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Evidence of Market Inefficiency from the Bucharest Stock Exchange

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Abstract This paper examines weak-form market efficiency in the Bucharest Stock Exchange (BSE) using dollar-converted returns from its main index BET. Employing a GARCH methodology, we find evidence that over ten years after its inauguration the BSE is still not weak-form efficient. Further evidence of market inefficiency is found in the consistent presence of a significant January effect. These findings are contrary to the conclusions in Harrison and Patton (2005), who conclude that the Romanian stock exchange was largely efficient by the year of 2000.

Keywords Market efficiency, Transition economy, GARCH

1. Introduction

A key problem in centrally planned economies is how to set-up a mechanism for efficient resource allocation. Central planning did not establish itself as a viable alternative to an operational market. Thus encouraging the development of functioning markets, including financial markets, is one of the priorities of economies transitioning from central planning to market economy. The performance of financial markets in these transitioning economies could serve as a benchmark of the overall progress of the reforms.

This paper investigates weak-form market efficiency in the largest stock market in Romania – the Bucharest Stock Exchange (BSE). We employ GARCH methodology and find evidence of market inefficiency and seasonal patterns in returns. There is however an indication that the market is becoming more efficient, compared to the first 4 years after its establishment.

Mendelson and Peake (1993) argue that equity markets are particularly important to transition economies in order to ensure efficient privatization of state owned enterprises. Yet, up to date relatively few papers have focused on stock markets in transition economies. Nivet (1997) examines the early years of trading on the Warsaw Stock Exchange and finds evidence of market inefficiency. Charemza and Majerowska (2000) again focus on the Warsaw Stock Exchange and find that price restrictions contribute to market inefficiency. Rockinger and Urga (2001) examine the efficiency of the Czech, Hungarian, Polish and Russian stock markets, concentrating on whether these markets are becoming more efficient over time. They find evidence of market efficiency only in the case of Hungary. Of greatest relevance for this paper is the paper by Harrison and Paton (2005), which focuses on Romania and finds evidence of market efficiency. Our paper shows that this result is sample-driven, as extending the sample by additional 5 years yields contrary results.

The rest of this paper is organized as follows: section 2 provides brief background on the Bucharest Stock Exchange (BSE), section 3 describes the data; section 4 is devoted to the methodology; section 5 reports our findings; and Section 6 concludes.

2. Background

The original Bucharest Stock Exchange was established in 1882, but seized its operations in 1945 after the communist party came into power. It was reestablished in 1995, and launched its index the BET in 1997. The Asian Crisis and internal economic difficulties led to a continuous decline in the index during its first three years. As of 2000 however the index has been growing steadily and was one of the fastest growing indices in 2006. The BSE is the largest stock exchange in Romania. As of May 2008, market capitalization of the BSE was approximately 54.8 billion USD, and of the smaller NASDAQ-resembling RASDAQ market section approximately 8.3 billion USD.[1]

3. Data

The data for this analysis comes from Datastream and the Bucharest Stock Exchange. Daily closing values of the Bucharest Exchange Trading Index (BET) for the period

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[1] See the information on BET provided by the BSE available at http://www.bvb.ro/IndicesAndIndicators/indices.aspx

9/19/1997 to 28/4/2008 are taken from Datastream. The BET is a free float weighted capitalization index of the most liquid 10 companies listed on the BSE. The companies which form it are reviewed quarterly in March, June, September and December. The period used in the study is the entire period during which the BET index has been reported on a daily basis. Several months prior to its official start the BET was reported semi-formally on every Tuesday and Thursday of the week.

Since Romania went through several periods of high inflation during the observed period it is important to adjust for inflation to get a more realistic notion of the actual magnitude of the returns. Inflation measures, however, are not available on a daily basis. Following Harrison and Paton (2005) the index is converted into US dollars using the dollar/lei exchange rate as reported by the BSE.

4. Methodology

The main variable used in this analysis is the dollar-adjusted daily return of the BET. Returns on day *t* in are calculated as the natural logarithms of the ratio of the value of the index on the current and the preceding day, multiplied by 100 for a convenient interpretation as percentages or:

$$R_t = 100*log(S_t/S_{t-1})$$

Initially, most of the literature investigating weak-form efficiency in emerging markets has concentrated on testing whether there historical values can be successful predictors of future prices. That is:

$$R_t = \alpha + \sum_{s=1}^{S} \beta_s R_{t-s} + \varepsilon_t, t = 1...T$$

For a market to be (weak form) efficient, the coefficients β should be indistinguishable from zero, indicating that historical information would not be useful in predicting current stock prices.

Asset returns, however, typically display heteroskedastici ty and the use of Ordinary Least Method (OLS) may be inefficient in estimating the coefficients of equation (1). The more recent empirical literature therefore uses the generalized autoregressive conditional heteroskedasticity (GARCH) approach of Bollerslev (1986) to investigate market efficiency. Specifically, the GARCH-in-mean framework (GARCH-M), described in Engle, Lilien and Robins (1987), allows for mean returns to be specified as a linear function of time-varying conditional variance.

The general GARCH-M model for stock returns at time *t* R_t may be represented by the following equations:

$$R_t = \alpha + \sum_{s=1}^{S} \beta_s R_{t-s} + \phi h_t + \varepsilon_t$$

$$h_t = \omega + \sum_{i=1}^{p} \gamma_i \varepsilon^2_{t-i} + \sum_{j=1}^{q} \delta_i h_{t-j}$$

Again, efficient markets will have insignificant β coefficients. The paper is looking to assess not only whether the BSE is currently efficient but also the evolution in market efficiency as the market moves towards a mature stage and participants and infrastructure grow in sophistication. We thus estimate the model separately for the full sample and then split the sample into three consecutive sub-periods: 9/19/1997 - 12/31/1999, 01/01/2000 - 12/31/2003 and 1/01/2004 - 4/28/2008 and compare the results. For all samples, we also estimate a TARCH model as proposed by Zakoian (1994). This model tests for asymmetry in the responses to positive and negative shocks.

The paper also explores other market anomalies including seasonal effects. Two of the most popular seasonal effects are the January effect (Rozeff and Kinney, 1976, Gultekin and Gultekin, 1983; Rogalski and Tinic, 1986; Thaler, 1987) and the day of the week effect (French, 1980; Keim and Stambaugh, 1984; Kiymaz and Berument, 2003). The "January effect" refers to stock price increases during the month of January, which is usually attributed to accounting-related end-of the year selling and start of the year buying. In order to test for the presence of January effect, a dummy variable equal to 1 for the first 10 work days in January of each year was created. The day of the week effect refers to the tendency of stocks to exhibit relatively large returns on Fridays compared to those on Mondays. It is particularly puzzling in light of the fact that Monday return values naturally incorporate returns over the weekend and are expected to be greater. In order to test for day of the week effect, two dummy variables start_of_the_week (equal to 1 if Monday and 0 otherwise) and end_of_the_week (equal to 1 if Friday and 0 otherwise) were created, with mid-week days serving as a reference category.

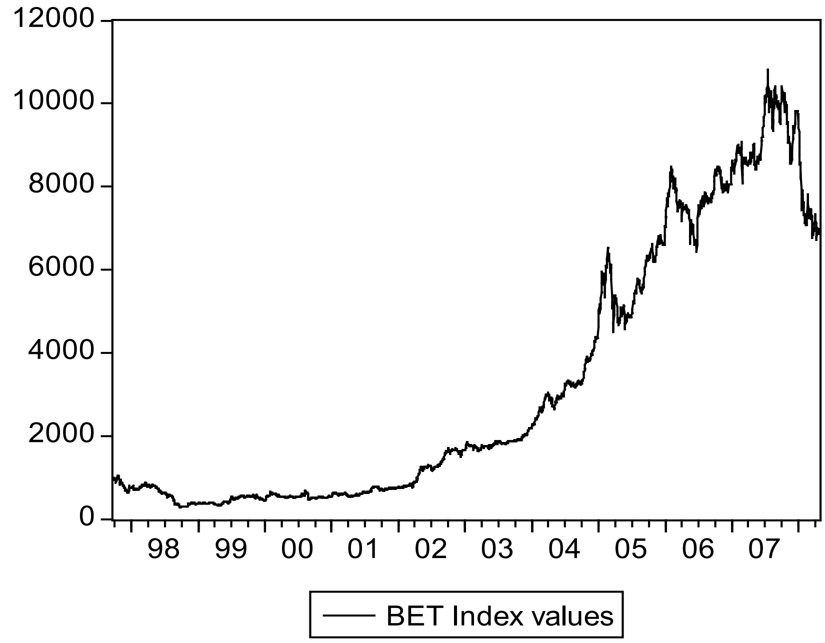
5. Results

Fig. 1a plots the nominal value and Fig. 1b plots the dollar-converted value of the BET from 9/19/1997 until 4/28/2008. The two series are generally co-moving. However, the initial loss of value in the index is much more pronounced when the index is converted in dollar terms.

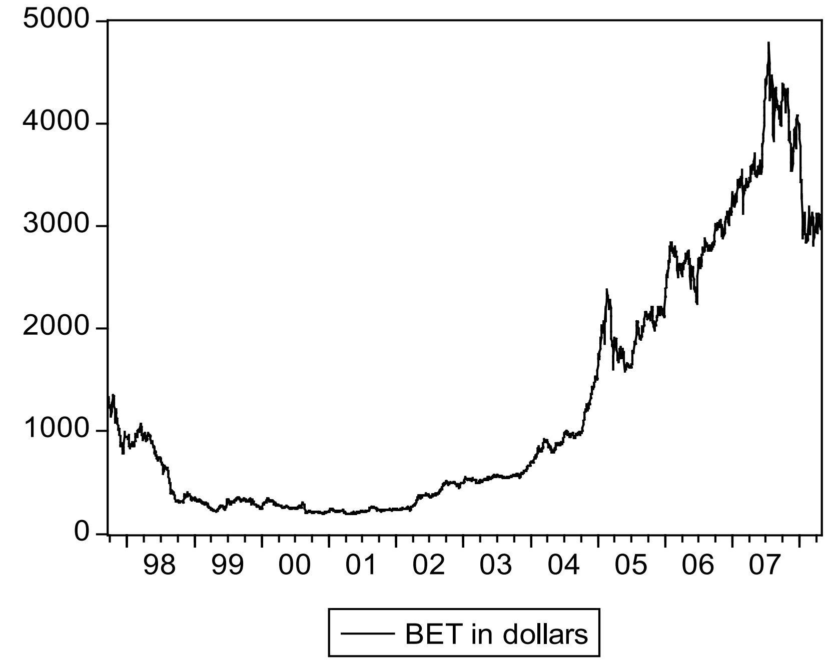
Fig. 2 plots the daily dollar returns of the BET. The graph clearly shows volatility to differ across the period. The returns of the index are particularly volatile at the beginning until the year of 2000, and become more stable afterwards with several volatility spikes in 2005 and 2007. This heteroskedasticity makes volatility modelling necessary in describing the stochastic process underlying the returns.

Table 1 presents the descriptive statistics for the BET series. Overall, the mean daily return over the entire period was 0.029. It is evident that BET returns vary greatly with a standard deviation of 1.829 for the full sample, and the impressive maximum and minimum daily returns of 11.454% and -11.895% respectively. The distributions of the full sample as well as the most recent period are negatively skewed, exhibiting a common feature in equity returns. Kurtosis values in all of the periods exceed the normal distribution value of 3, indicating fat-tail distributions, which again are typically observed in equity return distributions. Formally, the normality assumption is rejected at the 1% level in all of the samples using the Jarque-Bera statistic.

The initial period from 9/19/1997 to 12/31/1999 is characterized by negative average returns and the greatest standard deviation. The middle period from 01/01/2000 to 12/31/2003 is a period of relative stability with lower standard deviation and positive returns. The most recent period from 01/01/2004 to 04/28/2008 shows the greatest average daily returns of over .1 of a percent, along with an increase in volatility.



a)



b)

Figure 1. a) plots the actual BET daily values and b) plots the dollar-converted index

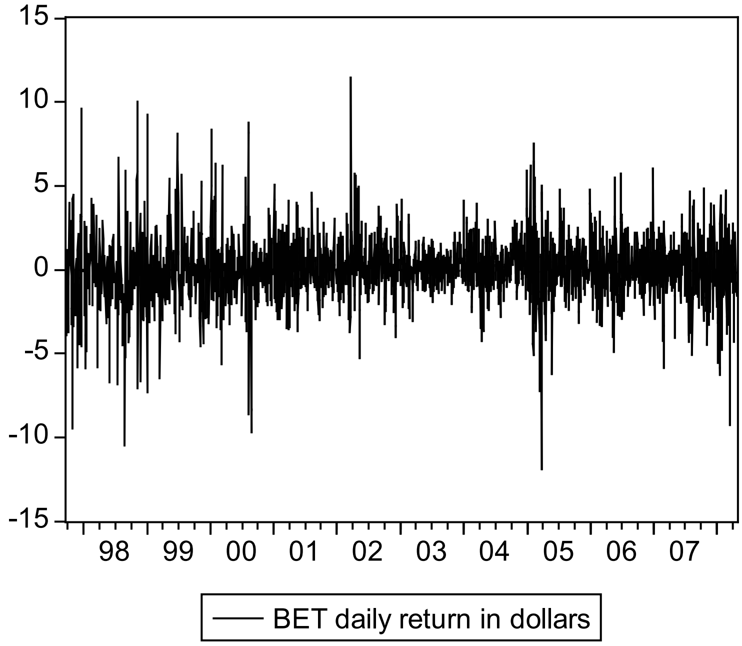


Figure 2. BET daily return in dollars

Table 1. Descriptive statistics of BET returns

Series:	**BET returns in dollars**			
Sample	**9/19/1997 - 4/28/2008**	**9/19/1997 - 12/31/1999**	**01/01/2000 - 12/31/2003**	**01/01/2004 - 4/28/2008**
Observations	2767	596	1044	1127
Mean	0.029	-0.285	0.095	0.133
Median	0.000	-0.266	0.000	0.136
Maximum	11.454	10.011	11.454	7.477
Minimum	-11.895	-10.488	-9.702	-11.895
Std. Dev.	1.829	2.251	1.602	1.759
Skewness	-0.108	0.130	0.367	-0.499
Kurtosis	8.274	6.744	11.342	6.990
Jarque-Bera	3212.642 ***	349.739 ***	3053.087 ***	794.971 ***

****, ** and * indicate significance at the 1%, 5% level and 10% level respectively*

The choice of the model of the mean was based on the minimization of Akaike's Information Criterion (AIC) and Schwartz's Bayesian Criterion (SBC). In all cases the AR(1) model was superior to other specifications and further lags of the return or the error term were mostly insignificant. The parameterization of the volatility equation, similarly was determined to be (1,1), as further lags of the squared error term or the conditional variance were insignificant. Next we will proceed with presenting our results.

First a GARCH(1,1)-M model for the full and split samples was estimated and Table 2 presents the findings. This benchmark model includes no asymmetry or seasonal effects.

Looking at the variance equation, the γ and δ parameters are significant across all samples, indicating the presence of GARCH effects. The half life of the variance shocks, calculated as $\log(0.5)/\log(\gamma+\delta)$ ranges from 19.8 to 3.5 days and is 4.9 for the full sample. This indicates a relatively short memory of the volatility responses.

The mean equation shows no evidence of a GARCH in mean effect, as the coefficient φ is insignificant for the full sample and all subsamples. As noted by Engle, Lilien and Robins (1987), the φ coefficient can be interpreted as a risk-premium. An insignificant φ coefficient indicates a risk-premium of 0, or risk-neutral investors.

The most important finding, consistent throughout all samples is the significance of the coefficient β. Thus, evidence of market inefficiency is found for even the most recent period from 01/01/2004 to 4/28/2008. Although the magnitude of the coefficients in more recent periods is smaller, overall the market is still significantly affected by historical information. This is contrary to the conclusion in Harrison and Patton (2005), who find evidence of market inefficiency for their early sample until 2000, but then conclude the market is efficient using a 2000-2002 sample.

Next we explore potential asymmetries in the responses of volatility to shocks with different signs using a TARCH model. The estimations of the TARCH (1,1) are reported in Table 3. Typically, market returns are found to exhibit a leverage effect: negative volatility shocks affect volatility more than positive shocks of the same magnitude. We find a statistically significant and positive λ coefficient for the full sample. In subsamples, only the latest sample has a positive and significant λ coefficient, indicating that it could be this sub-period which is driving the results for the overall sample. Earlier periods indeed display no leverage effect. These findings are consistent Harrison and Patton (2005), who focus on early samples and find no evidence of leverage effect.

Lastly, we present our findings with regards to seasonal effects in Table 4. Following Kiymaz and Hakan (2003), we include seasonal dummy variables in both the mean and the variance equation.

The mean equations show that the January effect is statistically significant and positive for the full sample, and for all subsamples except the earliest one. Since January effect is typically found in small cap firms, this is an indication that the firms comprising the BET have small-firm characteristics despite being the 10 most traded securities on the BSE. Thus further evidence of market inefficiency in the BSE is found. Harrison and Patton (2005) find no evidence of January effect possibly due to the fact that the initial period has a greater effect on their overall shorter sample. The January effect is also found to affect the conditional variance positively in all but the early sample.

Start or end of the week does not affect significantly the mean in any of the samples. The variance equation shows that the start of the week affected conditional volatility negatively in the earliest sample and positively in the latest sample. Overall, a longer sample would be necessary to reach a conclusion regarding the day of the week effect.

Table 2. GARCH-M estimates no seasonal effects included

Sample	9/22/1997 - 4/28/2008				9/22/1997 - 12/31/1999				12/31/1999 - 12/31/2003				1/01/2004 - 4/28/2008			
	Coefficient	Std. Errc	z-Stat.	Prob.	Coefficient	Std. Errc	z-Stat.	Prob.	Coefficient	Std. Erro	z-Stat.	Prob.	Coefficient	Std. Errc	z-Stat.	Prob.
Mean Equation																
α	0.109	0.054	2.034	0.042 **	-0.342	0.154	-2.228	0.026 **	0.116	0.064	1.807	0.071 *	0.146	0.091	1.606	0.108
β	0.188	0.021	9.133	0.000 ***	0.346	0.042	8.240	0.000 ***	0.124	0.032	3.921	0.000 ***	0.143	0.033	4.391	0.000 ***
φ	0.000	0.020	-0.002	0.998	0.031	0.035	0.871	0.384	-0.001	0.033	-0.024	0.981	0.023	0.034	0.674	0.501
Variance Equation																
ω	0.283	0.024	11.824	0.000 ***	1.614	0.206	7.822	0.000 ***	0.093	0.017	5.619	0.000 ***	0.292	0.051	5.729	0.000 ***
γ	0.227	0.014	16.292	0.000 ***	0.442	0.067	6.593	0.000 ***	0.159	0.014	11.100	0.000 ***	0.191	0.028	6.884	0.000 ***
δ	0.701	0.014	50.737	0.000 ***	0.245	0.057	4.303	0.000 ***	0.812	0.013	60.701	0.000 ***	0.719	0.035	20.533	0.000 ***
R-squared	0.043				0.102				0.028				0.020			
Adjusted R-squared	0.042				0.095				0.024				0.016			
Log likelihood	-5241.572				-1232.770				-1824.324				-2131.460			
Durbin-Watson	1.950				1.901				2.057				2.004			
AIC	3.794				4.164				3.506				3.790			
SBC	3.807				4.208				3.535				3.817			

****, ** and * indicate significance at the 1%, 5% level and 10% level respectively*

Table 3. TARCH-M estimates no seasonal effects included

Sample	9/22/1997 - 4/28/2008				9/22/1997 - 12/31/1999				12/31/1999 - 12/31/2003				1/01/2004 - 4/28/2008			
	Coefficient	Std. Err	z-Stat.	Prob.	Coefficient	Std. Err	z-Stat.	Prob.	Coefficient	Std. Err	z-Stat.	Prob.	Coefficient	Std. Err	z-Stat.	Prob.
Mean Equation																
α	0.097	0.054	1.813	0.070 *	-0.370	0.157	-2.361	0.018 **	0.114	0.065	1.752	0.080 *	0.118	0.093	1.259	0.208
β	0.190	0.021	9.110	0.000 ***	0.353	0.042	8.461	0.000 ***	0.124	0.033	3.796	0.000 ***	0.149	0.033	4.456	0.000 ***
φ	-0.012	0.019	-0.633	0.527	0.030	0.036	0.830	0.406	-0.002	0.033	-0.066	0.947	0.017	0.033	0.501	0.616
Variance Equation																
ω	0.271	0.025	10.992	0.000 ***	1.535	0.216	7.111	0.000 ***	0.092	0.017	5.533	0.000 ***	0.339	0.065	5.247	0.000 ***
γ	0.157	0.014	10.861	0.000 ***	0.345	0.066	5.220	0.000 ***	0.153	0.020	7.689	0.000 ***	0.116	0.028	4.104	0.000 ***
δ	0.712	0.014	49.561	0.000 ***	0.269	0.060	4.459	0.000 ***	0.812	0.014	60.120	0.000 ***	0.702	0.040	17.379	0.000 ***
λ	0.122	0.023	5.301	0.000 ***	0.178	0.103	1.725	0.085 *	0.013	0.025	0.508	0.612	0.142	0.046	3.046	0.002 ***
R-squared	0.043				0.106				0.029				0.022			
Adjusted R-squared	0.041				0.097				0.023				0.016			
Log likelihood	-5232.960				-1231.929				-1824.257				-2126.912			
Durbin-Watson	1.960				2.051				1.903				2.011			
AIC	3.789				4.164				3.508				3.784			
SBC	3.804				4.216				3.541				3.815			

****, ** and * indicate significance at the 1%, 5% level and 10% level respectively*

Table 4. GARCH-M estimates with seasonal effects for full and split sample

Sample	9/22/1997 - 4/28/2008				9/22/1997 - 12/31/1999				12/31/1999 - 12/31/2003				1/01/2004 - 4/28/2008			
	Coefficient	Std. Err	z-Stat.	Prob.	Coefficient	Std. Err	z-Stat.	Prob.	Coefficient	Std. Err	z-Stat.	Prob.	Coefficient	Std. Err	z-Stat.	Prob.
Mean Equation																
α	0.093	0.049	1.899	0.058 *	-0.415	0.170	-2.448	0.014 **	0.133	0.067	1.996	0.046 **	0.122	0.082	1.486	0.137
β	0.183	0.020	8.913	0.000 ***	0.348	0.042	8.312	0.000 ***	0.107	0.033	3.280	0.001 ***	0.149	0.032	4.646	0.000 ***
φ	-0.007	0.018	-0.375	0.708	0.037	0.037	1.016	0.310	-0.014	0.034	-0.413	0.680	0.012	0.030	0.394	0.694
MONDAY	0.002	0.065	0.037	0.971	0.139	0.145	0.952	0.341	-0.017	0.096	-0.175	0.861	-0.056	0.108	-0.521	0.602
FRIDAY	0.023	0.063	0.370	0.711	0.162	0.172	0.940	0.347	-0.045	0.097	-0.461	0.645	0.029	0.100	0.293	0.770
JANUARY	0.955	0.257	3.718	0.000 ***	-0.818	0.813	-1.007	0.314	1.315	0.416	3.164	0.002 ***	0.965	0.387	2.492	0.013 ***
Variance Equation																
ω	0.146	0.039	3.725	0.000 ***	1.864	0.250	7.453	0.000 ***	0.050	0.046	1.094	0.274	0.108	0.077	1.404	0.160
γ	0.242	0.014	17.123	0.000 ***	0.440	0.070	6.248	0.000 ***	0.164	0.015	10.589	0.000 ***	0.233	0.032	7.261	0.000 ***
δ	0.697	0.013	53.092	0.000 ***	0.207	0.057	3.604	0.000 ***	0.799	0.013	59.606	0.000 ***	0.673	0.036	18.488	0.000 ***
MONDAY	0.266	0.123	2.152	0.031 **	-1.005	0.269	-3.743	0.000 ***	0.080	0.150	0.536	0.592	0.721	0.236	3.052	0.002 ***
FRIDAY	0.176	0.107	1.651	0.099 *	0.298	0.358	0.832	0.405	0.153	0.135	1.135	0.256	0.132	0.194	0.682	0.495
JANUARY	1.279	0.321	3.986	0.000 ***	1.341	2.473	0.542	0.588	0.752	0.348	2.161	0.031 **	1.525	0.533	2.861	0.004 ***
R-squared	0.044				0.103				0.044				0.017			
Adjusted R-squared	0.041				0.086				0.034				0.008			
Log likelihood	-5208.882				-1227.899				-1811.748				-2108.799			
Durbin-Watson	1.935				2.074				1.894				2.005			
AIC	3.775				4.168				3.494				3.760			
SBC	3.801				4.256				3.551				3.814			
Half Life	11.018				1.588				18.409				6.997			

****, ** and * indicate significance at the 1%, 5% level and 10% level respectively*

6. Conclusions

This paper examines weak-form market efficiency in the largest Romanian stock exchange using dollar-converted returns from its main index BET. Employing a GARCH methodology, we find evidence that the BSE is still not weak-form efficient. Further evidence of market inefficiency is found in the consistent presence of a significant January effect. These findings are generally contrary to the conclusions in Harrison and Patton (2005), who conclude that the Romanian stock exchange was largely efficient by the year of 2000.

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