TESTING THE EFFICIENCY MARKET HYPOTHESIS FOR THE ROMANIAN STOCK MARKET

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ABSTRACT: Efficient Market Hypothesis has dominated the field of research on capital market theory. It states that asset prices are rationally connected to economic realities and always incorporate all the information available to the market. In this way, securities markets are seen as efficient in reflecting information about individual stocks or about the stock market as a whole. A large number of theoretical, as well as empirical papers around the world have had as objective testing this hypothesis. Beside reviewing the most important part of literature in this respect, the paper has as aim testing the Efficient Market Hypothesis on Bucharest Stock Exchange. The tested hypothesis is carried on time series of stock index BET (daily observations), for the period 2000-2009. The econometrical results assert that the weak form of the efficiency market hypothesis is accomplished.

Key words: *efficiency market hypothesis, Romanian stock exchange, BET*

JEL codes: G10, G12, G17

Introduction

The efficient market hypothesis (EMH) has been a subject of main debate of traditional finance for a long period of time. In his paper, Fama (1970: 383) stated that a stock market can be called efficient only if „the security prices always fully reflect the available information". When this condition is accomplished, the market participants cannot achieve unsusual returns, greater than those that can be obtained by holding a randomly selected portfolio of individual stocks with comparable risks. The efficient market hypthesis is associated with the concept of „ random walk", which assumes a price series where all subsequent price changes represent random departures from previous prices.

In this paper the authors aim at finding new evidence on the Efficient Market Hypothesis on the Romanian stock market, Bucharest Stock Exchange. Section 2 reviews a part of the relevant literature concerning this problem. Section 3 provides the analytical framework. Section 4 offers the empirical framework. The last section is dedicated to some conclusions and suggestions regarding potential further research.

Theoretical background

The theoretical literature concerning the efficient market hypothesis (EMH) is divided into 3 main categories (Fama, 1991): *studies about the predictability of the returns* (are the returns predictible depending on past exeperience or other variables?), *studies about the events that may lead to changes in the assets' prices* (changes in the distributed dividends, investment decisions or capital structure decisions) and *studies about private information* (are there investors that posess

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private information that is not totally reflected in the market prices?). The realised study will be only focusing on the theme approached by the first category of papers.

Fama outlined the fact that the market efficiency cannot be tested „per se", but in association with an equilibrium model. In other words, it is possible to test whether the information is right incorporated in the market prices only when there exists an adequate model of price formation. Moreover, it is worth mentioning that the markets do not become automatically efficient. It is the action of rational investors trying to maximize their benefits that makes the markets efficient. Apparently, there is a contradiction between rational investors and efficient markets in the sense that if the markets were efficient, then the rational investors would stop looking for ineficiences in order to make benefits, which would lead to unefficient markets. It makes sense thinking of an efficient market like a self-corrective mechanism, where all the inefficiencies appear at regular period of time, but disappear almost instanteneously when the investors find them end trade (Damodoran, 1996).

Fama identified **three levels of efficiency** which a market might actually have: *the strong form*, *the semi-strong form* and the *weak-form of efficiency*:

- **Strong-form EMH**

In its strongest form, the EMH says a market is efficient if all information relevant to the value of a share, whether or not generally available to existing or potential investors, is quickly and accurately reflected in the market price. For example, if the current market price is lower than the value justified by some piece of *privately* held information, the holders of that information will exploit the pricing anomaly by buying the shares. They will continue doing so until this suplimentary demand for the shares has taken the price to the level supported by their private information. At this point they will have no incentive to continue buying, so they will withdraw from the market and the price will stabilise at this new equilibrium level. This form of EMH is the most satisfying and compelling form of EMH in a theoretical sense, but it has also one important drawback in practice. It is difficult to confirm empirically, as the necessary research would be unlikely to win the cooperation of the relevant section of the financial community – insider dealers.

- **Semi-strong-form EMH**

The so called the *semi-strong* form of the EMH assumes, in a less rigorous form, that a market is efficient if all relevant *publicly available* information is quickly reflected in the market price. It says that the market will quickly incorporate the publication of relevant new information by moving the price to a new equilibrium level that reflects the change in supply and demand caused by the emergence of that information. What it may lack in intellectual rigour, the semi-strong form of EMH certainly gains in empirical strength, as it is less difficult to test than the strong form.

- **Weak-form EMH**

The *weak-form* of EMH asserts that the only relevant information set to the determination of current security prices is the historical prices of that particular security. In this regard, investors cannot expect to find any patterns in the historical sequence of security prices that will provide insight into future price movements and allow them to earn abnormal rates of returns. In most of the empirical literature, the random walk behaviour of security prices is used as the basis to test for weak-form EMH. Since new information is deemed to come in a random fashion in an efficient market, changes in prices that occur as a consequence of that information will seem random. Thus, price movements in a weak-form efficient market occur randomly and successive price changes are independent of one another.

Formally, the random walk model can be written as:

$$p_t = p_{t-1} + \mu_t \tag{1}$$

where p_t is the price at time *t*, p_{t-1} is the price in the immediate preceding period and μ_t is a random error term. A purely random process is what statisticians called 'independent and identical distribution' , such as a Gaussian with zero mean and constant variance. The price change, $\Delta pt = p_t - p_{t-1}$, is simply μ_t which being white noise, is unpredictable from previous price changes. Looking from a different perspective.

Equation (1) states that the best forecast of the price of a security at time t+1 is the price at time t, which in turn implies that the expected gain or loss for any holding period is zero. Therefore, analysis of past prices is meaningless because patterns observed in the past occurred purely by chance.

Identifying the right form of efficiency for a certain stock exchange is very useful in order to justify the excess returns, those returns that are obtained beyond the risks taken by agents operating on the exchange:

- if a market is *weak-form efficient*, there is no correlation between successive prices, so that excess returns cannot consistently be achieved through the study of historical prices of a particular security. This kind of study is called technical or chart analysis, because it is based on the study of past price patterns without regard to any further background information;
- if a market is *semi-strong efficient*, the current market price is the best available unbiased predictor of a fair price, having regard to all publicly available information about the risk and return of an investment. The study of *any* public information (and not just past prices) cannot yield consistent excess returns. This is a somewhat more controversial conclusion than that of the weak-form EMH, because it means that *fundamental* analysis – the systematic study of companies, sectors and the whole economy – cannot produce higher returns than are justified by the risks involved. Such a hypothesis put under doubt the relevance and value of a large sector of the financial services industry, namely investment research and analysis;
- if a market is *strong-form efficient*, the current market price is the best available predictor of a right price, making use of all relevant information, regardless the information is in the public domain or not. This implies that excess returns cannot consistently be achieved even by trading on inside information. As simple is this manner of explaining in theory, as difficult it is to put it in practice.

Critiques of EMH

We cannot ignore as well the growing body of literature which has been focusing, since early 1980s, on giving arguments in contradiction with the EMH theory or aiming at proving that in their case this theory does not holds up (Schleifer, 2000, Barber and Odean, 2000). There has been registered a shift toward studies that relate some ***behavioural science issues with finance***. In the contradiction with the neo-classical paradigm, these studies suggest that the entities that operate on the market may be as well irrational in their reactions to new information and may take wrong decisions regarding their investment portfolio. Consequently, the markets will end up with asset prices not reflecting predictions of past market models. The new approach of ***behavioural finance*** is brought here in order to show anomalies in which concerns the behaviour of the entities operating on the market. Of the most significant papers in this area we can mention Thaler contribution (1993, 2005) as well as Shefrin (2000, 2005) and Shleifer (2000).

One of the main anomaly associated to the supporters of behavioural finance is the one of excess volatility. Price movements tend to be much greater than they were supposed to be, according to the efficient market hypothesis (according to which there are no opportunities for achieving exceptional returns because if such opportunities existed, they would be quickly discovered and implemented by almost everyone). Many economists and psychologists as well have shown that cognitive biases and irrational behaviour are persasive, crowds can be foolish as well as wise and the asset prices do not necessarily always make sense[3].

[3] We can mention among the supporters of the inefficiency of the market the famous businessman Warren Buffett, who had stated in one interview that: *´´I´d be a bum in the street with a tin cup if the markets were efficient*" *[...] Investing in a market where people believe in efficiency is like playing bridge with someone who has been told it doesn't do any good to look at the cards".*

Moreover, the empirical evidence on the behaviour of investors show that they are affected by:

- **conservatism bias** that means that investors are conservative in adapting their beliefs in response to the new gathered information, reacting only gradually (Bodie, Kane and Marcus, 2005);
- **a tendency to under-react or over-react to news** (Shleifer, 2000; Barber and Odean, 2000; De Bondt and Thaler, 1987; Lakonishok et al., 1994); the investors may sell stocks that have registered recent losses and buy stocks that have known an increase in their price;
- **herd instinct**, that implies that investors focus only on a set of securities, ignoring other with similar characteristics (Hirshleifer, Subrahmanyam and Titman (1994)); this may result into pricing bubbles (Avery and Zemsky, 1998; Hong et al., 2005); Cipriani and Guarino (2003) even state that the herd behaviour may generate financial contagion;
- **sunk cost** which mean that investors tend to continue their endeavour once an investment in money, effort or time has been made, regardless the new received information from the market (Zeelenberger and Van, 1997; Moon, 2001);
- **noise –** Thaler (1993) mentioned the fact that in comparison with rational traders that make investment decisions on the basis of facts, forecasts, financial information in general, noise traders make decisions base don everything else;
- **culture** (Brown et al., 2002);
- **endowment effect** (Thaler, 2005) that presumes that an investor would demand much more for a stock that he owns than he would be willing to give for the same stock he does not own;
- **information asymmetries** (Coval and Moskowitz, 2001; Hong et al., 2005; Cohen, et al., 2007);
- **January effect -** January stock retruns are higher than in any other month (Rozeff and Kinney, 1976; Lakonishok and Smidt, 1989; Haug and Hirschey, 2006) given the fact that investors look at January as a fresh new start; there is also the stereotype that „as goes January, so goes the year", meaning that if the prices go well in January, the stock market would go well the rest of the year and vice-versa in the reversed situation;
- **„ Monday effect" or the weekend effect -** stock prices tend to go down on Mondays (Gibbons and Hess, 1981) or at least exibit realtively large returns on Fridays compared to those on Monday, although one would expect for higher return, given the longer period and greater assumed risk;
- **weather (**studies of Saunders (1993), Hirshleifer and Shumway (2003), Trombley (1997) find a significant correlation between the variable weather and investors´ behaviour arguing that on sunny days on average market returns are higher than on rainy days).

A global critique of EMH is adressed inside the framework of so-called Adaptative Market Hypothesis introduced by Lo (2004, 2005), that concludes that the markets are efficient with behavioural alternatives, by applying the principles of evolution – competition, adaptation, and natural selection - to financial interactions. In Lo (2005)´s view, the EMH can be viewed as the frictionless ideal that would exist if there were no capital market imperfections such as transaction costs, taxes, institutional rigidities and limits to the cognitive and reasoning abilities of market participants. In fact, these imperfections do exist, and the behaviour is not necessarily intrinsec and exogenous, but evolves by natural selection and depends on the environment through which selection occurs. Lo (2004) uses the term of „bounded rationality" (term first used by economist

Herbert Simon) to express the fact that individuals are bounded in their degree of rationality, they make choices that are merely satisfactory, not necessarily optimal.

The primary components of the AMH theory, according to Lo (2005) are:

- individuals act in their own self-interest;
- individuals make mistakes;
- individuals learn and adapt;
- competition drives adaptation and innovation;
- natural selection shapes market ecology.

The first component is common for EMH and AMH, while the others differ.

Regarding the measure of reflection in prices of the available information, Lo (2005) states that it is dictated by a combination of environmental conditions and the number and nature of species in the economy or, to use the appropriate biological term, the *ecology*. By species, Lo (2005) means distinct groups of market participants (for example, retail investors, pension funds, market makers, hedge fund managers), each of them behaving in a common manner. He says that if these multiple species (or the members of a single highly populous species) are competing for rather scarce resources within a single market, that market is likely to be highly efficient.

Markets are not simply either efficient or inefficient. Market efficiency can be viewed as a continuum running from the perfect market (i.e., precisely strong form efficient) to the grossly inefficient market where excess earning opportunities abound. We can then think of any market or securities in a market as being characterised by some degree of efficiency (Bowman and Buchanan, 1995).

Empirical evidence of EMH from stock market in developing countries is however mixed. The predictability of returns in the Budapest Stock Exchange (BSE) is investigated by Macskasi and Molnar (1996). The authors use the returns on the BUX index for the period 1990 – 1996 using Ljung-Box Q-statistics to show presence of autocorrelation. Further they employ standard ARMA and GARCH frameworks and filtering (buy-and-hold) rules to make ex post trading sequences. They conclude that BSE was not efficient because "it offered the possibility of excessively high returns".

Gordon and Rittenberg (1995) aimed at testing the Warsaw Stock Exchange (WSE) efficiency. The authors apply a filtering rule to 23 shares for a relatively short period (June 1993 – July 1994) and suggest that either the weak form efficiency does not apply to WSE or "prices do not adequately reflect information at a given point of time, thus resulting in sufficient time lags of which investors can take advantage". Finally, they use a rather descriptive approach to point out that the investors' psychology appears to have more significant role than the one described by the EMH proponents.

Vosvorda et al. (1998) investigate the EMH for the Prague Stock Exchange. Their study suffers again of the relatively small time period of the data employed – from 1995 to 1997. The authors reject the weak form market efficiency supporting their argument on magnitude of autocorrelation between subsequent returns. According to them the autocorrelation estimates for the PX50 index are much higher than the "normal" ones proposed by Fama (1970).

Chun (2000), with the help of some variance ratio tests, found that the Hungarian capital market was weakly efficient. Gilmore and McManus (2003) tested the EMH in its weak form for the three most developed CEE countries (Czech Republic, Poland and Hungary), for the period 1995-2000 and rejected the random walk hypothesis.

There are also numerous empirical studies that aim to test EMH on other emerging stock market. Dickinson and Muragu (1994) found evidence consistent with the EMH in their study of the Nairobi Stock Exchange. Zychowicz et al. (1995) concluded that on the Instanbul stock exchange, daily and weekly returns diverge from a random walk, while monthly returns are consistent with weak form market efficiency.

The list can continue, the EMH theory being tested almost on every European capital market and not only. Overall, the results of the studies have shown that emerging stock markets are not as informationally efficient as their developed counterparts. In what concerns the Romanian case, the most recent paper regarding this subject is realized by Dragotă et al. (2009) that proceeded on investigating the weak information efficiency of the Romanian capital market using a database that consists in daily and weekly returns for 18 companies listed on the first tier of the Bucharest Stock Exchange and in daily and weekly market returns estimated by using the indexes of the Romanian capital market. Applying Multiple Variance Ratio test to random walk hypothesis, it was found that for most of the stock prices the random walk hypothesis cannot be rejected. Pele and Voineagu (2008), proposing a model for stock´s decomposition, an autorgeressive process and a stationary zero mean process cannot reject as well the EMH.

Methodological framework

Our empirical analysis on Bucharest Stock Exchange is based on daily observations (from 10.04.2000 to 08.04.2009), that were previously seasonally adjusted. The main statistical properties (Skewness, Kurtosis) reveal the fact that the historical data is non-normally distributed[4]. The portmanteau BDS test, used to determine whether the residuals are iid (independent and identically distributed), shows us that the hypothesis of iid is rejected[5].

For outlining some superior-order autocorellations we have used the correlogram. Analysing the results provided by the correlogram, we can notice some significant first-order autocorellations. Moreover, Q-Statistics highlight the existence of some superior-order autocorellations[6].

The stationarity tests (Augmented Dickey- Füller, Kwiatkowski-Phillips-Schmidt-Shin and Elliott-Rothenberg-Stock) reveal the fact that the series are not stationary in levels, regardless the level of confidence (1 %, 5 % and 10 %). Complementary, the same tests have been done on first order differences confirming that the series evolution can be described as an I(1) process[7].

Empirical framework

The employment of random walk test reflects the fact that BET evolution can be described as a random-walk process. More exactly:

$$BET_t = BET_{t-1} + \mu_t \tag{2}$$

where μ_t is a stationary random disturbance term.

Sspace: SSRW
Method: Maximum likelihood (Marquardt)
Sample: 1 2261
Included observations: 2261
Convergence achieved after 1 iteration

	Final State	Root MSE	z-Statistic	Prob.
μ	2656.050	84.50052	31.43235	0.0000

Log likelihood	-13246.74	Akaike info criterion	11.71848
Parameters	1	Schwarz criterion	11.72101
Diffuse priors	1	Hannan-Quinn criter.	11.71940

[4] See Appendix 1 and Appendix 2
[5] See Appendix 3
[6] See Appendix 4
[7] See Appendix 5, Appendix 6 and Appendix 7

For outlining the structural changes in the evolution of BET, this can be modelled as an AR(1) process and a Chow Breakpoint test could be applied.

The *F-statistic* of this test is based on the comparison of the restricted and unrestricted sum of squared residuals.

The application of a Chow-*Breakpoint test* indicates the fact that the 1500th observation (the observation from 27.04.2006) can be considered a „point of structural break", reflecting a thorough change in the general conditions of the market. In this context, a re-evaluation of the random-walk test could lead to different results.

Chow Breakpoint Test: 1500 2261

Log likelihood ratio	9.656724	Probability	0.008000

Therefore it could be stated the hypothesis that there is a reduction in the infomational efficiency (in its weak form) of the market, given the prelonged financial instability.

Conclusions, limits and further research

In what concerns the Romanian capital market the empirical study proved some evidence regarding the informational efficiency (at least in what concerns the weak form of the EMH). This means, in the line of literature, that the only relevant information set to the determination of current security prices is the historical prices of that particular security. In other words, investors cannot expect to find any patterns in the historical sequence of security prices that will allow them to earn abnormal rates of returns. But, when analysing the Romanian capital market case, the conclusions may become slightly different than the ones stated in the literature. This, considering the fact that we are talking about a "turbulent" capital market, in a non-entire crystallized stage of development, with relative important and quickly changes in structures and mechanisms, with asymmetric and imperfect information, non-accurate rules of functioning and not wellcontoured support institutions. Moreover, in the context of the current financial crisis, when emotions and fears have replaced any theoretical principle, the investors are being negatively influenced in their market behaviour, this leading further to significant changes in the stock returns of the emergent capital markets, like the Romanian one.

Thus, this analysis must be viewed carefully. It could be improved by using some different methodologies of testing the informational effciency, among these we could mention a wider data set, as well of some variables that reflect the impact of institutional and functional changes that influence the capital market (using some dummy variables).

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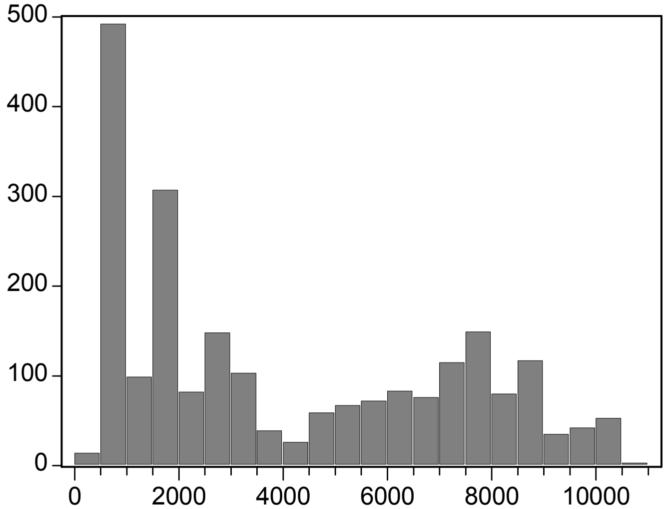
Appendix 1

Histogram



Series: BET	
Observations 2261	
Mean	4085.421
Median	2980.390
Maximum	10813.59
Minimum	471.4700
Std. Dev.	3104.147
Skewness	0.426496
Kurtosis	1.718600
Jarque-Bera	223.2343
Probability	0.000000

Appendix 2

Descriptive Statistics

Descriptive Statistics for BET
Categorized by values of BET
Sample: 1 2261
Included observations: 2261

BET	Mean	Median	Max	Min.	Quant.*	Sum.	Std. Dev.	Skew.	Kurt.	Obs.
[0, 5000)	1802.302	1677.250	4998.150	471.4700	1677.250	2467351.	1200.479	0.835884	2.887769	1369
[5000, 10000)	7414.222	7508.975	9990.220	5016.630	7508.975	6198290.	1250.838	-0.066937	2.183670	836
[10000, 15000)	10205.29	10167.68	10813.59	10002.34	10167.68	571496.0	177.0852	1.569533	5.678365	56
All	4085.421	2980.390	10813.59	471.4700	2980.390	9237137.	3104.147	0.426402	1.717840	2261

*Quantiles computed for p=0.5, using the Cleveland definition.

Appendix 3

BDS test

BDS Test for BET
Date: 06/11/09 Time: 11:36
Sample: 1 2261
Included observations: 2261

Dimension	BDS Statistic	Std. Error	z-Statistic	Normal Prob.	Bootstrap Prob.
2	0.085228	0.000566	150.6377	0.0000	0.0000
3	0.162697	0.001144	142.2734	0.0000	0.0000
4	0.232797	0.001730	134.5598	0.0000	0.0000
5	0.296115	0.002290	129.3121	0.0000	0.0000
6	0.353203	0.002804	125.9804	0.0000	0.0000
7	0.404680	0.003261	124.0966	0.0000	0.0000
8	0.451009	0.003658	123.3082	0.0000	0.0000
9	0.492691	0.003993	123.4031	0.0000	0.0000
10	0.530232	0.004267	124.2516	0.0000	0.0000
11	0.564004	0.004485	125.7472	0.0000	0.0000
12	0.594398	0.004650	127.8303	0.0000	0.0000

Raw epsilon	7325.335		
Pairs within epsilon	4612237.	V-statistic	0.902216
Triples within epsilon	9.56E+09	V-statistic	0.827442

Dimension	C(m,n)	c(m,n)	C(1,n-(m-1))	c(1,n-(m-1))	c(1,n-(m-1))^k
2	2294922.	0.899028	2302786.	0.902109	0.813800
3	2286927.	0.896690	2300598.	0.902050	0.733993
4	2279867.	0.894714	2298404.	0.901988	0.661917
5	2273385.	0.892961	2296218.	0.901929	0.596846
6	2267158.	0.891305	2294033.	0.901870	0.538101
7	2261244.	0.889768	2291858.	0.901815	0.485088
8	2255406.	0.888259	2289688.	0.901760	0.437250
9	2249649.	0.886779	2287523.	0.901708	0.394088
10	2244067.	0.885364	2285351.	0.901652	0.355132
11	2238598.	0.883992	2283180.	0.901596	0.319988
12	2233277.	0.882675	2281004.	0.901538	0.288276

Appendix 4

Correlogram

Included observations: 2261

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
|********	|********	1	0.999	0.999	2260.4	0.000
|********	| |	2	0.998	-0.057	4517.7	0.000
|********	| |	3	0.997	-0.007	6771.8	0.000
|********	| |	4	0.996	-0.028	9022.7	0.000

|********	| |	5	0.996	0.027	11270.	0.000
|********	| |	6	0.995	-0.007	13515.	0.000
|********	| |	7	0.994	-0.011	15756.	0.000
|********	| |	8	0.993	-0.046	17994.	0.000
|********	| |	9	0.992	-0.024	20228.	0.000
|********	| |	10	0.990	-0.002	22458.	0.000
|********	| |	11	0.989	0.015	24684.	0.000
|********	| |	12	0.988	-0.041	26906.	0.000
|********	| |	13	0.987	-0.009	29124.	0.000
|********	| |	14	0.986	-0.014	31338.	0.000
|********	| |	15	0.985	-0.026	33548.	0.000
|********	| |	16	0.984	-0.025	35753.	0.000
|********	| |	17	0.982	-0.004	37953.	0.000
|********	| |	18	0.981	0.001	40148.	0.000
|********	| |	19	0.980	0.029	42339.	0.000
|********	| |	20	0.979	-0.001	44526.	0.000
|********	| |	21	0.977	-0.007	46708.	0.000
|********	| |	22	0.976	0.038	48886.	0.000
|*******|	| |	23	0.975	-0.001	51059.	0.000
|*******|	| |	24	0.974	0.015	53228.	0.000
|*******|	| |	25	0.973	0.007	55393.	0.000
|*******|	| |	26	0.972	0.021	57554.	0.000
|*******|	| |	27	0.971	0.014	59712.	0.000
|*******|	| |	28	0.969	-0.011	61865.	0.000
|*******|	| |	29	0.968	-0.002	64015.	0.000
|*******|	| |	30	0.967	-0.001	66160.	0.000
|*******|	| |	31	0.966	-0.001	68302.	0.000
|*******|	| |	32	0.965	-0.008	70440.	0.000
|*******|	| |	33	0.964	-0.026	72573.	0.000
|*******|	| |	34	0.963	0.060	74703.	0.000
|*******|	| |	35	0.962	-0.022	76830.	0.000
|*******|	| |	36	0.961	-0.004	78952.	0.000

Appendix 5

Augmented Dickey-Fuller stationarity test

- Level

Null Hypothesis: BET has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic based on Modified HQ, MAXLAG=26)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		0.694232	0.9997
Test critical values:	1% level	-3.962108	
	5% level	-3.411798	
	10% level	-3.127787	

*MacKinnon (1996) one-sided p-values.

- First order difference

Null Hypothesis: D(BET) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 16 (Automatic based on Modified HQ, MAXLAG=26)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-9.531494	0.0000
Test critical values:	1% level	-3.962137	
	5% level	-3.411812	
	10% level	-3.127795	

Appendix 6

Kwiatkowski-Phillips-Schmidt-Shin stationarity test

- Level

Null Hypothesis: BET is stationary
Exogenous: Constant, Linear Trend
Lag length: 1 (Spectral GLS-detrended AR based on Modified HQ, MAXLAG=26)

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		8648.963
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Residual variance (no correction)	3579337.
HAC corrected variance (Spectral GLS-detrended AR)	8949.903

- First order difference

Null Hypothesis: D(BET) is stationary
Exogenous: Constant, Linear Trend
Lag length: 19 (Spectral GLS-detrended AR based on Modified HQ, MAXLAG=26)

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		8.861533
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Residual variance (no correction)	7128.738
HAC corrected variance (Spectral GLS-detrended AR)	334.8952

Appendix 7

Elliott-Rothenberg-Stock stationarity test

-Level

Null Hypothesis: BET has a unit root
Exogenous: Constant, Linear Trend
Lag length: 1 (Spectral GLS-detrended AR based on Modified HQ, MAXLAG=26)
Sample: 1 2261
Included observations: 2261

		P-Statistic
Elliott-Rothenberg-Stock test statistic		49.75175
Test critical values:	1% level	3.960000
	5% level	5.620000
	10% level	6.890000

*Elliott-Rothenberg-Stock (1996, Table 1)

HAC corrected variance (Spectral GLS-detrended AR)	8949.903

- First order difference

Null Hypothesis: D(BET) has a unit root
Exogenous: Constant, Linear Trend
Lag length: 19 (Spectral GLS-detrended AR based on Modified HQ, MAXLAG=26)
Sample (adjusted): 2 2261
Included observations: 2260 after adjustments

		P-Statistic
Elliott-Rothenberg-Stock test statistic		1.838001
Test critical values:	1% level	3.960000
	5% level	5.620000
	10% level	6.890000

*Elliott-Rothenberg-Stock (1996, Table 1)

HAC corrected variance (Spectral GLS-detrended AR)	334.8952