Efficiency-Market Hypothesis: case of Tunisian and 6 Asian stock markets

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Efficiency-Market Hypothesis: case of Tunisian and 6 Asian stock markets

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Abstract

In this paper we test the weak form of the Efficient-Market Hypothesis (EMH) using monthly data of stock prices for the period from **2010M01** to **2019M07** for seven markets (Tunindex) in Tunisia and 6 Asian countries : Saudi Arabia (TSAI), Japon (Nikkei 225), China (SSEC), Turkey (BIST100), India (BSE30), and Indonesia (JKSE) by using linear and nonlinear (KSS and Modified KSS) unit root tests. Our empirical results indicate that the stock markets are **efficient** [not **efficient]** in the weak form of EMH in **Tunisia** and **Saudi Arabia** [**Japan**, **Turkey, India, Indonesia, and China**]. The **major policy implications** is that in these five countries (**Japan**, **Turkey, India, Indonesia,** and **China**), fund managers and investors can enjoy excess returns to their investment.

Key Words: Efficient-Market Hypothesis (EMH); BDS test; Linear Unit root test; Nonlinear Unit root test, Tunisia and 6 Asian countries.
JEL classification : G1, G12, G14, C22, C12.

I. Introduction

(Fama, 1970) identified three different types of market efficiency depending upon types of information available in the market. The **weak** form of market efficiency which uses information from the **past** and is known as Efficient Market Hypothesis **(EMH)** has received the most attention.

A market is said to be **efficient** if prices in that market reflect all available information, hence any shock to prices must be **permanent** and eventually follow a **random walk** process (be **non-**stationary). Stock market prices are no exception on this regard. If a nonstationary time series receives any shocks, it will not revert to its mean path (that automatic return to a normal trend do not occur). For the purpose of forecasting, such time series is of little practical value. Thus, it is a common practice to apply unit root test to share prices in order to test the **EMH**. When market is efficient, investors **cannot** enjoy excess returns to their investment.

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On the other side, **stationary** time series will tend to its mean (called mean reversion) and fluctuations around this mean.[2] For the purpose of forecasting, depending upon available information, such time series is of great practical value. A market is said to be **inefficient** if prices in that market are stationary. When markets are inefficient, investors **can** enjoy **excess returns** to their investment.

Different studies have applied different **standard** unit root tests to test the **EMH** and have provided mixed results. Examples include (Kemp & Reid, 1971), (Conrad & Juttner, 1973), (Ang & Pohlmam, 1978), (D'Ambrusio, 1980), (Gandhi, Sanders, & Woodward, 1980), (McInish & Pulisi, 1982), (Wong & Kwong, 1984), (Panas, 1990), (Groenewold & Kang, 1993), (Macdonald, 1994), (Dickinson & Muragu, 1994), (Fawson, Glover, Fang, & Chang, 1996), and (Gharbi & Halioui, 2014). More recently, to test EMH, (Bahmani, Chang, Chen, & Tzeng, 2016) paper applied quantile unit root test developed by (Koenker & Xiao, 2004).

The empirical problem encountered in unit root tests is about using the **right** test procedure. Not using the right test procedure leads to misleading test results. The unit root tests could be classified as linear and nonlinear in both time series and panel data. If the data are nonlinear dependent, then the linear unit root tests will face the problem of power. These test results will be biased towards the non-rejection of the null hypothesis (Cuestas & Garratt, 2011).

The main purpose of this study is to test the **EMH** in the stock markets of Tunisia (Tunindex) and 6 Asian countries : Saudi Arabia (TSAI), Japon (Nikkei 225), China (SSEC), Turkey (BIST100), India (BSE30), and Indonesia (JKSE) by using linear and/or nonlinear unit root test for monthly data over the 2000M01 to 2019M07 periods. The major policy implications of our empirical findings are that non-stationarity of share prices in the 2 out of 7 considered countries support the weak-form **EMH** and imply that fund managers and investors cannot enjoy excess returns from their investment in these two markets (i.e., Tunisia and Saudi Arabia).

The remainder of the paper is organized as follows. After a brief introduction (section I), section II describes the data and give some analysis. Section III describes BDS independence test and the KSS type nonlinear unit root tests. Section IV presents the empirical results. Section V concludes the paper and presents its policy implications.

II. Data Analysis

This study covers a total of 7 stock index (SP) series from Tunisia (Tunindex) and 6 Asian countries : Saudi Arabia (TSAI), Japon (Nikkei 225), China (SSEC), Turkey (BIST100), India (BSE30), and Indonesia (JKSE).[3] The data are collected for the period from **2000M01** to

[2] The moments of the statistical distribution of a **stationary** time series are time invariant that is, those remain same no matter at what point they are measured.

[3] The emerging countries are chosen on the basis of the availability of required data. The three largest economies of the world will be China, India and the United States respectively by 2050. Indonesia will be the fourth, Saudi Arabia the twelveth, and Turkey the fourteenth largest economy in the world by 2050 (PwC, 2015).

2019M07. All observations are monthly. the data are expressed in Logarithms.[4] The data are obtained from investing.com. The growth of the stock prices for 7 countries according to Months is given in **Figure 1**. These markets have been following a growth trend since 2000s except for Japan, and China. However, they have been following some downward during the global crisis in 2008-2009. Looking at **Figure 1**, trend evolution for stock prices in Tunisia, Turkey, India and Indonesia may be **linear**, while those for stock prices in Saudi Arabia, Japan, and China are propably **nonlinear**. In order to emphasize the linear or **nonlinear** nature of the data, BDS test will be used on adequately detrended series.

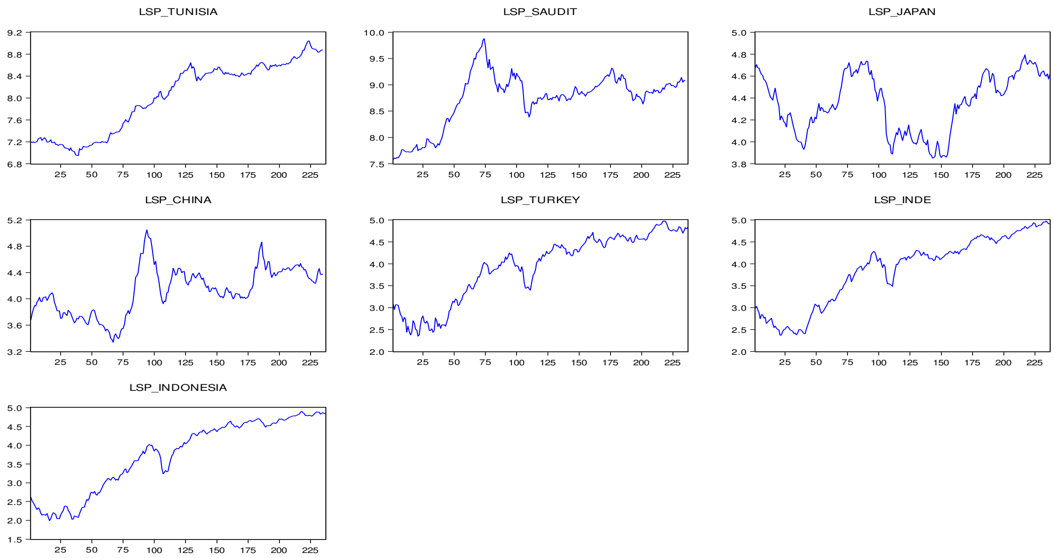

Figure 1: Stock price evolution in log (LSP) during 2000M01-2019M07 for Tunindex (Tunisia), TSAI (Saudi Arabia), Nikkei 225 (Japan), SSEC (China), BIST100 (Turkey), BSE30 BSE30 (India) and JKSE (Indonesia).

III. Methodology

1. BDS independence test

The most popular test for detecting nonlinearity is the (Brock, Dechert, Scheinkman, & LeBaron, 1996) (**BDS**) test, which is designed for testing the null hypothes of independent and identical distribution (i.i.d.) against a variety of possible deviations from independence including linear dependence, non-linear dependence, or chaos (nonlinearity and non-random chaotic dynamics).[5] One advantage of the **BDS** test that it is based on a statistic which requires no distributional assumption on the data to be tested. Moreover, (Barnett, et al., 1997) found that the **BDS** test is powerful against a wide range of linear and nonlinear alternatives. BDS test can then be used to detect the remaining dependence and the presence of nonlinear structure when it is applied to the detrended time series.

[4] The application of traditional unit root tests as the ADF and Phillips-Perron tests are less powerful and more size distorted when the data exhibit nonlinearity.

[5] The BDS test is a portmanteau test for time based dependence in a series.

The idea behind the test is fairly simple. If the observations of the series truly are i.i.d., then for any **pair of points**, the **probability** of the **distance** between these points being less than or equal to epsilon (ϵ) will be **constant**. We denote this **probability** by $C_{1,\epsilon}$. For multiple pairs of points, m consecutive points, the **joint probability** of every pair of points in the set of pairs of the form $\{\{y_t, y_s\}, \{y_{t+1}, y_{s+1}\}, \dots, \{y_{t+m-1}, y_{s+m-1}\}\}$ given an observation t, and an observations of a series y, satisfying the ϵ condition is denoted by $C_{m,\epsilon}$. Under the assumption of **independence**, this probability will simply be the product of the individual probabilities for each pair; $C_{m,\epsilon} = (C_{1,\epsilon})^m$. When working with sample data, we do not directly observe $C_{m,\epsilon}$ and $C_{1,\epsilon}$. We do not expect this relationship to hold exactly, but only with some error. *The larger the error, the less likely it is that the error is caused by random sample variation.* To estimate the probability for a particular dimension, we simply go through all the possible sets of that length that can be drawn from the sample and count the number of sets which satisfy the ϵ condition. The ratio of the number of sets satisfying the condition divided by the total number of sets provides the estimate of the probability. Given a sample of T observations of a series y, in mathematical notation this condition, can be easily stated and noted by $C_{m,T}(\epsilon)$.[6]

Given a time series y_t for t = 1, 2, 3, …, T, the BDS independence test statistic can be stated as (see (Bildirici & Turkmen, 2015) and (Zivot & Wang, 2003)):

$$BDS_{m,\epsilon} = \sqrt{T-m+1}\,\frac{C_{m,T}(\epsilon) - C_{1,T-m+1}(\epsilon)^m}{\sigma_{m,T}},$$

where $\sigma_{m,T}$ is the standart deviation of $\sqrt{T-m+1}\left(C_{m,T}(\epsilon) - C_{1,T-m+1}(\epsilon)^m\right)$. Under fairly moderate conditions the test converges in distribution to **N(0, 1).** Under the assumption of independence, we would expect this statistic to be close to **zero**. The null hypothesis of i.i.d. is rejected at the 5% significance level whenever $|BDS_{m,\epsilon}| > 1.96$.

2. Nonlinear Unit root tests

The application of traditional unit root tests as the **ADF** and Phillips-Perron (**PP**) tests are less powerful and more size distorted when the data exhibit nonlinearity. In this paper, we consider KSS type tests to study Efficient Market Hypothesis (**EMH**) via nonlinear unit root tests. Three statistics are presented in the following : **NLADF** (or **NLADFM** for demeaned data and **NLADFT** for de-trended data) and **CHLL** (or **MKSS** for original series).

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[6] $C_{m,T}(\epsilon)$ are referred by correlation integral which can be estimated as

$$C_{m,T}(\epsilon) = \frac{1}{T_m(T_m-1)}\sum_{m\le s<t\le T}\sum I_\epsilon(y_t^m, y_s^m),\ T_m = T-m+1,$$

where I_ϵ (.) is the indicator function which is equal to one if $|y_{t-i} - y_{s-i}| < \epsilon$ for i = 0, …, m-1 and zero otherwise for given distance ϵ.

a. KSS tests

(Kapetanios, Shin, & Snell, 2003) (hereafter KSS) extended the Augmented Dickey–Fuller (ADF) test to tackle the problem of traditional tests in case of nonlinearity in the Exponential Smooth Transition autoregressive (ESTAR) framework which is known as KSS or **nonlinear ADF (NLADF)** test. They state the null hypothesis of the presence of a unit root and hence is nonstationary against the alternative of globally stationary ESTAR process. The ESTAR model can be written as:

$$y_t = \beta y_{t-1} + \gamma y_{t-1}[1 - \exp(-\Theta y_{t-1}^2)] + \mathcal{E}_t \text{ , (1)}$$

Where

$$\mathcal{E}_t \sim i.i.d.(0, \sigma^2).$$

The null hypothesis of a unit root which in terms of the above model implies that $\beta = 1$ and $\Theta = 0$. The authors consider the following model:

$$\Delta y_t = \phi y_{t-1} + \gamma y_{t-1}[1 - \exp(-\Theta y_{t-1}^2)] + \mathcal{E}_t$$

in which $\phi = \beta - 1$, y_t is the **demeaned or de-trended** series of interest and $[1 - \exp(-\Theta y_{t-1}^2)]$ is the exponential transitional function.[7] In the above equation, if Θ is positive, it effectively determines the speed of mean reversion. In test procedures, specific parameter Θ is zero under the unit root null hypothesis (H_0: $\Theta = 0$) and positive under the globally stationary ESTAR alternative hypothesis (H_1: $\Theta > 0$). Since γ is not identified under the null, testing the null hypothesis H_0: $\Theta = 0$ directly is not feasible [(Davies, 1977)]. Therefore, using a first order Taylor series approximation, (Kapetanios, Shin, & Snell, 2003) obtained the following auxiliary regression:

$$\Delta y_t = \delta y_{t-1}^3 + v_t.$$

To handle the presence of **serial correlation in the error terms**, the above equation can be extended as follows

$$\Delta y_t = \boldsymbol{\delta} y_{t-1}^3 + \textstyle\sum_{j=1}^{p} \emptyset_j \Delta y_{t-j} + v_t, \text{ (2)}$$

where δ is the coefficient of interest for testing the presence of a unit root. (Kapetanios, Shin, & Snell, 2003) perform the KSS unit root test for H_0: $\boldsymbol{\delta} = \mathbf{0}$ against H_1: $\boldsymbol{\delta} < \mathbf{0}$ as the following *t*-test:[8]

$$\textbf{KSS} \equiv \textbf{NLADF} = \frac{\hat{\delta}}{\hat{\sigma}_{\hat{\delta}}}$$

(or **NLADFM** for demeaned data and **NLADFT** for de-trended data), where $\hat{\delta}$ and $\hat{\sigma}_{\hat{\delta}}$ are respectively, the estimated coefficient of δ and the estimated standard error of $\hat{\delta}$. The test statistic **NLADF** does not have an asymptotic standard normal distribution and therefore, (Kapetanios, Shin, & Snell, 2003) provided the critical values on p. 364 of their article.[9] If the

[7] When the data have non-zero mean such that $x_t = \mu + y_t$, the demeaned data $x_t - \overline{x}$, where $\overline{x}$ is the sample mean, is used to perform KSS test. When the data have non-zero mean and non-zero linear trend such that $x_t = \mu + \delta t + y_t$, the demeaned and de-trended data are obtained by $x_t - \hat{\mu} - \hat{\delta} t$, where $\hat{\mu}$ and $\hat{\delta}$ are the OLS estimators of μ and δ.

[8] The most common way of selecting an appropriate (optimal) lag structure is using information theoretic criteria such as the AIC, BIC, or HQ.

[9] In this paper, we use critical value calculated by STATA 15.

computed absolute value of the test statistic exceeds the critical values, the hypothesis H_0: $\boldsymbol{\delta} = \mathbf{0}$, will be **rejected** in which case the time series is said **stationary**.

b. Modified KSS test

The **nonlinear** unit root test developed by (Chong, Hinich, Liewand, & Lim, 2008) (hereafter CHLL) is a modified (an extended) form of unit root test developed by KSS (MKSS). The test is different from the KSS test as it was developed by adding **the cutting parameter and the trend** to the model to be used in the unit root test. The equation to be used for the test is as follows:

$$\Delta y_t = \mu + \phi D(trend) + \delta_3 y_{t-1}^3 + \sum_{j=1}^{p} \emptyset_j \Delta y_{t-j} + v_t \quad (3)$$

where y_t is the **original series** to be examined and $D(trend)$ is the trend variable and this variable can be in different forms. The trend variables used frequently are **linear** trend (t) and **nonlinear** trend variables (t^2). The null hypothesis for **nonstationarity** is H_0: $\boldsymbol{\delta_3}$ = 0 and the alternative hypothesis for stationarity is H_1: $\boldsymbol{\delta_3}$ < 0. The test statistics is the test statistics of the $\boldsymbol{\delta_3}$ parameter as it is the case with the conventional ADF test mentality. Since the asymptotic distribution of the *t* statistic in this case is also unknown, the corresponding critical values are simulated by (Chong, Hinich, Liewand, & Lim, 2008) from 5000 replications of various sample sizes. The resulting critical values are given in **Table A 4** see Appendix.

IV. Findings

This study covers a total of 7 stock index series from Tunisia (Tunindex) and from 6 Asian countries : Saudi Arabia (TSAI), Japon (Nikkei 225), China (SSEC), Turkey (BIST100), India (BSE30), and Indonesia (JKSE) during the period 2000M01-2019M07 (A total of T = 235 monthly data points for each country).

The empirical problem encountered in unit root tests is about choosing the right test procedure; linear or nonlinear tests.[10] Prior analysis to unit root tests have to be done. To test the null hypothesis of linearity against the alternative of non-linearity, we can employ the test of (Harvey, Leybourne, & Xiao, 2008). This investigation is beyond the scope of this study. In this paper, we use rather the most popular test for detecting linearity or nonlinearity, the (Brock, Dechert, Scheinkman, & LeBaron, 1996) (BDS) test, which is designed for testing the null hypothes of independent and identical distribution (i.i.d.) against a variety of possible deviations from independence (including linear dependence, non-linear dependence, or chaos).

Table 1 indicates that all the BDS independence test statistics are significantly greater than the critical values. Thus, the null hypothesis of i.i.d. is rejected at 1% significance level. The results strongly suggest that the **detrended series** are linearly or non-linearly dependent at all dimensions. Then, in addition to some conventional unit root tests (ADF, ERS, PP, and 'KPSS'), three KSS type tests (NLADFT, NLADFT, and CHLL or MKSS) will be applied.

[10] Not choosing the right test procedure leads to misleading test results.

For comparison purpose, we first apply the following four conventional unit root tests – ADF, ERS,[11] PP and 'KPSS' tests.

Table A 2 and **Table A 3** (in Appendix) present the results from the most commonly used tests of the unit root in time-series, the ADF, ERS, and PP (KPSS) unit root tests (stationarity test) for the level series. Due to capture different possibilities in the data generating process, this study apply the tests for both, with constants and with constants and trend terms in the test equations. The tests are designed to test the null hypothesis of a unit root against the alternative that the series is stationary.[12] However, in **Table A 2** the traditional **ADF** and **ERS** test results show that for **only** one country, **China**, the null hypothesis of the presence of a unit root is **rejected** at the 10% level of significance when only a constant term was included in the model. When a constant and a linear trend were incorporated as the deterministic term, it is apparent that the null hypothesis of nonstationarity is also rejected at 5% level of significance for China.[13] The results in **Table A 3** clearly indicate that the PP tests fail to reject the null of non-stationarity in stock prices in all 7 countries and **KPSS** test also get similar results **except for Japan**, indicating that stock price are non-stationary in these countries **except Japan**. Therefore, for the countries included in this study, the overwhelming evidence of nonstationarity in levels is supported.

Table 1: BDS test Results for **detrended** data.[14]

BDS test statistics	**Dimension (m)**	**2**	**3**	**4**	**5**	**6**
TUNISIA		44.95941	47.73589	50.87358	55.31468	61.33875
INDE		32.00727	33.65017	35.60807	38.43465	42.25067
SAOUDI		29.68288	31.36663	33.34180	36.12406	39.97385
INDONESIA		24.19647	25.22001	26.45321	28.25699	30.80560
JAPAN		39.93688	42.34326	45.06548	48.95249	54.18106
TURKEY		26.05540	27.04639	28.34752	30.15614	32.67595
CHINA		30.61082	31.94517	33.55075	36.00197	39.29527

Note : Critical value are those of Normal distribution. This is an output from Eviews 10.

Table 2 and 3 present the results from **Non-Linear ADF** (NLADF) tests of the unit root in time-series, the NLADFM for demeaned data and NLADFT for de-trended data and CHLL (or MKSS for original series).

Table 2 reports the results of **non-linear ADF** [KSS or NLADF : NLADFM for demeaned data (Panel A) and NLADFT for de-trended data (Panel B)] tests. The KSS test results show that for two countries (**Turkey** and **China**) in the case of NLADFM and only for one country (**Turkey**)

[11] ERS : Elliott-Rothenberg-Stock point optimal test.

[12] These tests are not very efficient tests because sometimes exhibit less power and more size distortion. The size distortion could result from excluding moving average (MA) components from the model or if the model is not appropriate.

[13] But null hypothesis of nonstationarity is not rejected even at 1% level of significance when no constant nor a linear trend were incorporated as deterministic term. This result is not reported in the Table.

[14] It is applied to the detrended time series (nonlinear trend for all except linear trend for China).

in the case of NLADFT, the null hypothesis of the presence of a unit root is **rejected**. That means for the two countries, **Turkey and China**, the stock price index series are **stationary** and they exhibit asymmetric or nonlinear mean reversion. However, in almost all of these countries where the series on stock price exhibit upward trends, the unit root tests based on NLADFT are more relevant.[15]

Table 2 – KSS Nonlinear unit root test results for level Stock Price series in log.

Panel A : Demeaned data (**NLADFM** test statistic).

	Criteria	Lags	KSS	p-value	1% cv	5% cv	10% cv	Conclusion
TUNISIA	AIC	8	-0.535	0.900	-3.520	-2.947	-2.658	Ho
	SIC	3	-2.068	0.302	-3.462	-2.905	-2.624	Ho
INDE	AIC	8	-0.626	0.888	-3.520	-2.947	-2.658	Ho
	SIC	2	-1.769	0.468	-3.462	-2.905	-2.624	Ho
SAOUDI	AIC	7	-0.253	0.931	-3.520	-2.947	-2.658	Ho
	SIC	4	-1.044	0.808	-3.462	-2.905	-2.624	Ho
INDONESIA	AIC	6	-1.398	0.683	-3.520	-2.947	-2.658	Ho
	SIC	2	-2.452	0.147	-3.462	-2.905	-2.624	Ho
JAPAN	AIC	8	-1.715	0.511	-3.520	-2.947	-2.658	Ho
	SIC	3	-2.596	0.107	-3.462	-2.905	-2.624	Ho
TURKEY	AIC	6	-3.860	**0.003**	-3.520	-2.947	-2.658	**SL2**
	SIC	2	-5.487	**0.000**	-3.462	-2.905	-2.624	**SL2**
CHINA	AIC	3	-3.046	**0.039**	-3.520	-2.947	-2.658	**SL2**
	SIC	3	-3.046	**0.034**	-3.462	-2.905	-2.624	**SL2**

Note : NLADF is based on OLS demeaned data. KSS test for Unit root hypothesis vs Ha: Stationary (**SL2**) nonlinear ESTAR model. Critical value for different levels are given by **STATA**. SL2 ≡ stationary process (rejection of unit root hypothesis). H_O ≡ no rejection of unit root hypothesis.

Table 2 (suite) Nonlinear unit root test results for level Stock Price series in log.

Panel B : Detrended data (**NLADFT** test statistic).

	Criteria	Lags	KSS	p-value	1% cv	5% cv	10% cv	Conclusion
TUNISIA	AIC	4	-2.894	0.162	-3.993	-3.418	-3.125	Ho
	SIC	4	-2.894	0.146	-3.909	-3.350	-3.067	Ho
INDE	AIC	3	-2.423	0.363	-3.993	-3.418	-3.125	Ho
	SIC	1	-2.182	0.477	-3.909	-3.351	-3.068	Ho
SAOUDI	AIC	1	-1.648	0.776	-3.993	-3.418	-3.125	Ho
	SIC	1	-1.648	0.765	-3.909	-3.350	-3.067	Ho
INDONESIA	AIC	3	-2.755	0.211	-3.993	-3.418	-3.125	Ho
	SIC	1	-2.642	0.239	-3.909	-3.351	-3.068	Ho
JAPAN	AIC	1	-1.986	0.608	-3.993	-3.418	-3.125	Ho
	SIC	1	-1.986	0.591	-3.909	-3.351	-3.068	Ho

[15] The nonlinear unit root test described above are sensitive to the choice of lag length *p* for augmenting unit root regressions in the presence of serial correlation (2). If *p* is too small then the remaining serial correlation in the errors will bias the test. If *p* is too large then the power of the test will suffer. Optimal choice is based on AIC and SIC.

TURKEY	AIC	3	-3.504	**0.040**	-3.993	-3.418	-3.125	**SL2**
	SIC	1	-3.476	**0.036**	-3.909	-3.351	-3.068	**SL2**
CHINA	AIC	4	-2.894	0.162	-3.993	-3.418	-3.125	Ho
	SIC	4	-2.894	0.146	-3.909	-3.350	-3.067	Ho

Note : NLADFT is based on OLS detrended data. KSS test for Unit root hypothesis vs alternative of Stationary nonlinear ESTAR model. Critical value for different levels are given by **STATA 15**. SL2 ≡ stationary process (rejection of unit root hypothesis). H_O ≡ no rejection of unit root hypothesis.

Table 3 reports the results of **non-linear ADF** [MKSS or CHLL] tests. The CHLL test results show that for three countries (**Tunisia, Saudi Arabia,** and **Japon**), the null hypothesis of the presence of a unit root is **not rejected**. That means for the remainder countries, **China, Turkey, India, and Indonesia**, the stock price index series are **stationary** and they exhibit asymmetric or nonlinear mean reversion.

Our empirical results indicate that the stock markets are **efficient** in the weak form for all markets except **Turkish, Indian, Indonesian, and Chineese** stock markets. The results imply that in three countries (**Tunisia**, **Saudi Arabia**, and **Japan**) one cannot enjoy excess returns to their investment.

Table 3 : HCLL Nonlinear unit root test results for level Stock Price series in log. [16]

Original data (**MKSS** test statistic)

	Trend	Lags	CHLL	10% cv	5% cv	1% cv	Conclusion
TUNISIA	Linear	1	-2.123139	-3.03	-3.31	-3.90	Ho
	Nonlinear	1	-0.653504	-3.06	-3.39	-3.96	Ho
INDE	Linear	3	**-3.949992**	-3.03	-3.31	-3.90	**SL2**
	Nonlinear	3	-2.057446	-3.06	-3.39	-3.96	Ho
INDONESIA	Linear	2	**-3.540730**	-3.03	-3.31	-3.90	**SL2**
	Nonlinear	2	-1.178806	-3.06	-3.39	-3.96	Ho
TURKEY	Linear	3	**-3.419387**	-3.03	-3.31	-3.90	**SL2**
	Nonlinear	3	-1.676903	-3.06	-3.39	-3.96	
CHINA	Linear	4	**-3.874825**	-3.03	-3.31	-3.90	**SL2**
	Nonlinear	4	**-3.656439**	-3.06	-3.39	-3.96	**SL2**
SAOUDI	Linear	8	-2.548350	-3.03	-3.31	-3.90	Ho
	Nonlinear	8	-2.530498	-3.06	-3.39	-3.96	Ho
JAPAN	Linear	1	-2.207859	-3.03	-3.31	-3.90	Ho
	Nonlinear	6	-2.231022	-3.06	-3.39	-3.96	Ho

Note : SL2 ≡ stationary process (reject of unit root hypothesis). SL2 ≡ stationary process (rejection of unit root hypothesis). Ho ≡ no rejection of unit root hypothesis. This Table is done by **Eviews 10**.

V. Conclusion

Unlike previous research that relied upon standard unit root tests, in this paper we test the weak form efficient-market hypothesis (EMH) using linear and nonlinear unit root tests for monthly

[16] Critical value (cv) are from **Table A 4** given in Appendix for different size sample.

data form stock markets of 7 countries [Tunisia and 6 Asian countries (Saudi Arabia, Japon, China, Turkey, India, and Indonesia)] over the period 2000M01–2019M07.

Based on **standard** unit root tests, only **Japeneese** (**PP**) and **Chineese** (**ADF**) stock markets which are found to be stationary. Since the **BDS** test results strongly suggest that the series are non-linearly dependent at all dimensions, three **KSS** type tests (NLADFT, NLADFT, and **CHLL** or MKSS) are applied. All unit root test results are summed up at **Table 4** here after**.**

The empirical findings from the nonlinear KSS unit root test (NLADFT) results using de-trended series, shows that the null hypothesis of nonstationarity is **rejected** in 1 out of the 7 considered countries indicating asymmetric mean reversion and nonlinear stationarity in only **Turkish** stock market. While KSS unit root test (NLADFM) results using de-demeaned series, shows that the null hypothesis of nonstationarity is **rejected** in **Turkish** and **Chineese** stock markets.

Our empirical results from **CHLL** test indicate that only **Tunisia, Saudi Arabia,** and **Japon** stock markets which are **nonstationary**. **Stationarity** of share prices in the remaining four countries (**Turkey, China, India,** and **Indonisia**) do not support the weak-form of **efficient** market hypothesis and imply that fund managers and investors cannot enjoy excess returns from their investment in these Three markets (i.e., **Tunisia, Saudi Arabia,** and **Japon**).

Looking at **Table 4**, the **major policy implications** of our empirical findings are that stationarity of share prices in the 5 out of 7 considered countries do not support the weak-form of **EMH** and imply that fund managers and investors can enjoy excess returns from their investment in these five markets (i.e., **Japan, Turkey, China, India,** and **Indonisia**).

Table 4: Sum up of unit root test results.

	Tunisia	**Saudi Arabia**	**Japon**	**Turkey**	**China**	**India**	**Indonesia**
Linear tests							
PP							
ERS					**SL2**		
ADF					**SL2**		
KPSS			**SL2**				
Nonlinear KSS type tests							
NLADFM				**SL2**	**SL2**		
NLADFT				**SL2**			
CHLL				**SL2**	**SL2**	**SL2**	**SL2**

Source: Article calculations. SL2 ≡ stationary process (rejection of unit root hypothesis). Empty case is for no rejection of H_0 of unit root hypothesis.

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Appendix: Tables

Table A 1 ： Summary statistics for level Stock price series in log.

	INDONesia	INDE	JAPAN	TURKEY	CHINA	SAUDI	TUNISIA
Mean	3.739688	3.852724	4.353861	3.927799	4.127702	**8.734066**	**8.013999**
Std. Dev.	0.951279	0.787164	0.268762	0.768437	0.359989	0.509756	0.637094
Skewness	-0.511109	-0.518956	-0.259020	-0.637723	-0.044209	-0.709201	-0.294686
Kurtosis	1.798908	1.966238	1.798314	2.082022	2.466570	2.985356	1.537809

Obs	237	237	237	237	235	235	235
J-B	24.56456	21.19102	16.91010	24.38578	2.862748	19.70160	24.33585
Prob	0.000005	0.000025	0.000213	0.000005	**0.238980**	0.000053	0.000005

Table A 2 : Linear unit root test (**ADF and ERS**) results for **level** Stock Price series in log.

		ADF						
		TUNISIA	**SAUDI**	**CHINA**	**INDONE**	**INDE**	**JAPAN**	**TURKEY**
With Constant	**t-Stat**	-0.3047	-2.1802	-2.7686	-0.8804	-0.7642	-1.8401	-0.7519
	Prob.	0.9208	0.2142	**0.0644**	0.7932	0.8267	0.3604	0.8301
		n0	n0	*	n0	n0	n0	n0
With Constant & Trend	**t-Stat**	-1.5072	-1.9005	-3.6456	-2.1246	-2.5910	-2.1951	-2.4248
	Prob.	0.8247	0.6511	**0.0282**	0.5289	0.2849	0.4897	0.3657
		n0	n0	**	n0	n0	n0	n0
		ERS TEST						
		TUNISIA	**SAUDI**	**CHINA**	**INDONE**	**INDE**	**JAPAN**	**TURKEY**
With Constant & Trend	**stat**	30.34579	30.52912	**2.521297**	13.19042	10.07097	23.99767	10.35539
		n0	n0	**	n0	n0	n0	n0

Note : ERS : Elliott-Rothenberg-Stock point optimal test statistic, critical value : for 1% level, 5% level, 10% level are repectively **4.033350, 5.652600, and 6.865550**. n0 ≡ Ho.

Table A 3 : Linear unit root test (PP and KPSS) results for **level** Stock Price series in log.

		UNIT ROOT TEST TABLE (PP)						
		CHINA	**INDONE**	**INDE**	**JAPAN**	**TURKEY**	**TUNISIA**	**SAUDI**
With Constant	**t-Stat**	-2.3088	-0.6351	-0.4903	-1.8321	-0.7743	-0.3982	-2.2286
	Prob.	0.1700	0.8590	0.8894	0.3643	0.8240	0.9060	0.1968
		n0	n0	n0	n0	n0	n0	n0
With Constant & Trend	**t-Stat**	-2.7495	-2.1565	-2.4761	-2.1117	-2.4405	-1.7625	-1.9835
	Prob.	0.2179	0.5112	0.3398	0.5362	0.3577	0.7199	0.6069
		n0	n0	n0	n0	n0	n0	n0
		KPSS TEST						
		CHINA	**INDONE**	**INDE**	**JAPAN**	**TURKEY**	**TUNISIA**	**SAUDI**
With Constant	**t-Stat**	0.9422	1.8008	1.8852	**0.3087**	1.8441	1.9319	0.7852
	Prob.	***	***	***	**n0**	***	***	***

Note : n0 ≡ Ho.

Table A 4: The Simulated Critical Values of modified KSS statistic, MKSS (t).

Sample Size	**Specification of Trend**					
	Linear (trend)			**Nonlinear (trend ^{2})**		
	10%	5%	1%	10%	5%	1%
25	-3.10	-3.42	-4.33	-3.13	-3.50	-4.31
50	-3.06	-3.38	-4.05	-3.10	-3.44	-4.07
100	-3.05	-3.35	-3.96	-3.07	-3.40	-4.02
200	**-3.03**	**-3.31**	**-3.90**	**-3.06**	**-3.39**	**-3.96**

400	-3.00 -3.29 -3.89	-3.04 -3.35 -3.94
800	-2.99 -3.29 -3.88	-3.04 -3.35 -3.94