*Finans Ekonomi ve Sosyal Araştırmalar Dergisi Cilt5/Sayı3* *Makale Geliş Tarihi: 17.07.2020*
*Research of Financial Economic and Social Studies (RFES)* *Makale Yayın Tarihi: 30.09.2020*
*ISSN : 2602 – 2486* *DOI : 10.29106/fesa.770660*

# DOES EXCHANGE RATE FOLLOW THE WEAK-FORM MARKET EFFICIENCY IN NEXT 11 COUNTRIES? EVIDENCE FROM COMPREHENSIVE UNIT ROOT TESTS

# GELECEK 11 ÜLKELERİNDE DÖVİZ KURU ZAYIF FORM PİYASA ETKİNLİĞİNİ TAKİP ETMEKTE MİDİR? KAPSAMLI BİRİM KÖK TESTLERİ İLE KANITLAR

***Mehmet Levent ERDAŞ*** [*]
***Gamze GÖÇMEN YAĞCILAR*** [**]

**Abstract**

The purpose of this study is to investigate the validity of weak-form market efficiency by using linear and nonlinear unit root tests of the US Dollar exchange rate of the Next 11 countries over the period of January 1998-December 2019. For this purpose, we firstly performed the Harvey et al. (2008) linearity test to determine the characteristics of the series. Afterward, Kwiatkowski et al. (1992), Zivot-Andrews (1992) and Lee-Strazicich (2013) tests were applied to linear series while Kapetanios et al. (2003) and Kruse (2011) tests were performed to nonlinear series. Generally, the findings indicate that the validity of the weak-form market efficiency is accepted for the Next 11 countries' exchange rates. Accordingly, it can be asserted that in the majority of the Next 11 countries, the future prices of the exchange rates cannot be estimated by evaluating its historical prices. The obtained results suggest that temporary shocks in the exchange rate leave permanent effects in the majority of Next 11 countries.

**Keywords:** Efficient Market Hypothesis, Weak-Form Market Efficiency, Exchange Rate, Linear and Nonlinear Unit Root Tests, Next 11 Countries

**JEL Codes:** C22, F30, F31, G10, G14, G15

**Özet**

Bu çalışmanın amacı, Ocak 1998-Aralık 2019 dönemi için Gelecek 11 ülkelerin Dolar kurlarına doğrusal ve doğrusal olmayan birim kök testleri uygulanarak zayıf form piyasa etkinliğinin geçerliliğini araştırmaktır. Bu amaçla serilerin özelliklerini belirlemek için ilk olarak Harvey vd. (2008) doğrusallık testi uygulanmıştır. Ardından, doğrusal olan döviz kuru serileri için Kwiatkowski vd. (1992), Zivot-Andrews (1992) ve Lee-Strazicich (2013) birim kök testleri; doğrusal olmayan döviz kuru serileri için Kapetanios vd. (2003) ve Kruse (2011) birim kök testleri uygulanmıştır. Genel olarak bulgular, Gelecek 11 ülkelerinin döviz kurları için zayıf form piyasa etkinliğinin geçerli olduğunu göstermiştir. Dolayısıyla, Gelecek 11 ülkelerinin çoğunda, geçmiş fiyat hareketlerinden yola çıkılarak döviz kurunun gelecek fiyatlarının tahmin edilemeyeceği söylenebilir. Elde edilen sonuçlar döviz kurundaki geçici şokların Gelecek 11 ülkelerinin çoğunda kalıcı etkiler bıraktığını göstermektedir.

**Anahtar Kelimler:** Etkin Piyasa Hipotezi, Zayıf Form Piyasa Etkinliği, Döviz Kuru, Doğrusal ve Doğrusal Olmayan Birim Kök Testleri, Gelecek 11 Ülkeleri

**Jel Kodu:** C22, F30, F31, G10, G14, G15

[*] Ass. Prof. Dr., Akdeniz University, Faculty of Serik Business Management, Department of Economics and Finance, leventerdas@gmail.com, ORCID: 0000-0001-6594-4262

[**] Ass. Prof. Dr., Suleyman Demirel University, Faculty of Economics and Administrative Sciences, Department of Banking and Finance, gamzeyagcilar@sdu.edu.tr, ORCID: 0000-0002-5009-4696

## 1. Introduction

The main factors which make individuals and institutions to economize and to make transactions in financial markets are return expectations. However, the market risks can change the transaction motivation as they affect the return expectations. Since uncertainty is one of the main factors posing risks to investments, investors have been trying to produce new techniques to decrease that kind of uncertainty and to earn abnormal profits by predicting prices in advance. The question is then "Are the prices predictable?". One of the theories developed within this context is the efficient market hypothesis (EMH).

Testing the different forms of EMH is one of the operations which have been continuing to be relevant since 1970 when Fama proposed some evidence related to the validity of it. The possible reason why the hypothesis has aroused such interest is that it suggests that if it is valid, investors cannot be beat the markets and no investor can earn abnormal profits. When it is considered that the main way followed by the investors who try to earn speculative profits from financial markets is taking advantages of previous prices to predict the current prices by depending on several technical analysis methods; weak-form market efficiency can mean that all of those efforts are only a waste of time. Therefore, the discussions on which markets and to what extent the hypothesis is valid for are one of the attractive research objects today.

EMH, which suggests that all kind of information which can affect the prices reaches to all market participants at an equal rate and is reflected the prices by being similarly interpreted by all investors through several assumptions, is generally based on random walk. According to Levy (1967); if share markets are competitive actively, the consecutive price changes are expected to be random (i.e. statistically independent). Random walk was first formulized by Bachelier (as cited in Levy, 1967) and was clarified by Osborne (as cited in Levy, 1967). Samuelson (1965a; 1965b) provided significant contributions to develop the model. Fama claimed in his study in 1965 that; prices can move randomly only in an active market, the market prices thus can reflect the intrinsic value of shares or they at least are randomly close to the intrinsic value and the intrinsic value changes independently from previous price changes through new information (Fama, 1965: 56). Therefore, the random walk behavior is a basis applied to explain the market activity in empirical studies.

Random walk suggests that the prices are independent of the previous ones and it is impossible to predict the current or future prices with the help of previous data. According to Gupta and Basu (2007), to test the market efficiency, it is essential to investigate the short-run trends of market returns and to try to determine the main processes which introduce those returns. If the market is efficient, the model will fail to identify any pattern and it will mean that the returns follow a random walk and they cannot be predicted. Several methods are used to evaluate the independence of price trends, and the method which is observed to be the widest is testing stationarity through unit root tests. Firoj and Khanom (2018) indicated that market data should follow the random walk to be able to mention the weak-form market efficiency and that it is related to the fact that time series contain unit roots, i.e. they are not stationary. According to Zhang et al. (2012), the fact that whether prices are determined or not through unit roots has an important inference about EMH which suggests that it is not possible to predict the prices through previous price changes. If the prices follow a stationary I(0) process at the level, the effect of any kind of shock will be temporary. Thus, the trends of prices from a level to another level will return to the average. From the investors' perspective, it means that it is possible to estimate future price trends through previous data and to develop strategies to earn abnormal profits (Zhang et al., 2012). The price series I(1) should follow the process, i.e. they should contain unit roots to be able to mention weak-form market efficiency, and it indicates that the incoming shocks make lasting impacts on the stochastic component (Wang et al., 2015: 157).

There are several economic results in determining the degree of market efficiency. Rizvi and Arshad (2017) indicated that the policy-makers can avoid the improper resource distribution which has negative effects on long-run economic development. This is because; at the time all of the relevant data are revealed and they join in the prices of financial assets, the new capital will incline to more productive investments (Khediri and Charfeddine, 2015: 67). Ali et al. (2018) suggested that the profits to be demanded against the potential risk in the non-efficient market will also be higher, and they claimed that the decision-making periods of the institutions responsible for the supervision of the business managers and capital markets will be affected by the market efficiency.

The exchange rate has been figured to be important for developing countries particularly open economies such as Next 11 countries which are qualified by mainly concentrated export sector and have emerging markets that could potentially become some of the world's largest economies. The exchange rate represents the policy-makers which investors, firms, governments, financial institutions, and trader's currencies (Ibrahim et al., 2011: 55). Also, in these countries, the highest volatility of the exchange rate affects the national and international investment position and caused to be negative in the real economy (Mabakeng and Sheefeni, 2014: 169). US Dollar is preferred as the exchange rate since it is used for the international processes, it is the most preferred international payment currency and it has the highest liquidity. To this effect, this study focuses on the announcement impact of historical price on exchange rates. The weak-form market efficiency of exchange rates in these countries is analysed by using comprehensive unit root tests. Although many researching works have been analysed on the efficiency of the exchange rate in developed markets, little is known about those markets in the developing markets. The main of this study is to explore the validity of the weak-form market efficiency in the Next 11 countries and its dollar exchange rates. This paper emphasized only on the weak-form of the dollar exchange rates of Next 11 countries. To the best of our knowledge, it is the first study in which validity the weak-form of the EMH in terms of the RWH in the Next 11 countries' exchange rates are analysed through the linear and nonlinear unit root tests. Accordingly, this research contributes to the existing literature on the weak-form efficiency of the Next 11 countries' exchange rates.

With the motivation and objective in place, the rest of the paper is structured as follows. Section 2 briefly describes the existing literature relating to the validity of the weak-form market efficiency. Testing procedures are outlined and briefly defines linear and nonlinear unit root tests in Section 3. Section 4 outlines the data description and the obtained empirical results. The conclusions and the policy related to the implication and future studies are presented in Section 5.

## 2. Literature Review

In literature, EMH and RWH are analysed by parametric and nonparametric tests. Unit root tests are tests carried out to determine the stationarity of the time series. It has been observed that these tests are generally used in the studies which are carried out to prove which theoretical study explaining the validity of the weak-form market efficiency in the exchange rate markets is valid. It has been also observed that the results are different according to the samplings and methods they used in the relevant literature.

Jensen (1978) suggested that there is not another proposal which is supported as EMH with empirical proofs and it provide consistent results for the whole country and market groups; and author also indicated that this kind of consistency started to be destroyed due to the accessibility of the better data such as daily price data and newly-developed econometric methods. So indeed it is not possible to say that consistent results are provided after analysing the current studies. It can be as a result of the econometric methods used in the studies or the development levels of the markets.

Tests related to EMH can be applied to all markets of the relevant country and different market segments. For example; Charles et al. (2013) tested the relationship between spots and forward prices in the European Carbon Markets through the transportation costs model. It was observed in the study which was carried out by using data between the period 13th March 2009 and 17th January 2012 that there is a cointegration relationship between forward prices and spots and the result did not change when the structural breaks were considered. According to those results, the transportation costs model was rejected, it was discovered that the carbon market is not efficient and it was determined that there is an opportunity for arbitrage. Tang et al. (2013) used unit root tests, cointegration tests, and error correction model to analyse the efficiency of European carbon futures market; Zhao et al. (2017) employed ADF test and runs test to examine the efficiency of carbon emission market in China; Jebabli and Roubaud (2018) used Hurst exponent and threshold vector error correction model to determine the weak-form market efficiency in terms of daily spots and futures prices in the USA food and energy markets.

Khediri and Charfeddine (2015) evaluated the weak-form market efficiency for energy markets by testing random walk behaviors of spots and futures prices. The data they used include crude oil, petrol, heating oil, and propane daily closing prices of NYMEX spot and future markets. They used the variance ratio test and the DFA test. The results indicated that the profits change in time. Besides, they concluded that energy markets follow a random walk and they are efficient in weak-form.

Charfeddine et al. (2018) tested the Adaptive Market Hypothesis in the markets of the USA, England, South Africa, and India. They used the GARCH-M model to analyse them through the approaches that allow weak-form market efficiency to change in time. Their results indicate that the efficiency of those markets change in time depending on economic and politic developments and market conditions. They also concluded that the level of weak-form efficiency increases gradually and the most efficient market among four bond markets is the USA market.

Among the studies analysing precious metals market, Westerlund (2013) used the monthly ounce prices of four precious metals between January 2000 and July 2012 and studied the efficiency of the precious metals markets of specific Asian countries and additionally Australia, Hong Kong and New Zealand through the unit root test he/she developed himself/herself. Nitm et al. (2015) used the LM variance ratio test and its non-parametric version based on ranks and signs to study the efficiency of gold markets of 28 developed and developing countries between January 1968 and August 2014. They concluded that it is more possible for developed markets to be efficient. When the share markets are considered, different results are observed and the prices are predictable in the markets, i.e. the markets are non-efficient in most of the analysed studies.

Freund et al. (1997) used R/S and Hurst exponent model in their study where they studied whether market efficiency changes once the electronic trade starts in Toronto Exchange. The results indicate that the profits are not random, they create a model following a trend in short-run and they return to the average in a longer run.

Worthington and Higgs (2006) tested the market efficiency for Australia, New Zealand, and thirteen Asian countries by using serial correlation, Augmented Dickey-Fuller (ADF), Phillips-Perron (PP) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) unit root tests and variance ratio test. Serial correlation and run tests rejected weak-form efficiency for all markets and the unit root tests rejected it for the markets except Australia and Taiwan. The variance ratio test concluded that no market follows a random walk.

Hasanov and Omay (2007) used linear and non-linear unit root tests for the share prices in the eight transition countries and determined that linear unit root tests can provide more successful results. They concluded that the markets of the four of the eight countries are not efficient. Gupta and Basu (2007) concluded that share markets in India are not efficient by using ADF, PP and KPSS tests. Tabak (2007) studied the bilinear models which constitute the majority of the non-linear models. Accordingly, discovering that the profits are not linear is provided as proof for market non-efficiency. The unit root determination hypothesis for 35 of 53 shares in Brazil Sao Paolo index was accepted.

The results obtained by Pele and Voineagu (2008) through the ADF unit root test, autocorrelation test, and ARMA model revealed that EMH is not valid for the share market of Romania. Tas and Tokmakcıoglu (2010) researched the market efficiency in 11 developing share markets through the cointegration test. As a result of the analysis, the VECM was found to be insufficient to explain the determination of market efficiency although two cointegrated vectors were determined. Demireli et al. (2010) tested the EMH for S&P500. In the study which was carried out through weekly logarithmic profits, the unit root tests and correlograms indicated that the S&P500 profit series are stationary and the ARMA test indicated that the profit series do not have a significant relationship with the previous period. The authors concluded that the index provides a random process and it is efficient in weak-form.

Nisar and Hanif (2012) applied the comprehensive analysis such as autocorrelation runs ADF unit root, and variance ratio tests on monthly, weekly and daily data from share markets of the biggest four South Asian countries. Even though Runs test provides different results for different markets and frequencies, all of the other tests reject the EMH for all of the markets. Zhang et al. (2012) indicated that exchange indexes of five African countries are not stationary through ADF, PP and KPSS unit root tests and different panel unit root tests. When the structural breaks were considered through panel SURKSS test with a Fourier function, markets of two countries were discovered to have stationary series.

Ananzeh (2014) studied the market efficiency of Amman Exchange through autocorrelation, unit root, and runs tests. The results of the study which was carried out through profit series revealed that the market is not efficient in weak-form. Lee et al. (2014) tested market efficiency through non-linear panel unit root tests for different country groups by using real share prices. The results indicated that the stationarity levels change depending on the regional and economic development levels. Shiller and Radikoko (2014) used parametric and non-parametric tests in addition to univariate unit root tests through daily profits of seven indexes in their study where they analysed the market efficiency in Canada Exchange market. Accordingly, the RWH was rejected and it was concluded that the market is not efficient in weak-form and market profits can be predictable. Tiwari and Kyophilavong (2014) concluded that the series is stationary in all countries except Russian Federation and they can be predictable by analysing previous data in their study which they studied BRICS countries by using wavelet-based unit root tests which also consider structural breaks.

Wang et al. (2015) indicated that the share prices in seven Asian markets are not stationary by applying traditional unit root tests. Furthermore, they employed the LM Fourier unit root test and a stationarity test with a Fourier function to consider structural breaks. Contrary to the conventional unit root tests, the results provided by tests with Fourier function supported that returning to the average is possible in all of the Asian countries under analysis. The results obtained by Charfeddine and Khediri (2016) through GARCH-M and long memory models indicated the different degrees of efficiency changing in time and periods where the efficiency develops in GCC countries. The common findings of runs test and ADF and PP unit root tests applied by Stakic et al. (2016) for BELEXI 15 index of Serbian share market indicates that the index profits are stationary and therefore they do not hold a random process and they break weak-form efficiency.

In the studies carried out after 2017, the MF-DFA method where multifractal structures are considered gained importance. Ali et al. (2018) indicated that this method can test efficiency and also provide information about the level of non-efficiency. In the study where the relative efficiency of the conventional share markets of 12 countries, 4 of which are Islamic countries, against the Islamic markets of the same countries were analysed through MF-DFA method the results indicated that the markets of developed countries have the highest efficiency level and the markets of BRICS countries follow them.

Rizvi and Arshad (2017) applied MF-DFA and MGARCH models on 24-year data in their study where they analysed the efficiency and integration of the Japanese share market. The MF-DFA method which is used to determine market efficiency also considers the multifractal structure of the relevant market. It was observed that the efficiency increased gradually in the Japanese market. Mensi et al. (2018) revealed that the multifractal structure exists in all of the share markets of fragile five countries (GIPSI) in Europe and the USA through the MF-DFA approach and long memory is valid for time series. Greece is the country which has the most powerful long memory in the short- and long- run and it is also the country which has the lowest market efficiency. Portugal and Ireland are the countries that have the lowest non-efficiency levels. In a similar study; Mensi et al. (2018) examined the weak-form market efficiency of five countries which are members of the Gulf Cooperation Council (GCC) by comparing them with several global, regional or Islamic indexes. It was discovered that all of the market profits have multifractal structure through the MF-DFA approach. GCC share markets were also discovered to be less efficient than global, regional and Islamic markets.

Gil-Alana et al. (2018) tested the EMH by using fractional integration models in their study focused on indexes of four share markets of three Baltic countries. This method is based on a long memory approach instead of conventional unit root tests which are insufficient with regards to trend stationarity, the presence of structural breaks, regime changes and, fractional integration cases was used. Random walk is rejected for all markets. It was indicated that the Baltic share markets are not efficient and the path which will be followed by the prices can be predicted before. In the study of Hill and Motegi (2019); while the existence of unit roots for level values cannot be rejected through PP unit root tests in Chinese, Japanese, English and USA share markets, unit roots cannot be determined when their log values are assigned. White noise hypothesis was accepted in Chinese and Japanese share markets through applying the CvM method and those markets were discovered to be efficient in weak-form. It was also concluded that English and USA markets are not efficient.

It has been observed that different methods provide different results in the studies where Turkey is also included. Celik and Tas (2007) applied Runs test, unit root tests and variant ratio test for the share markets of 12 countries. Different results were obtained through different methods and no test can reject the market efficiency for the Turkish market. Gozbası et al. (2014) used the ESTAR model as a result of determining that the series are not linear for the BIST100 index and three sectoral indexes. It was concluded that the indexes in the Turkish share market contain unit roots, i.e. they are not stationary and therefore the market is efficient in weak-form through applying non-linear unit root tests. Gumus and Zeren (2014) tested RWH for share markets of 17 G20 countries. According to the linearity or non-linearity of the dataset, the Fourier ADF and Fourier KSS unit root tests which consider structural breaks were applied. It was observed that the dataset is stationary for the 8 countries including Turkey and accordingly the markets contradict the RWH. For the other 9 countries, the EMH is discovered to be valid. Altunoz (2016) applied ADF and PP unit root tests for the shares of 8 different banks processed in the BIST and BIST banking index, and he/she determined that the level values of all series contain unit roots and the first differences are stationary. This result was interpreted as that all series reveal a coincidental distribution and the market is efficient in weak-form.

One of the markets where EMH tests are applied widely in foreign exchange markets. There is no common result related to the efficiency of exchange markets in the studies using different methods. Wickremasinghe (2008) used the Autocorrelation test, Ljung-Box Q statistics and KPSS unit root test to analyse the weak-form efficiency for the foreign exchange rate of Sri Lanka. Cross-correlation test was used to test the semi-strong efficiency. It was determined in the study that the profits from four different currencies have relationships with previous period profits, i.e. the existence of autocorrelation; accordingly, the market breaks the weak-form efficiency hypothesis. While the results obtained through Q statistics support this finding, the profits of different currencies were revealed to have relationships with the lagged profits of the other currencies. In another study, Giannellis and Papadopoulos (2009) aimed to explore the efficiency of foreign exchange markets of the Czech Republic, Slovakia and Poland, which are 3 developing EU countries. Equilibrium exchange rates were modelled through VAR-based cointegration tests by using basic macroeconomic indicators. Conventional and structural break unit root tests were applied to analyse the significance of the deviations between the calculated equilibrium exchange rates and actual rates. In the study which suggests that the rates contain all accessible information in case the series related to deviations are stationary, accordingly the market is efficient; the foreign exchange market of Poland was discovered to be efficient, the foreign exchange market of Czech Republic was away from being efficient and the foreign exchange market of Slovakia was semi-strong efficient. Firoj and Khanom (2018) tested EMH for the foreign exchange market of Bangladesh. They used three different unit root tests and cointegration tests. Even though the findings of unit root tests applied through seven different currencies provided contradictory results for Japanese Yen and Sweden Krona against the currency of Bangladesh, they supported the market efficiency in weak-form for the other 5 currencies. Johansen cointegration test was applied to test the semi-strong efficiency form, it was observed that there are cointegrations between all currencies and it was concluded that the market breaks the semi-strong efficiency form.

Azad (2009) tested the RWH and efficiency hypothesis for foreign exchange markets of 12 Asian-Pacific countries. Individual and panel unit root tests and two variant ratio tests were applied in the study. The unit root tests provided proofs for unit roots for all series and the variant ratio tests provided proofs for martingale behavior for most of the series when the daily data were used. When the weekly data were used; while the panel unit root tests determined the presence of unit roots in foreign exchange rates, individual unit root tests could identify unit roots for 10 markets. Variant ratio test rejected the martingale behavior for most of the rates. Barkoulas et al. (2003) aimed to investigate the weak-form efficiency for foreign exchange markets through dataset consisting of daily spot and forward rates of US Dollar against 6 different currencies by using the Johansen Likelihood Ratio. The results support the efficiency of the foreign exchange market for 6 main currencies by revealing that the forward premiums of all analysed rates are stationary.

## 3. Methodology

Most of the financial time-series, share prices, real estate profits, precious metals, foreign exchange rates, etc. serve as models for the RWH and those variables can show trends without any kind of specific direction. The RWH serves as an important model for the non-stationary process, i.e. unit root process (Gujarati, 2012). Therefore, it is possible to explain why the unit root test is applied to explore the weak-form market efficiency in this way. Even though some different methods were applied to analyse the weak-form of EMH in the literature, it has been seen that the traditional unit root tests which are pretty popular recently and unit root tests considering structural breaks have been performed.

As mentioned earlier, this paper utilizes Harvey linear test, standard and structural breaks unit root tests, and nonlinear ESTAR unit root tests. Hence, a brief explanation of these tests is outlined in this section. To this end, firstly; Harvey et al. (2008) linearity test where a linearity analysis will be carried out to the series. Then, KPSS (1992) test among standard unit root tests, ADF type Zivot-Andrews (1992) (henceforth called the ZA) and LM type Lee-Strazicich (2013) (henceforth called the LS) tests will be included to be applied for linear series and ESTAR type Kapetanios et al. (2003) (called the KSS) and Kruse (2011) tau unit root tests for non-linear series will be introduced.

The some standard unit root tests that can be performed to analyse for the null hypothesis of deterministic trend against unit root alternative of non-stationarity (Matebejana et al., 2017: 115). One of these tests is the KPSS test developed by Kwiatkowski et al. (1992). This test based upon the Lagrange multiplier test for the assumption that the random process has zero variance. This test is employed for analysing a null hypothesis that an observable time series is stationary around a deterministic trend. (Firoj and Khanom, 2018: 101). In other words, different from the hypotheses established in ADF and PP tests, the null hypothesis suggests that series are stationary and alternative hypothesis suggests that series contain unit roots in the KPSS test. The KPSS test performs similarity to the Lagrange multiplier test.

Let's assume that the $y_t$ (t=1,2,…,T) series is a tested series of stationarity. In the KPSS test, an observable time series can be formulated as a sum of three components which are deterministic time trend, a random walk, and a stationary error term. The KPSS test in the literature follows the following linear regression equity.

$$y_t = \beta t + \varphi_t + \varepsilon_t \tag{1}$$

In the equation (1), $y_t$ is the observed time series, $\beta_t$ is the deterministic trend, t is the time series, $\varepsilon_t$ is the error term. If the $y_t$ is stationary (I(0)), the random walk equation is important for testing the model. The random process in the equation assign a logged value from random term ($\varphi_t$) and it is demonstrated as follows:

$$\varphi_t = \varphi_{t-1} + u_t \tag{2}$$

where, $\varphi_t$ is a random walk, $t$ deterministic trend, $u_t$ is identical and independently distributed error term. There is no autocorrelation between $\varepsilon_t$ and $u_t$ in the equation 1 and 2. While calculating the KPSS test statistics, firstly $y_t$ is regressed on the truncation and trend, then the total partial processes ($S_t$) of the residuals are calculated as follows:

$$S_T = \sum_{t=1}^{T} \varepsilon_t \qquad t = 1, 2, 3,\ldots, T \tag{3}$$

where, $e_t$ ,$t$ = 1,2,3,….,$T$ are residuals which are obtained from the regression of $y$ which contains trends and intercept. $S_t$ is the partial sum of deviations of residuals and the following long run variance of $\varepsilon_t$ is identified:

$$\sigma^2 = \lim_{T\to\infty} T^{-1} E(S_T^2) \tag{4}$$

If there is no deterministic trend in the series, regress $\{y_t\}$ on deterministic components which consist either of a constant or of a constant and trend. The LM statistic is defined as (Kwiatkowski et al. 1992: 163):

$$LM = \sum_{t=1}^{T} \frac{S_t^2}{\sigma_\varepsilon^{\,2}} \tag{5}$$

where $\sigma_\varepsilon^{\,2}$ is the variance of $\varepsilon_t$ and $\sigma_\varepsilon^{\,2} = \sum \varepsilon_i^2 / T$ . However, residuals may be autocorrolated with each other. Hence, under the null hypothesis, $\sigma_\varepsilon^{\,2}$ is a consistent estimator of the long-run variance of $\varepsilon_t$, it is calculated by $s^2(\ell)$ errors. In this case, the test statistic will be reformulated as follows:

$$LM = \sum_{t=1}^{T} S_t^2 / s^2(\ell) \tag{6}$$

In the KPSS test, $s^2(\ell)$ is a consistent Newey-West estimator of the long run variance $\sigma^2$ of the regression error (Newey and West, 1987: 704). In this test method, it is the Barlett Kernal window estimation method which enables $s^2(\ell)$ to be positive and it is expressed with the following equation Kwiatkowski et al. 1992: 165):

$$s^2(\ell) = T^{-1} e_t^2 + 2T^{-1} \sum_{T=1}^{\ell} \sum_{t=s+1}^{T} w(s,\ell) e_t e_{t-s} \tag{7}$$

In Equation (7), $w(s,\ell)$ is a non-compulsory weighting function that corresponds to the preference of a spectral window and $w(s,\ell) = [1 - s/(\ell+1)]$ . $[1 - s/(\ell+1)]$ is an optional weighting function utilized to smooth the sample auto covariance function (Ibrahim et al., 2011: 59). The lag truncation parameter should be $(\ell) \to \infty$ while it was $(\ell)$, $T \to \infty$ in order for the $s^2(\ell)$ estimator to enable consistency (Schwert, 1989: 147).

In the KPSS test, critical values were derived by a simulation and are listed in Kwiatkowski et al. (1992) and the $H_0$ and $H_1$ hypotheses for this test are stated as follows:

$H_0$: there is no unit root test in the series that is the series is stationary,

$H_1$: there is a unit root test in the series that is the series is not stationary.

According to the Perron (1989) and Chen (2002), the KPSS test has the power to refuse the $H_0$ hypothesis of level and trend stationarity of a time series in the existence of structural regimes. Therefore, the KPSS test was applied to determine the stationarity of linear time series in this paper.

Besides, Perron (1989) indicated in the analyses of time series that the unit root tests applied ignoring breakpoints formed between the analysis periods can provide insufficient results and the unit root tests induce to false non-rejection of the null when there is stationary alternative linearity and the structural breaks are not considered (Perron, 1997). The disadvantage of traditional unit root tests that they ignore a possibility for structural breaks in models. This is because; policy changes, crisis, important changes in sectors or external factors etc. may cause breaks in the economic indicators of the countries. Since different results will be revealed as a result of testing the stationarity of possible structural breaks in the series because those unit root tests do not consider the structural breaks in the series, applying also the unit root tests considering structural breaks can be useful. Therefore, by including the structural breaks into the unit root process in the time-series, the structural break unit root tests are enabled to be developed. By considering the abovementioned issues, the ADF-type based ZA (1992) and LM-type based LS (2013) unit root tests with one break are used in the analysis.

If the standard unit root tests discover the series as non-stationary, unit root tests with structural breaks are used to analyse whether non-stationarity is caused by a structural break. Since the standard unit root tests do not consider the structural breaks in the series and thus the potential structural breaks will provide different results as a result of stationarity tests for potential structural breaks, it will be beneficial to apply unit root tests with breaks considering structural breaks. Besides; to examine whether the series in the study are affected from the structural breaks in the Next 11 countries, ZA (1992) and LS (2013) unit root tests with structural breaks testing the stationarity under structural break.

ZA (1992) test with structural break is based on Perron (1989) test. In order to support the test procedure on determining the break points of Perron a data-based algorithm is used. Additionally, the authors criticized the Perron's test procedure by indicating that the break points occurred in the series can be determined endogenously, not exogenous. By criticizing the Perron's (1989) external break points assumption, a new unit root test procedure was developed considering an estimated break in the trend function under alternative hypothesis (Zivot and Andrews, 1992). The authors obtain a solution and endogenously identified a structural break where the unit root statistic is the minimum. The authors suggested three different test statistics analysing the existence of unit roots in case the existence of structural breaks in the series. These models are shown in Equation (8-10). In the Zivot-Andrews (1992) test the following regression equations are estimated for all potential breaks and *t* statistics is calculated for estimated parameters. ZA (1992) provided a unit root test based on the following three models against a structural break alternative (Zivot and Andrews, 1992: 254):

Model A (break in intercept)

$$Y_t = \mu + \beta_t + \theta DU_t(T_b) + \alpha y_{t-1} + \sum_{i=1}^{k} c_i \Delta y_{t-i} + e_t \tag{8}$$

Model B (break in trend)

$$Y_t = \mu + \beta_t + \gamma DT_t(T_b) + \alpha y_{t-1} + \sum_{i=1}^{k} c_i \Delta y_{t-i} + e_t \tag{9}$$

Model C (break in both)

$$Y_t = \mu + \beta_t + \theta DU_t(T_b) + \gamma DT_t(T_b) + \alpha y_{t-1} + \sum_{i=1}^{k} c_i \Delta y_{t-i} + e_t \tag{10}$$

Each of three models is equal to ADF test when break variables are removed. Here; $t = 1,2,\ldots,T$ indicates time, $T_b$ indicated break time and $T_b/T$ indicates break point. The $DU_t$ is the dummy variable in the level and $DT_t$ is the dummy variable in the slope demonstrating the structural change in the models. $\Delta y_{t-i}$ terms are added on the right side of the equations in order to prevent potential autocorrelation in the error terms. $T_b$ on the right side of the equation is the break point and $\lambda = T_b/T$. Authors suggest the 'trimming region' be specified as [0.15T, 0.85T] (Narayan and Smyth, 2004: 708). The existence of breakpoint is only sought in $\lambda$ zone (Yilanci and Ozcan, 2010: 25). In Equation (8-10), $DU_t$ is an indicator dummy variable while $DT_t$ is corresponding trend shift variable at a possible break-date. Considering the following equations:

$$DU(\lambda) = \begin{Bmatrix} 1 & t > T_b \\ 0 & t \le T_b \end{Bmatrix} \quad DT(\lambda) = \begin{Bmatrix} t - T\lambda & t > T\lambda \\ 0 & t \le T_b \end{Bmatrix} \tag{11}$$

We have chosen the structural break base on the minimum value of *t* statistic for a $\alpha$. In the equations above, the null hypothesis will be as "$H_0$: the series contain unit roots" and the alternative hypothesis will be as "$H_1$: the series are stationary with a structural break determined internally". For each of the three models; in case of $\alpha = 0$, the null hypothesis will not be able to be rejected, i.e. it will mean the unit roots exist. In the ZA test, for $t = 1, 2,\ldots,(T-1)$ regressions in the number of $(T-2)$ are established successively through the Least Squares (LS) method by using a different dummy variable for each of the potential breakpoint and the breakpoint which is in the model where $\alpha$ which is the coefficient of $y_t$-1 variable has the least *t* statistic is selected as the proper break point in order to determine the break point. After the break date is determined; in case the calculated *t* statistic of $\alpha$ is bigger than ZA (1992) critical value, the main hypothesis which indicates the existence of unit roots without structural break is rejected. In case the obtained *t* statistic is smaller than ZA (1992) critical value as an absolute value, the alternative hypothesis indicating that the series are trend stationary with a structural break formed in the trend function (Yılancı, 2009: 328). Perron (1997) accepted that most of the time series can be modelled by using Model A and Model C. Therefore, model A and model C is widely preferred when ZA (1992) test is applied in the literature. To this end, in this study, we employed model A and Model C which are the most comprehensive specification.

There are some other LM-type test strategies aside from the ADF-type test strategies used in the analysis of unit roots with breaks widely. The most common tests among them are the LS (2013) test with a one break. The basic logic of those tests is that they act according to the LM principal and they determine the break date endogenously.

Considering the following regression equations for LM unit root test:

$$y_t = \delta Z_t + e_t \text{ and } e_t = \beta e_{t-1} + \varepsilon_t \tag{12}$$

Here, $Z_t$ denotes the vector containing exogenous variables, $\varepsilon_t = iidN\left(0, \sigma^2\right)$ denotes residuals. The null hypothesis is determined as $\beta = 1$ to test the unit roots. If the $Z_t$ exogenous variable is determined by considering the single break, the Model A allows single break in the constant term. When $D_t$ is $t \ge T_b+1$, it is equal to the $Z_t = [1, t, D_t]$ value in the numbered model to indicate the dummy variable which 0 value is assigned for in other cases. The Model C is used in order to test the break for constant and trend. When the Model C $DT_t$ is $t \ge T_b+1$, $t-T_b$ indicates the dummy variable which 0 value is assigned for in other cases.

The LS (2003) test is acquired from the Equation (13) for the regression estimation:

$$\Delta y_t = \hat{\delta}\Delta Z_t + \phi \hat{S}_{t-1} + \varepsilon_t \tag{13}$$

In this equation, $\hat{S}_{t-1} = y_t - \hat{\psi}_x - Z_t \hat{S}_{t-1}$, $t$=1,2,…, $T$. $\hat{\delta}$ indicates the coefficients obtained from the regression of $\Delta y_t$ on $\Delta Z_t$. $\hat{\psi}_x$ is constituted with $y_1 - Z_1\delta$. $y_1$ and $Z_1$ indicate the starting values of the matrixes. The null hypothesis is constituted as $\phi = 0$. The $t$ statistic which tests the main hypothesis of unit roots of LM test statistics is obtained through $\hat{\tau}$ value. After clipping 15% from the start and the end to determine the break times, $LM_\tau = \underset{\lambda}{Exc}\, \hat{\tau}(\lambda)$ is selected from the points where the $\hat{\tau}$ test statistic is minimum among the remaining dates. In other words, date of the structural breaks is identified by choosing the break with the lowest value possible. The hypotheses to discover whether the series contain unit roots or not are as follows: $H_0$: "They contain unit roots, i.e. the series are not stationary." $H_1$: "They do not contain unit roots, i.e. the series are stationary." The unit root main hypothesis is refused in case the test statistics obtained through ZA (1992) and LS (2013) tests are higher than the ZA (1992) table critical values.

Economic series can be linear or non-linear series due to the reasons caused by the characteristics of the series. However, linearity assumptions are crucial for econometric analyses. For example; the reason for non-linearity in the exchange indexes can be the existence of heterogeneous actors, asymmetric information, and inefficiency market. When the data characteristics display nonlinear, the linear unit root tests may not hold strength and accurate interpretations. Just as the strength of conventional unit root test decreases in the conditions where structural breaks are not considered, the same happens for not applying the tests which are non-linear but acts as linear for the series. It can cause for the series to be interpreted incorrectly. Thus, the nonlinear unit root test introduced by Kapetanios et al. (2003) and Kruse (2011) are performed in the time-series econometrics literature. Within this context, it is necessary to analyse the series in terms of linearity in order to reveal their characteristics. It has been seen that many linearity tests have used in the empirical literature. There are tests introduced by Harvey and Leybourne (2007) and Harvey et al. (2008) among them. The Harvey et al. (2008) has better finite sampling, dimension and strength characteristic when it is compared to the Harvey and Leybourne (2007) test. Besides; since the Harvey et al. (2008) test method is based on the Wald statistic, it provides more consistent and strong results when it is compared to the Harvey and Leybourne (2007) test. Due to the abovementioned reasons, the Harvey et al. (2008) test was applied for the linearity analyses of the series in this study.

The linearity test which was added by Harvey et al. (2008) in the literature contains two different linearity tests by assuming that the series are stationary and they contain unit roots. The weighted mean of those two tests constitutes the Harvey et al. linearity test (Yılancı, 2013: 6). While the main hypothesis of the test indicates that the series are linear, the alternative hypothesis indicates that the series are non-linear. If the test statistic calculated as a result of the Harvey et al. test is lower than the table critical values prepared by Harvey et al. (2008), the main hypothesis is accepted. The hypotheses in the Harvey et al. (2008) linearity test are as follows and the model under the assumptions that the time series are stationary (I(0)) and the time series are non-stationary (I(1)) is estimated through Equation (14) (Harvey et al., 2008: 3-4). Harvey et al. (2008) also suggested a method enabling to test the linearity when the unit root characteristics of the time series are indefinite. In the cases where the time series are integrated from stationary zero degree (I(0)), the following regression model is estimated to test the linearity:

$$y_t = \beta_0 + \beta_1 y_{t-1} + \beta_2 y_{t-2}^2 + \beta_3 y_{t-3}^3 + \sum_{j=1}^{p} \beta_{4,j} \Delta y_{t-j} + \varepsilon_j \tag{14}$$

In the cases where the time series are from non-stationary first degree (I(1)), the following regression model is estimated to test the linearity:

$$\Delta y_t = \lambda_1 \Delta y_{t-1} + \lambda_2 \left(\Delta y_{t-1}\right)^2 + \lambda_3 \left(\Delta y_{t-1}\right)^3 + \sum_{j=1}^{p} \lambda_{4,j} \Delta y_{t-j} + \varepsilon_t \tag{15}$$

In the equation, Δ indicates the difference operator and $p$ indicates the lag number. After Harvey et al. (2008) determined the suitable lag number as ($p$) and maximum lag number as $p_{max}$ = int[8(T/100)$^{1/4}$], they suggest to determine them through successive test method by using 10% significance level.

Under the null hypothesis, the standard Wald statistic is calculated to test the constraints. For the model at the I(0) level, the case where the null hypothesis is linearity and the alternative hypothesis is non-linearity are defined as follows:

$H_{0,1(0)}$: $\beta_2 = \beta_3 = 0$ (linear)

$H_{1,0(0)}$: $\beta_2 \neq \beta_3 \neq 0$ (non-linear)

The null and alternative hypotheses in the I(1) level are identified as follows:

$H_{0,1(0)}$: $\lambda_2 = \lambda_3 = 0$ (linear)

$H_{1,0(0)}$: $\lambda_2 \neq \lambda_3 \neq 0$ (non-linear)

The approach suggested by Harvey et al. (2008) can also be used in the cases where the ($y_t$) linearity degree of the series are uncertain. For those kinds of cases, the authors developed the following weighted statistics to test the linearity under null hypothesis and non-linearity under alternative hypothesis. The Wald test is calculated separately for the case where the series are stationary both at the level and in the first difference for this reason. The test statistics $W_0$ calculated for stationarity and $W_1$ calculated for non-stationarity in the equation and the Harvey et al. (2008) $W_\lambda$ test statistic are calculated as follows:

$$W_\lambda = \{1-\lambda\}W_0 + \lambda W_1 \tag{16}$$

where $\lambda$ value is a function that converges in probability to zero if the series are stationary at the I(0) level, and it is one if the series are stationary at the I(1) level. $\lambda$ is a function which approximates to zero if the series are stationary, and which approximated to one if the series are non-stationary.

If the test statistic calculated as a result of the Harvey et al. test is lower than the table critical values prepared by Harvey et al. (2008) the main hypothesis is accepted, otherwise the main hypothesis is rejected.

The Harvey et al. (2008) test is carried out to evaluate whether the series are linear. Applying linear unit root tests for the non-linear series can cause to obtain incorrect results. Therefore; in the cases where the time series are non-linear, it is essential to perform the non-linear unit root tests in order to determine the unit root characteristics. It has been observed that the ESTAR-type unit root tests are frequently used to estimate the behaviours of the non-linear time series. To address this concern, in the empirical analysis stage of the study, the non-linear ESTAR unit root tests suggested by Kapetanios et al. (2003) and Kruse (2011) which are preferred frequently in the literature are used finally. KSS critical table values are used for Kapetanios et al. (2003) test and tau critical table values are used for Kruse (2011) test in order to analyse whether the series contain unit roots.

Kapetanios et al. (2003) suggested a test based on ESTAR model to analyse the stationarity globally in the non-linear time series. KSS test is a version of linear ADF unit root test developed for non-linear structures. A brief introduction of Kapetanios et al. (2003) is presented in the following equations. When the $y_t$ series are date to test the existence of unit roots under null hypothesis and of global stationary ESTAR process under alternative hypothesis, the following ESTAR regression model is identified:

$$\Delta y_t = \alpha y_{t-1} + \phi y_{t-1}\left(1-\exp\left\{-\gamma\left(y_{t-1}c\right)^2\right\}\right) + \varepsilon_t \tag{17}$$

where $y_t$ can be raw data, demean and detrend according to the data generation process of the relevant variable. $\lambda$ is smooth transition and $c$ is location parameters. In the Model (3); if $\alpha = 0$, when the ESTAR model is $\gamma = 0$, the random walk (unit root) transforms into a process. The stochastic term $\varepsilon_t$ is supposed to be normally distributed, with a zero mean and a constant variance. Additionally, $\gamma \geq 0$ is known as a transition parameter of the ESTAR model which represents the transition process. In Equation (17), the maintained hypotheses are that $H_0$: unit root ($\gamma = 0$) and that $H_a$: Nonlinear, but globally stationary ($\gamma > 0$). Thus, under the $\alpha = 0$ constraint, the model (19) can be rewritten as follows:

$$\Delta y_t = \phi y_{t-1}\left(1-\exp\left\{-\gamma\left(y_{t-1}c\right)^2\right\}\right) + \varepsilon_t \tag{18}$$

A random process can be obtained by applying the restriction $\phi = 0$ in the Model (18). Kapetanios et al. (2003) applied the assumption of $c = 0$ to test whether the time series contain unit roots from Equation (18), therefore they obtained the following model.

$$\Delta y_t = \phi y_{t-1}\left(1-\exp\left\{-\gamma y_{t-1}^2\right\}\right) + \varepsilon_t \tag{19}$$

KSS test used the Taylor approach to test the unit root main hypothesis ($H_0$: $\gamma = 0$) against global stationary ESTAR process ($H_1$: $\gamma > 0$). The authors indicated the Taylor approach from the first degree of the soft transition autoregressive main model through the following equation by assuming that the transition variable lags in the KSS test are exactly equal (Kapetanios et al., 2003: 363-365):

$$\Delta y_t = \delta y_{t-1}^3 + \sum_{i=1}^{j} p_i \Delta y_{t-i} + e_t \tag{20}$$

The asymptotic critical values of $t_{NL}$ statistics are obtained for the three cases (raw data, demean data and detrend data) in the study of Kapetanios et al. (2003). The Equation (21) is estimated after the suitable data generation process is obtained in this test process. Then the hypothesis tests are applied for the equation (20). After the model is estimated, the $t$ statistic value of the relevant series is compared with the $T_{NL}$ critical table value provided by KSS for each of the cases (raw data, demean data and detrend data). In the case where the null hypothesis is rejected, the series are decided to be stationary with smooth structural breaks.

Afterwards, Kruse test (2011) which is called the tau test in the time-series econometrics literature. Kruse (2011) is the development function of KSS test and it has introduced that in real world. Therefore, the author extends the KSS unit root test to permit for a nonzero location parameter, namely, *c*, to be zero (Anoruo and Murthy, 2014). Kruse (2011) suggested a model under the assumption of $c \neq 0$ by eliminating the assumption of $c = 0$ in the study of Kapetanios et al. (2003). The time series model allowing the location parameter which is not zero at the exponential smooth function in Kruse (2011) test can be indicated as follows:

$$\Delta y_t = \phi y_{t-1}\left(1-\exp\left\{-\gamma\left(y_{t-1}-c\right)^2\right\}\right)+\varepsilon_t \tag{21}$$

where $\varepsilon_t$ is *IID* $(0, \sigma^2)$, $\gamma$ is the smoothing parameter and $c$ is the location parameter. Following Kapetanios et al. (2003), Kruse (2011) performs a first order Taylor expansion to the transition function $G\left(y_{t-1};\gamma,c\right)=\left(1-\exp\left\{-\gamma\left(y_{t-1}-c\right)^2\right\}\right)$ around $\gamma = 0$. Thus, KSS test procedure is expressed in the following the regression test (Vasconcelos and Junior, 2016: 120):

$$\Delta y_t = \beta_1 y_{t-1}^3 + \beta_2 y_{t-1}^2 + \beta_3 y_{t-1} + u_t \tag{22}$$

To enhance the power of the test, Kruse (2011) imposes $\beta_3 = 0$ on equation (22); thus:

$$\Delta y_t = \beta_1 y_{t-1}^3 + \beta_2 y_{t-1}^2 + u_t \tag{23}$$

Accordingly, Kruse (2011) suggested tau ($\tau$) test in his study to test the unit root main hypothesis ($H_0$: $\beta_1 = \beta_2 = 0$) against global stationary ESTAR process ($H_1$: $\beta_1 < 0$, $\beta_2 = 0$), which is based on the Wald test developed by Abadir and Distaso (2007). Kruse (2011) tau test is indicated in the following equation.

$$\tau = t_{\beta_2^{\perp}=0}^2 + 1\left(\hat{\beta}_1 < 0\right)t_{\beta_1=0}^2 \tag{24}$$

The critical values for $\tau$ statistic in the Kruse (2011) test are tabled for three cases as in KSS test. After the model is estimated, the *t* statistic value of the relevant series is compared with the $\tau$ critical table values provided by Kruse for each of the three cases. In case the null hypothesis is refused, the series are accepted to be stationary with smooth structural breaks.

## 4. Data and Results

In this paper, the validity of the market efficiency in the weak-form of the foreign exchange rate of US Dollar in the country group identified by Goldman Sachs (2007) as Next 11, depending on their economic growth performance and population structure was studied. Therefore; by considering the accessibility of the data, the dataset of the study consists of the natural logarithm of the monthly closing prices of the foreign exchange rates between January 1997 and December 2019 of the Next 11 countries. The US Dollar currency was preferred for this study since it is the most preferred currency variable analysed in the literature. Besides, it was also preferred since it has higher liquidity in the international markets. The series included by the analyses are obtained from investing.com. To address this concern, we first begin with the Harvey et al. (2008) linearity test in order to specify the characteristics of exchange rates. Following this conclusion, firstly, we employ the KPSS test which does not consider any structural breaks in the data. Afterward, we employ more relevant unit root tests that permit one structural break, ZA (1992) and LS (2013) tests to examine the determine of structural breaks. We then employ ESTAR type Kapetanioset et al. (2003) and Kruse (2011) tests for non-linear series. Harvey et al. (2008) linearity test, Kapetanioset et al. (2003) and Kruse (2011) tests were performed by using R for windows; KPSS test was applied by using Eviews 10.0; ZA (1992) and LS (2003) tests were applied by using Gauss 10.0. Detailed data descriptions reported in Table 1.

**Table 1:** Data Descriptions of Next 11 Countries

| Countries (Next 11) | Exchange Rates (US Dollars) | Period Covered | Observation |
|---|---|---|---|
| Bangladesh | USD/BDT | 01/1997-12/2019 | 276 |
| Egypt | USD/EGP | 01/1997-12/2019 | 276 |
| Indonesia | USD/IDR | 01/1997-12/2019 | 276 |
| Iran | USD/IRR | 01/1997-12/2019 | 276 |
| Mexico | USD/MXN | 01/1997-12/2019 | 276 |
| Nigeria | USD/NGR | 01/1997-12/2019 | 276 |

| | | | |
|---|---|---|---|
| Pakistan | USD/PKR | 01/1997-12/2019 | 276 |
| Philippines | USD/PHP | 01/1997-12/2019 | 276 |
| Turkey | USD/TRY | 01/1997-12/2019 | 276 |
| South Korea | USD/KRW | 01/1997-12/2019 | 276 |
| Vietnam | USD/VND | 01/1997-12/2019 | 276 |

**Notes:** For consistency for a time series analysis, we express all the series based on a common currency denominator of US dollars.
**Source:** investing.com.

Table 2 presents basic descriptive for the variables used in our analyses.

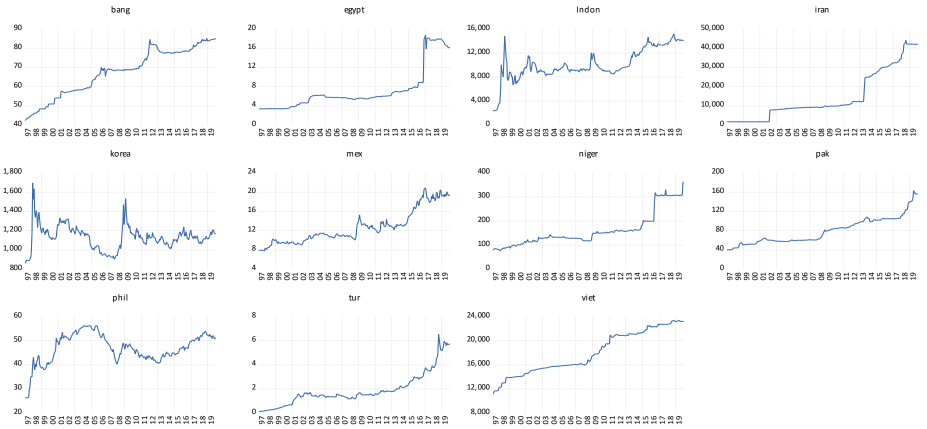
**Table 2:** Descriptive Statistics of Next 11 Countries

| Countries | Mean | Median | Maximum | Minimum | Std. Dev. | Jar-Bera |
|---|---|---|---|---|---|---|
| Bangladesh | 66.95440 | 68.77500 | 85.17000 | 42.45000 | 12.01358 | 17.30519* |
| Egypt | 6.925475 | 5.763300 | 18.72500 | 3.389700 | 4.127102 | 246.8775* |
| Indonesia | 10014.31 | 9392.500 | 15202.50 | 2376.500 | 2499.057 | 24.30197* |
| Iran | 13743.95 | 9315.000 | 44180.00 | 1747.500 | 11883.98 | 49.05385* |
| Mexico | 12.50433 | 11.38000 | 20.83400 | 7.772000 | 3.322267 | 39.61083* |
| Nigeria | 157.0286 | 133.1000 | 330.2500 | 75.72000 | 65.16102 | 100.7791* |
| Pakistan | 77.20717 | 64.10000 | 146.9550 | 40.08000 | 24.46562 | 17.03404* |
| Philippines | 46.75078 | 46.76500 | 56.35000 | 26.33100 | 6.123639 | 44.99923* |
| South Korea | 1131.004 | 1130.150 | 1695.000 | 864.0000 | 126.5655 | 67.96801* |
| Turkey | 1.776942 | 1.506400 | 6.538000 | 0.116200 | 1.201022 | 176.1476* |
| Vietnam | 17830.96 | 16140.00 | 23412.50 | 11182.50 | 3454.696 | 20.27907* |

**Source:** Own calculation and values acquired from Eviews.
**Note:** * $p < 0.01$. The series are not normally distributed.

The descriptive statistics of the data of the time series provide strong idea tips related to the things happened in the past. Therefore, analysing the data by evaluating the descriptive statistics is important to form an opinion. Table 2 reports mean, maximum, minimum, and standard deviation and Jarque Bera exchange rates of the Next 11 countries. The statistical description is being calculated based on the monthly closing prices of the Next 11 countries' exchange rates. The mean of Bangladesh is ranging from 42.45 to 85.17, of Egypt is from 3.3897 to 18.725, of Indonesia is ranging from 2376.5 to 15202.5, of Iran is ranging from 1747.5 to 44180, of Mexico is ranging from 7.772 to 20.834, of Nigeria is ranging from 75.72 to 330.25, of Pakistan is ranging from 40.08 to 146.955, of Philippines is ranging from 26.331 to 56.35, of South Korea is ranging from 864 to 1695, of Turkey is ranging from 0.1162 to 6.538, of Vietnam is ranging from 11182.5 to 23412.5. It was observed that Indonesia has the highest average with 9966.483 and Turkey has the lowest average with 1.731723 among those series. It was also observed that Iran has the highest standard deviation value with 11559.38 and Turkey has the lowest standard deviation value with 1.128896 among those series. Besides, the standard deviation values of the foreign exchange rates of the countries are not close to each other. The high standard deviation values prove the high instability of the series in the analysed period. Turkey was observed to have the lowest foreign exchange mobility in the Next 11 countries. According to the Jarque Bera test statistics, the null hypothesis where the data fits into normal distribution is rejected. In other words, the fact that Jarque-Bera assigns high values as test values supports the results where the series do not have a normal distribution. The progress of the data of the exchange rate for the mentioned period is indicated in Figure 1. Figure 1 displays the graph from January 1997 to December 2019.

**Figure 1:** The Plot of the Data of Exchange Rate



**Source:** Own calculation and values acquired from Eviews.

The foreign exchange rates of the Next 11 countries can be observed to increase significantly between 1997 and 2019 in Figure 1. The plot of the data of the exchange rate in Figure 1 approves the findings of unit root tests in that these exchange rates display a trend. Furthermore, it is also possible to observe that the foreign exchange rate series of the Next 11 countries have unstable structures. Besides, the differences in the relevant data during the analysed period also attract attention. In 2008, there is a break experienced on the foreign exchange rate series of the Next 11, and it reflects the effect of the global financial crisis. The macroeconomic conditions between 1997 and 2019 can be interpreted as they caused increases in the foreign exchange rate series of the Next 11. The currencies of the Next 11 can be observed to continue to lose their values against the dollar. Furthermore, the observation time series for exchange rates reveal the existence of possible structural breaks and regime shifts.

If time series is stationary, their average and variance do not change in time. If the series are non-stationary, the variance of the series depends on time (Gujarati, 2003). Stationarity implies the temporary effect of any information or shock while non-stationary that is unit root existence will reflect the permanent effect of the information or shock. Stationary series return to their long-run averages. The average and variance of the non-stationary time series depend on time (Ertugrul and Soytas, 2013).

In this study, where it is analysed whether the foreign exchange rates of the Next 11 countries are converged to the group average, the unit root tests with different characteristics are used. In the wide-ranging unit root test analysis, the findings of the linear unit root tests, the results of the unit root tests with structural breaks and the results of the non-linear unit root tests are provided respectively.

Before applying the non-linear unit root tests on the foreign exchange rate series, it is necessary to determine whether the series is linear as a primary test. The results of the Harvey et al. (2008) test statistics determining the characteristics of the analysed series are indicated in Table 3.

**Table 3:** The results of Harvey et al. (2008) Linearity Test

| **Exchange Rates (US Dollars)** | $W_\lambda$ | **Results** |
|---|---|---|
| Bangladesh | $9.008^{**}$ | Non-linear |
| Egypt | 1.457 | Linear |
| Indonesia | $24.373^{***}$ | Non-linear |
| Iran | $6.281^{**}$ | Non-linear |
| Mexico | 0.318 | Linear |
| Nigeria | $11.674^{***}$ | Non-linear |
| Pakistan | $8.642^{**}$ | Non-linear |
| Philippines | $11.993^{**}$ | Non-linear |
| South Korea | $64.692^{***}$ | Non-linear |
| Turkey | 2.891 | Linear |
| Vietnam | $6.083^{**}$ | Non-linear |

**Notes:** Exchange rates represent the exchange rate against the US dollar. The $W_\lambda$ statistic follows the $\chi_2^2$ distribution and the relevant critical values are 9.21 (1%), 5.99 (5%) and 4.60 (10%). The estimation and tests were conducted using a program code written in GAUSS that was introduced by Harvey et al. (2008). $^{***}$ and $^{**}$ denote the rejection of the null of linearity at the 1% and 5% significance level, respectively.
**Source:** Own calculation and values obtained from R for Windows.

While the main hypothesis of the Harvey et al. (2008) linearity test indicates that the series is linear, the alternative hypothesis indicates that the series is non-linear. According to the results of the Harvey et al. (2008) linearity test carried out for the foreign exchange rate series of the Next 11; the test statistic values calculated for the series of Bangladesh, Indonesia, Iran, Nigeria, Pakistan, Philippines, South Korea, and Vietnam were found to be higher than the determined critical values. On the other hand; the test statistic values calculated for the series of Egypt, Mexico and Turkey are found to be lower than the determined critical values. It revealed that the exchange rate series of the countries except Egypt, Mexico and Turkey are nonlinear with 1% and %5 significance levels, whereas the series of other countries are linear. Therefore, the main hypothesis indicating that “the analysed series are linear” where the linearity is tested cannot be rejected for the series of Egypt, Mexico, and Turkey. As a result, the hypothesis of linearity is, hence, rejected in 8 cases of 11 Next 11. It means that the foreign exchange markets of those countries are hypersensitive against internal and external shocks.

After the characteristics of the series are determined, the next step is to analyse whether the EMH is valid for the foreign exchange rate values of the Next 11, i.e. whether those values follow a random walk. The conventional unit root tests with breaks are used for the countries with linear foreign exchange rate values and ESTAR-type unit root tests are used for the countries with non-linear foreign exchange rate values firstly. Several stationarity tests have been developed for the non-linear series. In this study, the ESTAR-type Kapetanios et al. (2003) and Kruse (2011) new generation unit root tests which have been widely preferred in the literature recently are used.

Firstly, we apply the KPSS test as a traditional unit root test to evaluate the degree of integration of the linear series. In our analysis, both intercept and trend and intercept models were taken into consideration while performing the KPSS test. The lag length selection is based on Schwarz and Akaike information criterion. Based on this basic finding, the linear unit root test developed by KPSS (1992) for linear series was utilized and the results are tabulated in Table 4.

**Table 4:** The Results of Traditional Unit Root Tests

| Exchange Rates ($) | **Kwiatkowski et al. (1992) (KPSS) unit root test** | | | |
|---|---|---|---|---|
| | Intercept | | Trend & Intercept | |
| | Level | 1st difference | Level | 1st difference |
| Egypt | 1.616862 | 0.194078* | 0.245214 | 0.078261* |
| Mexico | 1.912648 | 0.038612* | 0.216875 | 0.034516* |
| Turkey | 1.628868 | 0.621407** | 0.265045 | 0.142867** |

**Notes:** KPSS test is selected automatically by Newey and West Band with using Bartlett Kernal Spectral estimation method. * and ** denote the rejection of the null of a unit root at the %1 and %5 significance level at first difference, respectively. The KPSS unit root test indicates that all series are integrated of I(1). Test equations for all cases contain an intercept and time trend. The critical values for the KPSS test on the intercept 0.739 (1%), 0.463 (5%) and 0.347 (10%), the critical values for the KPSS test on the trend and intercept 0.216 (1%), 0.146 (5%) and 0.119 (%10). The dollar-denominated exchange rates of these countries include unit roots both in intercept models and models with trends and intercept, and their integration degrees are I(1).
**Source:** Own calculation and values obtained from E-views 10.0.

In Table 4; the KPSS test results of, Egypt, Mexico, and Turkey which are the countries with linear structure among the Next 11. Models that have both trends and intercepts are considered for this test. It was determined that the foreign exchange rate values denominated in dollar of all countries are non-stationary at the level values in the models which have both trends and intercepts, hence these countries have unit roots; however, denominated in the dollar series of these countries are stationary at the different significance levels of 0.01, and 0.05 for their first differences, hence any pair of these countries do not contain unit roots. Accordingly, it was concluded that the foreign exchange rate series denominated in dollar contain unit roots. The results of the KPSS test indicated that the foreign exchange rates denominated in dollar of the Next 11, namely Egypt, Mexico, and Turkey conform with the weak-form EMH. In this case, it is not possible to predict future prices through the previous price trends of those countries and to obtain abnormal profits by using technical and basic analysis methods. According to another result, it was observed that the series have coincidental distribution; therefore, the series are also in conformity with the RWH. Consequently; since the foreign exchange rates in those countries follow the RWH, it is possible to say that it is impossible to earn abnormal profits through previous price information or technical analysis methods. However; since the conventional unit root tests do not consider the breaks in the series, it is important to reveal the results of a unit root test considering the breaks. Accordingly; a unit root test considering structural breaks was also used to analyse the stationarity of the foreign exchange rate series of the linear countries, i.e. whether they are efficient in weak-form. The aim here is to obtain better results by using unit root tests with breaks providing better results when they are compared with the conventional unit root tests to test the stationary and to analyse whether the conventional unit root tests show consistency with the results of the unit root tests with breaks. Therefore, ADF-type ZA (1992) test and LM-type LS (2013) test which allow a one break to be determined internally in the series were used to analyse the validity of the weak-form market efficiency of the foreign exchange series for the linear countries.

The results of the unit root test with structural breaks used to analyse the existence of the weak-form efficient market in Egypt, Mexico, and Turkey countries are presented in Table 5. The Model A which indicates the breaks at the intercepts and the Model C which indicates the breaks at the trends and intercepts are considered. The linear unit root tests developed by ZA (1992) and LS (2013) for linear series were used and the results are reported in Table 5.

**Table 5:** The Results of Unit Root Test with One Structural Break

| Exchange Rates (US Dollars) | **ZA (1992) ADF Test** | | | |
|---|---|---|---|---|
| | Model A | Breakpoints | Model C | Breakpoints |
| Egypt | -3.551 | 10/2015 | -2.919 | 05/2013 |
| Mexico | -4.527 | 09/2014 | -4.307 | 09/2014 |
| Turkey | -4.418 | 05/2006 | -3.704 | 08/2015 |

| Exchange Rates (US Dollars) | LS (2013) LM Test | | | |
|---|---|---|---|---|
| | Model A | Breakpoints | Model C | Breakpoints |
| Egypt | -1.710 | 12/2014 | -2.877 | 10/2015 |
| Mexico | -2.957 | 11/2014 | -3.816 | 08/2014 |
| Turkey | -0.891 | 01/2002 | -2.532 | 02/2003 |

**Notes:** Zivot-Andrews (1992) test indicates the single break unit root test; Lee-Strazicich (2013) indicates the LM-type single break unit root test. The values in the Model A and C indicate the t-statistic. The model A indicated the break on the intercept model and the model C indicates the break on the intercept and trend models. The optimal lag length is selected using Schwarz and Akaike information criterion. The critical values related to the statistics of the test were taken from the study of Zivot-Andrews (1992). The critical values for the Zivot-Andrews test: Model A: -5.34, -4.80 and -4.58; Model C: -5.57, -5.08 and -4.82 at the 1%, 5% and %10 levels, respectively. The critical values for the Lee-Strazicich test: Model A: -4.239, -3.566 and -3.211; Model C: (-5.05 to -5.11), (-4.45 to -4.50) and (-4.17 to -4.21) at the 1%, 5% and %10 levels, respectively.
**Source:** Author's compilation and values obtained from Gauss 10.0.

According to the results of the ZA (1992) unit root test allowing a single break; the results of the Model A which indicates the changes at the level where one break is considered for the series of all countries and of the Model C which allows changes at the level and at the trend indicate that the test statistic determined at the 0.01 significance level is lower than the critical value as an absolute value. The hypothesis indicating that the foreign exchange rate series of all countries contain unit roots at the significance level of 0.01 for Model A and Model C at the level. Therefore, the existence of the EMH is determined for all the countries. The results of ZA (1992) test indicated that it is not possible to predict the future values through the previous values of the series and it is also not possible to earn profits higher than the market average. Besides, the $H_0$ main hypothesis is not rejected for the foreign exchange rate series of all the countries. It was discovered through the ZA (1992) test that the foreign exchange rate series of Indonesia are not in conformity with the weak-form market efficiency hypothesis and RWH. The results of the LS (2013) test allowing a single break indicated that the unit root main hypothesis is not rejected for the foreign exchange rate series of all countries. According to the results of the LS (2013) test; none of the series are non-stationary with a single break at the significance level of 0.01 for Model A and Model C, when the first differences of the series containing unit root at the level values are taken, they become stationary, and therefore the integration degree of the series is I(1). For this reason, it indicates that the weak-form of the EMH is valid for the foreign exchange rate series of those countries. According to those results; it is observed that the foreign exchange rate values in those countries reflect all of the current data, they follow a random walk and it is impossible to predict the future values of the foreign exchange prices through previous prices of the foreign exchange rate values. Consequently, it is possible to say that it is impossible to earn abnormal profits in the markets of those countries through the previous price data or technical analysis methods. When the results of the unit root tests from Table 4 and Table 5 are compared, it can be observed that they provided consistent results for the data between 1998 and 2019. Accordingly; it can be inferred that the conventional unit root tests and unit root tests considering breaks provide same results, and the linear foreign exchange rate series of the Next 11, namely Egypt, Mexico, and Turkey contain unit roots. It was concluded through those results and the results of the conventional unit root tests and unit root tests with breaks that a shock on the foreign exchange rate prices is permanent for Bangladesh, Egypt, Indonesia, Mexico, Philippines, South Korea, Turkey and Vietnam, and the prices are inclined to return to the trend. Those results indicate that the mobility of the foreign exchange rate in Next 11 are not affected by their previous values and they do not have predictable structure. Therefore, the relevant results for linear series reveal that the selected foreign exchange rate profits of the Next 11 are efficient in weak-form.

According to the ZA (1992) and LS (2013) tests; the dates of the estimated structural breaks as a result of the tests applied separately are observed to be expanded in a period between 2002 and 2015. According to the estimation results, the period between 1998 and 2019, for which the structural breaks are detected, corresponds to the terms when the important external and internal events occurred. Those structural breaks on the foreign exchange rates of the Next 11 indicate the period affected by the global crises in 2008 in international economy. It is possible to say that the periods affected by the global financial crisis in 2008 are different for the countries and it affect the economies of some countries later. This is because this crisis based on the mortgage crises in USA occurred at beginning of 2008 and it lasted until the end of 2011. Therefore, it is possible to say that the foreign exchange rate values of the Next 11 differ before and after the global financial crisis and it affected the countries' national markets. Besides, it is also possible to say for Turkey that the Turkish economic crisis in 2001 has an important role to determine the dates of the estimated breaks for both of the unit root tests.

In the Table 6, the results of the nonlinear ESTAR unit root tests suggested by Kapetanios et al. (2003) and Kruse (2011) applied to determine the unit root characteristics of the non-linear foreign exchange rate series included by the analysis are presented in 3 different columns as raw data, demean data and detrend data.

**Table 6:** Results of the ESTAR Type Unit Root Tests

| ***Exchange Rates*** | ***KSS ($t_{NL}$)*** | | | ***tau ($\tau$)*** | | |
|---|---|---|---|---|---|---|
| (US Dollars) | **Raw** | **Demeaned** | **Detrended** | **Raw** | **Demeaned** | **Detrended** |
| Bangladesh | 3.5562 | -2.8521* | -3.2075* | 22.0828*** | 12.1565** | 11.3307 |
| Indonesia | 0.9893 | -2.8467* | -2.8696 | 23.4893*** | 11.7182** | 13.2448** |
| Iran | 1.5917 | -1.3518 | -3.0366 | 3.9296 | 4.5042 | 10.4097 |
| Nigeria | 2.2865 | -0.2443 | -1.6233 | 5.5117 | 3.8574 | 3.0350 |
| Pakistan | 3.1729 | -0.8535 | -2.1696 | 10.6890** | 14.8401*** | 6.05704 |
| Philippines | 1.0734 | -3.9322*** | -3.6801** | 18.3306*** | 18.5927*** | 15.1898** |
| South Korea | 0.1450 | -6.1981*** | -6.0029*** | 16.3465*** | 41.3445*** | 44.5513*** |
| Vietnam | 4.7510 | -2.9949** | -3.4779** | 28.8167*** | 24.0554*** | 16.14491** |
| ***Critical Values*** | | | | | | |
| %1 | -2.82 | -3.48 | -3.93 | 13.15 | 13.75 | 17.10 |
| %5 | -2.22 | -2.93 | -3.40 | 9.53 | 10.17 | 12.82 |
| %10 | -1.92 | -2.66 | -3.13 | 7.85 | 8.60 | 11.10 |

**Notes:** KSS($t_{NL}$): Kapetanios et al. (2003). $\tau$: Kruse (2011). The critical values for the two statistics are obtained from KSS (2003) and Kruse (2011). ***, ** and * denote the rejection of the null of a unit root at the %1, %5 and 10% significance level, respectively. Optimal lag length was selected using Schwarz and Akaike information criterion with maximum lag order of 12.
**Source:** Author's compilation and values obtained from R for Windows.

The results of the KSS and tau non-linear unit root tests for the 8 countries whose foreign exchange rate series are non-linear are presented in the Table 6. According to the KSS test results; Bangladesh, Indonesia, Iran, Nigeria and Pakistan contain unit roots for foreign exchange rate of dollar for the demeaned and detrended models whereas Philippines, South Korea and Vietnam do not contain unit roots for foreign exchange rate of dollar for the demeaned and detrended models. According to the results of the KSS test, it was discovered that the foreign exchange yields of Bangladesh, Indonesia, Iran, Nigeria and Pakistan are non-stationary. Accordingly, the weak-form of the EMH is valid for Bangladesh, Indonesia, Iran, Nigeria and Pakistan while is not valid for the Philippines, South Korea and Vietnam. According to the results of Kruse (2011) tau test; the foreign exchange rate yields of Iran and Nigeria in the raw, demeaned and detrended models are found to be containing unit roots. It was observed that while the foreign exchange rate yields of Bangladesh contain unit roots in the detrended model, it does not contain unit roots in the raw and demeaned models. On the other hand; the foreign exchange rates of Pakistan were determined not to contain unit roots in the raw and demeaned models, in the detrended model, and it contains unit roots. Accordingly, the weak-form of the EMH is valid for Bangladesh, Iran, Nigeria and Pakistan while is not valid for the Indonesia, Philippines, South Korea and Vietnam. Similar results are indicated for the other countries with the exception of the Indonesia.

The results of the KSS unit root test indicate that the weak-form EMH is valid for the foreign exchange rate series of Bangladesh, Indonesia, Iran, Nigeria and Pakistan, and the foreign exchange rate series of Philippines, South Korea and Vietnam are not in weak-form efficiency. The results of tau unit root test indicate that the weak-form EMH is valid for the foreign exchange rate series of Bangladesh, Iran, Nigeria and Pakistan within the analysed period. In other words, it is possible to say that it is impossible to earn profits above the average of the market through the previous price trends of the foreign exchange rates of those 4 countries and any kind of shock in the foreign exchange market is expected to be permanent.

When all analyses carried out for the foreign exchange series of the Next 11 countries are evaluated, it is observed that the linearity hypothesis is not rejected for Egypt, Mexico and Turkey; and it is rejected for Bangladesh, Indonesia, Iran, Nigeria, Pakistan, Philippines, South Korea and Vietnam. Except in a very few cases, obtained results from unit root tests provide support for the validity of the weak-form of EMH. According to the KPSS (1992) and ZA (1992), LS (2013) unit root test results, it is observed that weak-form of efficiency market hypothesis is valid for all Next 11, namely, Egypt, Mexico and Turkey countries' exchange rates. While the KSS test supports the existence of weak-form of efficiency market hypothesis, the Kruse (2011) test which is relatively more recent rejects the existence of weak-form of efficiency market hypothesis. Therefore, the current value of the exchange rates of Bangladesh, Indonesia, Iran, Nigeria and Pakistan cannot be predicted using its historical prices. This implies that the future price of the index is correlated with historical prices.

Our results show mainly that the majority of Next 11 countries follow random walk process and, therefore, are weak-form efficiency. Depending on these results, it can be asserted that exchange rates of Next 11 countries follow random walk process. Therefore, it supports the result which indicates that it is not possible to predict the future prices through the previous data of the foreign exchange prices in those markets.

## 5. Conclusion and Policy Implications

For the national economies of the small countries which have intense exportation sectors with import-dependence such as Next 11, exchange rate is considered to be very important. It is argued by the followers of the EMH that since the producers and consumers have to pay large amounts as a result of excess exchange rate volatility and thus their decisions will be less allocative and finally the real economy is damaged. Accordingly, it is crucial for the policy-makers. If the foreign exchange market is efficient; since the exchange rates cannot be predicted, the governments can influence the exchange rate movement at a limited degree. The informational efficiency raises investment opportunities of investors by appeasing moral hazard and asymmetric information issues associated with the traders of exchange markets. Hence, it depends on the market efficiency whether investors can compose beneficial investment opportunities by means of micro-macro-economic conditions. Within this context, it was analysed whether the weak-form efficiencies of the foreign exchange rate profits are valid for those countries by analysing the Next 11 separately in terms of their foreign exchange rate profits through the comprehensive unit root tests. The Harvey et al. (2008) test was employed to explore the characteristics of the foreign exchange rate series of the countries primarily for this reason. The analysis of the stationarity of the series was observed through the KPSS (1992) among the conventional unit root tests, ZA (1992) and LS (2013) tests which allow one break among the unit root tests with breaks. The stationarity of the non-linear series were analysed through the ESTAR-type Kapetanios et al. (2003) and Kruse (2011) unit root tests.

According to the results of the Harvey et al. (2008) test, it was concluded that the foreign exchange rate series of Egypt, Mexico and Turkey are linearity; and the foreign exchange rate series of Bangladesh, Indonesia, Iran, Nigeria, Pakistan, Philippines, South Korea and Vietnam are non-linearity. Two different unit root tests were applied as conventional unit root test and unit root test with breaks for the countries with linear foreign exchange rate series. In the analysis of the linear foreign exchange rate series, the results of the KPSS (1992), the ZA (1992) and the LS (2013) unit root tests revealed that the null of a unit root, namely $H_0$ hypothesis indicating that the foreign exchange rate series of Egypt, Mexico and Turkey contain unit roots cannot be rejected. All of the three unit root tests provided consistent results. According to the three unit root tests; it was concluded that the selected foreign exchange rate yields of Egypt, Mexico and Turkey are non-stationary and they contain unit roots. It is possible to say that the weak-form market efficiency hypothesis is valid for the foreign exchange rates of those 3 countries analysed in this study. Consequently; since the foreign exchange rate yields follow a random walk in those countries, it is possible to say that it is impossible to earn abnormal profits through the previous price data or technical analysis methods in those countries. In the analysis of the non-linear foreign exchange rate series; the KSS unit root test indicated that the foreign exchange rate yields of Bangladesh, Indonesia, Iran, Nigeria and Pakistan are non-stationary; they contain unit roots while others do not. The Kruse (2011) unit root test indicated that the foreign exchange yields of Iran and Nigeria is non-stationary for all three of the raw, demeaned and detrended models; the foreign exchange rate yields of Bangladesh and Pakistan are non-stationary in detrended model, and they contain unit roots. In general, those results support that the weak-form EMH is valid for the foreign exchange markets of the Next 11 countries; the markets are efficient in the weak-form; those markets follow the RWH to determine the prices; the investors behave rationally; therefore, the participants cannot earn abnormal profits from the foreign exchange markets in the Next 11. Those results indicate that the shocks on the foreign exchange markets and the policies to be followed will have permanent effects for the Next 11 and they can also affect the other macroeconomic factors. Another result of the study indicates that it is more sufficient to analyse the foreign exchange rate series through the non-linear unit root tests in addition to the linear unit root tests and unit root tests with breaks. According to the another result of the study, each of the break points determined in all series is determined to occur during the global financial crisis from USA which started in 2008 and lasted until the end of 2011.

The results of this study have substantial policy suggestions for policymakers and participants of the foreign exchange market of Next 11. Finding a solution to the validity of weak-form market efficiency problem that induces substantial economic and financial problems is one of the field missions for policymakers. The effect of a well-working, developed and efficient financial structure to establish a stable economic structure is obvious for all countries. Therefore, the countries should develop strategies supporting the existence of the innovative financial markets in their growth policies and they should provide incentives because market information efficiency provides encouragements for investors to go into new investment initiatives and companies. In the countries where the EMH is provided, the rates for savings increase and the investment opportunities for financial instruments and cushion of capitals are presented to the national economy. Given the weak-form efficiency of the exchange rate of Next 11, increased foreign exchange market activities will undoubtedly lead to the recovery in the allocation of funds because an efficient exchange market plays a role to the efficient allocation of a nation’s financial funds. Hence, it is crucial for the policymakers to develop long-run policies for their financial markets to be efficient. However, in an inefficient exchange rate, government responsibilities can evaluate the best way to affect exchange rates, decrease exchange rate movements and determine the outcomes of different economic policies. Besides;

since those countries have fragile economic structures, the foreign exchange selections become more important for them.

It is observed from the studies carried out that the rates of savings increase and the investment opportunities for financial instruments and cushion of capitals are presented to the national economy in the countries where the EMH is provided. Within this context, providing the market efficiency is crucial for the Next 11 which has fragile structures in terms of increasing the rates of savings and providing investment opportunities for financial instruments. Therefore, the policy-makers should take the necessary measures, carry out legal regulations and provide several incentives to enable the efficient market hypothesis to be valid. It is necessary to remove the fragile structure of the Next 11 in the financial markets and to direct the current resources to the investments in a best way possible. Several policies should be developed to minimize the extreme mobility of the foreign exchange markets of the Next 11 countries. Enabling a capital market which is efficient and which fulfils its duties will contribute to the development of the national economies and financial markets undoubtedly. Furthermore, it can be important for the governments to guarantee to provide hot money flow to their own countries and that their foreign exchange markets are efficient to enable to increase the number of investments in their own countries.

We recommended future studies consider exchange rates, other econometric models such as asymmetric and nonlinear models and using different unit root tests to examine and compare with current findings. Moreover, since most of the economic time series have unit roots, evaluating the Harvey test for the linearity analysis to be carried out in the future will be beneficial for the reliability of the results. Additionally, the results to be obtained through repeating those kinds of studies in different periods can guide the investors. The unit root tests considering one structural break were also used in the study to analyse the stationarity of the linear series. It is necessary to mention that there were several financial and economic crises in the developing countries during the analysed period. From this point of view, it is suggested to study whether the foreign exchange rates are stationary and whether the weak-form EMH is valid through the unit root tests considering multiple structural breaks. Besides, this research only focused on weak-form market efficiency in Next 11, hence future studies might consider testing the semi-strong and strong market efficiencies in Next 11.

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