Economic Modelling 38 (2014) 381–384

Contents lists available at ScienceDirect

Economic Modelling

journal homepage: www.elsevier.com/locate/ecmod

Re-examining the Turkish stock market efficiency: Evidence from nonlinear unit root tests

Onur Gozbasi [a,*], Ilhan Kucukkaplan [b], Saban Nazlioglu [c]

[a] Department of Business Administration, Nuh Naci Yazgan University, Kayseri, Turkey
[b] Department of International Trade and Finance, Pamukkale University, Denizli, Turkey
[c] Department of Econometrics, Pamukkale University, Denizli, Turkey

ARTICLE INFO

Article history:
Accepted 17 January 2014
Available online 15 February 2014

JEL classification:
G14
C22

Keywords:
Efficient market hypothesis
Turkish stock market
Nonlinearity
Emerging markets

ABSTRACT

This paper re-examines the efficient market hypothesis (EMH) in the Turkish stock market by utilizing the recent developments in nonlinear unit root tests. To this end, we first employ the linearity test developed by Harvey et al. (2008) and then carry out the nonlinear ESTAR unit root test recently developed by Kruse (2011). The results show that Borsa Istanbul stock price index series have nonlinear behavior and follow the random walk (non-stationary) process, supporting the EMH in Turkish stock market which has weak-form efficiency.

1. Introduction

The efficiency of stock markets is an old question and its importance continues since there is a lack of consensus in empirical studies. In the international literature on different countries, while a number of studies report a lack of evidence to support the EMH (see *inter alia*, Lo and MacKinlay, 1988; Poterba and Summers, 1988; Kavussanos and Dockery, 1996; Al-Loughani and Chappell, 1997; Grieb and Reyes, 1999; Chaudhuri and Wu, 2003; Narayan, 2006; Narayan, 2008; Hasanov, 2009), some other studies conclude that the behavior of stock prices is consistent with the EMH (Alexeev and Tapon, 2011; Buguk and Brorsen, 2003; Cheung and Coutts, 2001; Munir and Mansur, 2009; Narayan, 2005; Narayan and Smyth, 2004, 2005; Qian et al., 2008).

The controversy in the international literature is also available for the Turkish stock market. Table 1 summarizes the EMH literature on Turkey by focusing on data description, empirical tool(s), and results for the EMH hypothesis. Balaban (1995), by using parametric and non-parametric tests, found that the Istanbul Stock Exchange (ISE) is neither weak-form nor semi-strong-form efficient. Balaban and Kunter (1997) reported significant deviations from the EMH. Demirer and Karan (2002) focused on the existence of the "daily effect" in the ISE and indicated the evidence on market anomalies which is inconsistent with EMH. Buguk and Brorsen (2003) tested the random-walk hypothesis for the ISE using its composite, industrial and financial indexes by employing a batter of unit root tests which provided conflicting results. By taking into structural shifts, Ozdemir (2008) found out that the ISE-100 composite index is characterized by a unit root, implying the validity of the EMH. Karan and Kapusuzoglu (2010) examined the random walk and overreaction hypothesis and indicated that the Turkish stock market is a weak efficient market. By employing nonlinearity and chaos theories, Ozer and Ertokatli (2010) examined the behavior of the ISE all share equity indices and they supported the existence of nonlinear structure and chaos in the ISE market.

The reason why a consensus has not been achieved may be attributed to either the employment of different periods for different markets which have varying development levels, or to the application of different methods that have various levels of restrictive assumptions. Recent studies have also shown that nonlinearity[1] in stock prices plays a crucial role in determining the behavior of stock markets. One of the recent tendencies in the EMH literature is the focus on accounting for the nonlinear process of financial series (Hsieh, 1991; Kim et al., 2008; McMillan, 2005; Shively, 2003). Therefore, the potential nonlinearities in financial time series should be taken into consideration to avoid misleading results (Hasanov, 2009). It is understood that the possible nonlinearities in the stock markets of developing countries have not been sufficiently

* Corresponding author. Tel.: +90 352 3240000; fax: +90 352 3240004.
E-mail address: onurgozbasi@gmail.com (O. Gozbasi).

[1] The transaction costs, market frictions, noise traders, short sales, the existence of bid-ask spreads, and corporate restrictive applications can cause nonlinearity (Hasanov and Omay, 2008; McMillan, 2003).

0264-9993/$ – see front matter
http://dx.doi.org/10.1016/j.econmod.2014.01.021

Table 1
Summary of the EMH literature on Turkey.

Study	Data	Methodology	Series	EMH
Balaban (1995)	January 04, 1988 August 05, 1994	Runs test OLS regression	ISE composite index	Reject
Balaban and Kunter (1997)	January 1989 July 1995	Granger causality	ISE composite index	Reject
Demirer and Karan (2002)	January 04, 1988 March 29, 1996	Kruskal Wallis Test Three way ANOVA	ISE composite index	Reject
Buguk and Brorsen (2003)	Weekly data 1992-1999	ADF unit root Fractional integration Variance ratio tests	ISE composite, industrial, and financial indexes	Accept
Ozdemir (2008)	January 1990 June 2005	Structural breaks unit root test ADF unit root Runs test Variance ratio test	ISE-100 index	Accept
Karan and Kapusuzoglu (2010)	2003–2007	Nonlinear programming model	21 firms' stocks in ISE-30 index	Accept
Ozer and Ertokatli (2010)	February 02, 1997 March 16, 2009	ADF unit root test BDS nonlinearity test Hinich bispectral test NEGM test	ISE-100 index	Reject

studied so far (Hasanov and Omay, 2007; Lim and Brooks, 2011; Lim and Liew, 2007).

This empirical paper re-examines the EMH for the Turkish stock market by means of recently developed time series methods within the context of a nonlinear framework. In this respect, we first question whether or not the Turkish stock market is characterized by linear or nonlinear behavior by employing the nonlinearity test developed by Harvey et al. (2008). After we found evidence on nonlinearity, we then proceed to testing the EMH by utilizing the nonlinear unit root tests recently proposed by Kruse (2011). This study shows evidence that the EMH is supported by the Turkish stock market.

Although Turkey has experienced rapid growth during the last decade, there are still limited studies investigating the behavior of Turkish stock market in the international literature. To the best of our knowledge, there is no study which applies nonlinear unit root methods for testing the EMH in the case of Turkish stock market.

2. Econometric methods

2.1. Linearity test

Harvey et al. (2008) proposed a linearity test that can be applied in cases that the unit root properties of data are unclear. If the time series is stationary (*I(0)*), the following model is estimated:

$$y_t = \beta_0 + \beta_1 y_{t-1} + \beta_2 y_{t-2}^2 + \beta_3 y_{t-3}^3 + \sum_{j=1}^{p} \beta_{4,j} \Delta y_{t-j} + \varepsilon_t \quad (1)$$

where p is the number of lags,[2] and Δ is the first difference operator. To test for the null hypothesis of linearity; ($H_{0,I(0)} : \beta_2 = \beta_3 = 0$) is tested against the alternative hypothesis of nonlinearity ($H_{1,I(0)} : \beta_2 \neq 0$ and/or $\beta_3 \neq 0$) by the use of Wald statistic defined as $W_0 = T(RSS_0^r / RSS_0^u - 1)$, where T is the number of observations, RSS_0^u and RSS_0^r are, respectively, the residual sum of squares from the unrestricted and restricted forms of the model (1). On the other hand, in cases when the series are non-stationary (*I(1)*), the regression model is:

$$\Delta y_t = \lambda_1 \Delta y_{t-1} + \lambda_2 (\Delta y_{t-1})^2 + \lambda_3 (\Delta y_{t-1})^3 + \sum_{j=1}^{p} \lambda_{4,j} \Delta y_{t-j} + \varepsilon_t \quad (2)$$

where the null hypothesis of linearity ($H_{0,I(1)} : \lambda_2 = \lambda_3 = 0$) is tested against the alternative hypothesis of nonlinearity ($H_{1,I(0)} : \lambda_2 \neq 0$ and/or $\lambda_3 \neq 0$) by the Wald statistics defined as $W_1 = T(RSS_1^r / RSS_1^u - 1)$ where RSS_1^u and RSS_1^r are the residual sum of squares from the unrestricted and restricted form of the model (2).

If the unit root characteristics of the series are unknown, it also becomes unclear which statistic (W_0 or W_1) will be used. The approach by Harvey et al. (2008) asymptotically chooses W_0 if the series is stationary and W_1 if the series is non-stationary. If the integration of the series is unknown, the weighted statistic – $W_\lambda = \{1 - \lambda\} W_0 + \lambda W_1$ – is applicable to test the null of linearity against the alternative of nonlinearity, where λ is some function that converges in probability to zero when the series is stationary and to one if the series is non-stationary. This simply implies that under the null of either *I(0)* or *I(1)* linearity, W_λ selects the efficient test in the limit, and is asymptotically distributed as chi-square with two degrees of freedom.

2.2. Nonlinear unit root test

The developments in the unit root literature show that time series are generated by nonlinear characteristics, and therefore it is important to take into account this information (nonlinear properties) for modeling and forecasting. In developing nonlinear unit root tests, the exponential smooth transition autoregressive (ESTAR) models are widely utilized to better understand the nonlinear properties of macro variables as well as a variety of financial series. Within the context of ESTAR specification in unit root testing, the Dickey–Fuller type test proposed by Kapetanios et al. (2003) is widely utilized. Their approach assumes that the location parameter in the smooth transition function is zero, which is difficult to hold in empirical analysis on financial series (see, for instance, Taylor et al., 2001; Rapach and Wohar, 2006).

Table 2
Linearity test.

Index	W_λ statistic
BIST-100 composite	34.01***
Industry	55.88***
Financial	27.95***
Services	25.77***

The critical values for χ_2^2 distributions: 9.21 (1%), 4.60 (10%), and 5.99 (5%).
*** Denotes 1% significance level.

[2] Harvey et al. (2008) recommend that it can be determined by means of the sequential testing method using a 10% significance level, after the suitable number of lags (p) is determined to be the maximum number of lags $p_{max} = \text{int}[8(T/100)^{1/4}]$.