resold at an even higher price in the future. We employ a special methodological technique examine the presence of the phenomenon of stock market bubbles in the Visegrad group countries (Czech Republic, Hungary, Poland, and Slovakia) and selected developed European stock markets. The methodology is based on the examining of residuals of VAR fundamentals with exclusion of ARCH effects. The presence of bubbles is studied by regime switching tests and Hurst persistence tests. Although we examine the bubbles presence over various time periods we found almost no evidence of speculative bubbles across the markets.

Keywords: stock bubble, regime switching test, Hurst persistence test

JEL Classification: G14, G15
AMS Classification: 91G70

1 Introduction

The phenomenon of asset bubbles has been known and studied for centuries, but there is still no common framework on how to detect or predict the formation of a bubble. Since 1980s bubbles are investigated with application of time series econometric analysis. However, the use of such mathematical apparatus raises the question of whether econometric tests can truly detect a bubble or just discover an error in the market evaluation of assets. The majority of empirical research (such as Bohl [4] or Nasseh and Strauss [15]) examines the existence of stock market bubbles using traditional unit root tests of price-dividend ratios of US highly capitalized companies, for which long-term data are available. Other studies were also conducted on markets, for which the history of dividend payments exists. Unfortunately, there are only few papers investigating the occurrence of asset bubbles in emerging markets, especially considering the fact that in the last twenty years those economies were the subjects of large financial inflows and the data on dividends are of limited use. Emerging market studies, primarily focused on China or countries of MENA region (such as Jahan-Parvar and Waters [10], Lehkonen [13] or Ahmed et al [3]), reveal inconsistent results. We can find several references concerning the stock bubbles in Visegrad group countries within some of published papers (such as Kizys and Pierdzioch [11]. The study dealt with the collapse of stock markets in the Czech Republic, Poland and Hungary during the financial crisis and if it was due to international linkages of deteriorating fundamentals or international spillovers of speculative bubbles; Hanousek and Novotný [8] performed an extensive analysis of price jump for emerging stock market indexes from the CEE Visegrad region), but not overall research focused on the stock market bubbles in this region. Clearly new methodological approaches and more research in the area are needed. Furthermore, the individual analysis of the possibility of stock market bubbles in smaller financial markets in Europe, including the Czech Republic and other central European countries, is of particular interest.

The main aim of this paper is to examine the presence of stock market bubbles in the central European countries, namely in the Czech Republic, Hungary, Poland, and Slovakia. In order to prove the statistical significance of proposed methodology, the results are compared to the outcomes of research obtained from selected European developed markets, such as Germany, Austria, France and the United Kingdom. The presence of the 2007-2009 market turmoil brought by the global financial crisis is addressed by dividing the long-time horizon data into three periods: before, during and after the financial crisis.

Identifying stock bubbles is a challenging task not only in terms of time, but also in terms of distinguishing the fundamental and non-fundamental determinants. Since the fundamental value is not directly observable, it must be estimated. On the other hand, it is difficult to confirm the existence of a bubble with a particular

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certainty, since the determination of the fundamental value is not a trivial task [12]. The majority of valuation models include dividend payments in their calculations, which values are not available in our inquiry. Therefore, following the methodology of Ahmad et al [1], [2], we assume, that changes in dividends are reflected in the market prices, and abstract from dividends, basing our analysis only on the stock index returns.

2 Data

For the purposes of our study high-frequency daily data are preferred, taking into consideration the market environment of advanced information technology and rapid general information sharing. Daily data capture speedy information as both short run and long run dynamic linkages play role in the bubble formation. We employ the data from the main stock indices representing the chosen markets (basic characteristics of stock exchanges is given in Table 1), weighted indices of the profitability (long-term interest rates) of 10-year government bonds for each country (as calculated in Bloomberg), and the MSCI world index, summarizing the developments of the global stock markets. Returns of the variables as their first log differences are used.

Tick symbol	Country	Number of listed stocks	Market capitalization, mln. USD	Market capitalization as % of GDP	Market turnover, mln. USD	Market turnover as % of GDP	Market liquidity %
PX	Czech Rep (CZ)	16	43 055.6	22.4	14 082.5	7.3	29.4
BUX	Hungary (HU)	48	27 708.4	21.5	26 466.1	20.6	94.5
WIG	Poland (PL)	569	190 234.9	40.5	77 463.9	16.5	47.6
KSM	Slovakia (SK)	90	4 149.6	4.8	173.7	0.2	3.9
ATX	Austria (AU)	86	67 682.8	17.9	48 117.4	12.7	79.4
DAX	Germany (DE)	571	1 429 706.7	43.6	1 405 037.1	42.8	103.0
CAC	France (FR)	901	1 926 488.3	75.3	1 467 073.7	57.3	75.3
UKX	UK	2056	3 107 037.9	137.4	3 006 680.0	132.9	101.9

Sources: The World Bank (World Development Indicators)

Table 1 Stock market characteristics of selected stock exchanges at the end of 2010

The study period is similar for all countries. The total sample period is divided into three sub-periods according to clearly observed trends in the prices' movements. The sub-periods are the pre-crisis period (May 2004 – July 2007), the crisis period (August 2007 – March 2009) and the post-crisis period (April 2009 – March 2012).

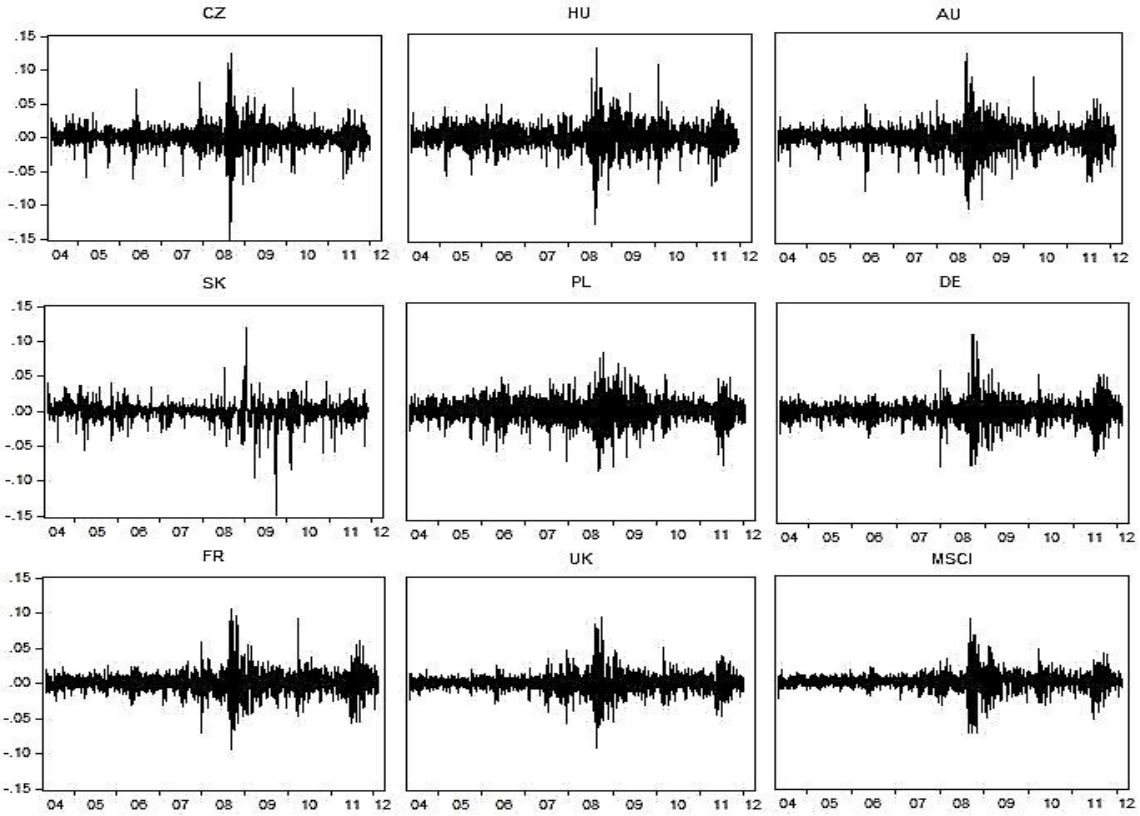

Figure 1 Daily returns (in %) of stock market indices during the whole period

The beginning of the study period is set as an accession date of the Visegrad group countries to the European Union. We chose the crisis period to not start with the Lehman Brothers bankruptcy and major panic on the markets; instead we would like to capture prior anticipations on the markets, when the 2007 banking crisis changed the comfort expectations with a fear of it becoming a sovereign debt crisis. Fluctuations of index returns are illustrated in Figure 1.

3 Methodology

To estimate the fundamental value of index returns we apply the methodology based on the VAR modeling. The VAR model with index returns, government bonds' interest rate and world index returns is employed for each country:

$$r_t = A_1 r_{t-1} + \cdots + A_p r_{t-p} + B msci_t + C b_t + \varepsilon_t \tag{1}$$

where r_t are index returns, $msci_t$ are returns of the MSCI world index, b_t are 10-year government bond interest rates and ε_t is an error term.

To exclude the phenomenon of changing volatility in the time series we should remove autoregressive conditional heteroskedasticity (ARCH) effects from VAR residual series. According to Engle [6] the nonlinear variance dependence measure of ARCH is:

$$\varepsilon_t = \delta_t \mu_t \tag{2}$$

$$\delta_t^2 = \alpha_0 + \sum_{i=1}^{n} \alpha_1 \varepsilon_{1-i}^2 \tag{3}$$

with μ is independent and identically distributed (i.i.d.) variable and α_1 is a coefficient for chosen lags.

Two tests for the identification of stock market speculative bubbles are used. First, we employ the Hurst persistence test to find the existence of long-term linear dependence (memory) in the stock market volatility. Second, we perform the rescale range test. The method based on the Hurst persistence approach is also called rescaled range (R/S) analysis because the significance test breaks the sample into sub-subsamples and then estimates a Chow test on the null that the sub-periods possess identical slopes [1]. This test was developed by Hurst [9] and was firstly implemented in economic analysis by Mandelbrot [14]. Using the R/S analysis, the Hurst exponent H is estimated from the VAR residual series:

$$(R/S)_n = \frac{1}{S(n)}\left[\max_{1\le t\le n} \sum_{t=1}^{n} \left(\varepsilon(t) - \bar{\varepsilon}(n)\right) - \min_{1\le t\le n} \sum_{t=1}^{n} \left(\varepsilon(t) - \bar{\varepsilon}(n)\right)\right] \tag{4}$$

where S_n is the standard deviation estimation and $\bar{\varepsilon}(n)$ is the sample mean of the return time series:

$$\bar{\varepsilon}(\mathrm{n}) = (1/\mathrm{n}) \sum_{\mathrm{n}} \varepsilon(\mathrm{n}) \tag{5}$$

R/S is then described as:

$$(R/S)_n = \left(\frac{n}{2}\right)^H \tag{6}$$

Hurst exponent allows us to reveal the behavior of stock market efficiency over time [16]. If 0 < H < 0.5, it denotes an anti-persistent behavior, which means that positive trends in one period tend to become negative and vice versa. If 0.5 < H < 1, a persistent behavior is indicated in stock market behavior, that is, positive trends in one period tend to continue being positive and vice versa. If H is close to 0.5, it indicates a random walk in data, meaning that market returns are independent. Estimated Hurst exponents are then used to compute F-values for the Chow test to examine its statistical significance.

Second test to detect bubbles in stock market time series is the regime-switching test introduced by Hamilton [7]. The approach of Engle and Hamilton [5] is utilized to test the null hypothesis of no bubbles:

$$\varepsilon_t = trend_t + z_t \tag{7}$$

where z_t is the white noise and $trend_t = \mu_1 + \mu_2 s_t$ (8)

with $s = 1$ being a positive trend and $s = 0$ being a negative trend. Moreover, we let:

$$Prob[s_t = 1\ s_{t-1} = 1] = p, Prob[s_t = 0\ s_{t-1} = 1] = 1 - p \tag{9}$$

$$Prob[s_t = 0\ s_{t-1} = 0] = q, Prob[s_t = 1\ s_{t-1} = 0] = 1 - q \tag{10}$$

The null hypothesis of no trend is given by $p = 1 - q$ and the Wald test statistic calculated as:

$$\frac{p - (1-q)}{var(p) + var(1-q) + covar(p, 1-q)} \tag{11}$$

The Wald test statistic evaluates how close the unrestricted estimates come to satisfying the restrictions under the null hypothesis.

The results of both tests allows us perceiving asset bubbles in the chosen Eastern European countries with a certain degree of confidence, since tests unveils different characteristics of the same time series.

4 Empirical findings

Both tests' results indicate the same situation of no bubbles in stock markets of studied countries (with one exception of Slovakia from the results of Hurst persistence test). There is no significant difference in persistence of stock returns in the highly developed European countries and the Visegrad countries, except for Slovakia. For the majority of cases, Hurst exponent values are not significantly different from its average of 0.5 (see Table 2). Stock index prices follow random walk and do not show any speculation developments.

However, Hurst exponent values for Slovakia highlight irregular market dynamics, which probably disclose the overall inefficiency of the market rather than the existence of price bubbles. The statistical significance of Hurst persistence tests is verified by the Chow test, F-values of which are above its critical values, hence the null hypothesis of no persistence in the time series is rejected.

Estimated Hurst exponents of residuals				
	Full sample	**Pre-crisis period**	**Crisis period**	**Post-crisis period**
PX	0.526192	0.571909	0.508225	0.504513
BUX	0.517590	0.568348	0.418661	0.533226
SKSM	0.653698	0.731891	0.612539	0.531983
WIG20	0.498979	0.496172	0.406587	0.464584
ATX	0.543151	0.557359	0.463424	0.534663
DAX	0.484378	0.466146	0.452908	0.590430
CAC	0.550297	0.486435	0.448344	0.549227
UKX	0.452292	0.515526	0.482410	0.511554
F-values for Chow test				
	Full sample	**Pre-crisis period**	**Crisis period**	**Post-crisis period**
PX	59.093300	60.659000	60.193500	60.400200
BUX	59.603600	56.668500	65.820900	58.693000
SKSM	52.023100	48.131800	54.246500	58.766000
WIG20	60.722600	60.903800	66.618200	62.857500
ATX	58.100000	57.293400	62.944600	58.608400
DAX	61.615200	62.757900	63.608500	55.434000
CAC	57.686500	61.499000	63.898900	57.762200
UKX	63.623400	59.738100	61.763500	59.977100
Critical value F = 4.61				

Source: Authors' calculations based on data from Bloomberg

Table 2 Hurst exponents and related Chow test results

Based on the Hurst exponent values in the sub-periods, the Visegrad stock markets appear to be more volatile than the developed markets in the later periods (except for Poland), supposedly indicating the presence of growing financial inflows. From the results of the Hurst persistence test, the global financial crisis might be seen as a stabilizing mechanism updating the upturning and downgrading market forces (for example, through changing the trading trends in France and Germany). Less than 0.5 values of Hurst exponents in the crisis period signify the decline of asset prices in all observed markets.

Table 3 reports results of regime switching tests. The null hypothesis of no trend in all investigated stock market returns is rejected. Estimated critical value for rejecting the null hypothesis is in all cases lower than the values of the Wald test statistics.

	Full sample	Pre-crisis period	Crisis period	Post-crisis period
PX	819.360	568.246	136.253	304.379
BUX	1123.30	760.251	138.439	441.899
SKSM	791.087	510.217	113.721	265.227
WIG20	1191.91	692.992	236.185	385.211
ATX	707.994	394.937	147.353	290.520
DAX	444.307	480.623	43.4170	136.398
CAC	1552.93	961.337	351.834	780.026
UKX	447.418	324.963	119.101	128.735
Critical value $\chi^2(1) = 3.84$				

Source: Authors' calculations based on data from Bloomberg

Table 3 Wald test results

5 Conclusions

We found no evidence of stock market bubbles neither in the countries of the Visegrad group, nor in the developed European countries. However, taking into consideration the limitations of the proposed methodology, we could not declare with the full certainty that asset bubbles are not present in those markets. If tests have not proved the existence of bubbles, they at least have identified the substantial volatility. Further search of relevant methodology is needed, while tests should be performed not only on market indices, but also on chosen stocks and industry indices.

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