A STUDY ON THE RISKS AND EFFICIENCY OF THE FOREX MARKET BASED ON THE DETRENDED FLUCTUATION ANALYSIS

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OPEN ACCESS

How to cite this paper: Shehu, E., Çupi, B., & Duraj, B. (2024). A study on the risks and efficiency of the forex market based on the detrended fluctuation analysis. *Risk Governance and Control: Financial Markets & Institutions, 14*(4), 59–67.
https://doi.org/10.22495/rgcv14i4p6

ISSN Online: 2077-4303
ISSN Print: 2077-429X

Received: 18.04.2024
Accepted: 18.10.2024

JEL Classification: E00, F49, G40
DOI: 10.22495/rgcv14i4p6

Abstract

Exchange rate fluctuations profoundly impact macroeconomic variables, making them a focal point for policymakers. This study is grounded in the efficient market hypothesis (EMH), asserting that such forecasts offer no utility due to all relevant information being embedded in asset prices. The research problem is rooted in the dynamics of currency exchange rate fluctuations and their impact on the Albanian economy. The research aims to analyse Albanian lek (ALL)/euro (EUR) exchange rate dynamics and their impact on Albania's economy, assessing market efficiency and providing insights for monetary and fiscal policy design. The method used is a detrended fluctuation analysis (DFA) which consists of a root mean square analysis of a random walking pattern (Peng et al., 1994). This method is used to assess adherence to the weak form of EMH. Findings indicate that the Albanian foreign exchange market closely resembles a random walk, suggesting efficiency during specific periods. The study underscores the exchange rate's dual impact: its influence on domestic price levels and its broader implications for the real economy and balance of payments. This paper is relevant as it offers crucial insights into currency exchange rate dynamics and their economic impacts, supporting policymakers in improving Albania's economic stability and market efficiency.

Keywords: Efficient Market Hypothesis, Foreign Exchange Market, DFA, Random Walk

Authors' individual contribution: Conceptualization — E.S. and B.Ç.; Methodology — B.Ç.; Investigation — E.S. and B.Ç.; Resources — E.S. and B.Ç.; Writing — E.S., B.Ç., and B.D.; Writing — Review & Editing — B.D.; Supervision — E.S.; Funding Acquisition — B.D.

Declaration of conflicting interests: The Authors declare that there is no conflict of interest.

1. INTRODUCTION

Globalization is a phenomenon that integrates different markets around the world into one. As markets increasingly interact in the world economy, exchange rate management takes on a critical role in a country's macroeconomic policy. Rusi (2016) states that "with a small and open economy such as Albania, the local currency exchange rate plays an important role in both the price level and the balance of payments, in the level of productivity, in the volume of foreign assets in the country, as well as in attracting foreign investment and many other factors in the country" (p. 8). Cakrani (2014) cites that the real exchange rate is seen as a key indicator of a country's competitiveness, and it is

even considered the most reliable indicator of competitiveness in the Albanian context. Furthermore, there is evidence that a volatile exchange rate can have negative implications for economic growth.

So far, there is a considerable gap in the literature on this behalf. There is limited empirical research focusing on the Albanian currency exchange rate dynamics and their implications for the Albanian economy. Most existing studies are either generalized for broader regions or focus on more developed economies, leaving a gap in country-specific analysis for Albania. Secondly, the influence of technological advancements, such as algorithmic trading and digital currency trends, on the Albanian forex market is largely unexplored. Assessing how these factors affect market behaviour and efficiency could provide insights into future market developments. Last, but not least, efficient market hypothesis (EMH) has been extensively studied in global forex markets. Nevertheless, there is limited literature examining the efficiency of the Albanian forex market. Investigating whether the market adheres to the weak form of EMH remains underexplored.

EMH has been extensively studied in the context of various currencies. If the forex market is efficient, all available information is fully utilized by risk-neutral agents to set current and future exchange rates, leading to an expected zero return from speculation (Baillie et al., 1983). According to EMH, currency prices incorporate all relevant market news, meaning that investors cannot achieve extra returns by analysing past price movements. Frenkel and Mussa (1980) further suggest that the assumption of a strong link between current exchange rates and future expectations should hold true at least in the short term. From this point of view, the purpose of this paper is to study the exchange rate fluctuations in Albania and its efficiency during a timeframe from 2008 to 2017. The research aims to analyse Albanian lek (ALL)/euro (EUR) exchange rate dynamics and their impact on Albania's economy, assessing market efficiency and providing insights for informed monetary and fiscal policy design.

Various studies on exchange rates indicate fluctuations in the market, with periods of depreciation and appreciation (Rusi, 2016). According to the EMH, market prices should properly adjust to reflect all available information on an asset, contrasting with some empirical results. This paper seeks to answer the research question:

RQ1: How efficient is the forex market in Albania?

Specifically, it investigates whether exchange rate fluctuations can be predicted or if they follow a random walk.

As a starting point, the paper is based on the EMH, which is a widely accepted economic theory in recent years. The review focuses on the foreign exchange market, but these records are also relevant to other asset markets, such as stocks.

In terms of methodology, this paper utilizes detrended fluctuation analysis (DFA), a method introduced by Peng et al. (1994), to examine long-term financial relationships in asset prices. DFA, which involves a root mean square analysis of random walking terms, is simpler and more effective than many other methods for evaluating long-term correlations in non-stationary time series. Applied to daily ALL/EUR exchange rate data, DFA will assess the efficiency of the Albanian forex market by dividing data into non-overlapping groups and analysing local trends. Using this methodological perspective and by assessing whether these fluctuations can be predicted or follow a random walk, the research provides crucial insights for policymakers, investors, and researchers aiming to enhance market stability and economic planning.

The structure of this paper is as follows. Section 2 reviews the relevant studies and literature contributions related to forex fluctuations and EMH. Section 3 describes the DFA used to run the analysis and data description. Section 4 reveals the results and discussion related to the research problem discussed earlier in this paper. Section 5 summarizes the conclusions.

2. LITERATURE REVIEW

2.1. From random walk to behavioural finance: The EMH debate

The EMH is a theory that has been accepted by economists only in recent decades, but according to Sewell (2011) starting from the 16th century we find literature of various authors that are clearly related to the EMH. The full formulation of this hypothesis dates to the 1960s when many authors considered the capital market efficient. According to Fama (1970), as cited in Delcey (2019), the EMH describes a competitive market where price fluctuations are random due to prices converging toward their fundamental values. This is commonly referred to as "Fama's EMH". However, it was the work of Fama (1970), that this theory became known, thus winning the 2014 Nobel Prize in economics. He defined an "efficient market" as a market which "adapts quickly to new information". Next, E. F. Fama in the revised article defines an "efficient market" as a market in which asset prices "reflect all available information" (Fama, 1991, p. 1575). This means that the market processes information rationally, in the sense that relevant information is considered, and no systematic errors are made (Beechey et al., 2000).

EMH is related to the idea of a "random walk", which is a term widely used in the financial literature to characterize a price series, where all price changes represent random deviations from previous prices. According to Malkiel (2003), the logic of random progress is that, if the flow of information is unimpeded and the information is immediately reflected in the prices of assets, then the change in future prices will reflect only the news of the future, regardless of price changes today. So, this theory considers that the future evolution of prices cannot be predicted (Ţiţan, 2015).

Ţiţan (2015) notes that until the early 1930s, the theory of random walk was ignored by scholars and scientists. Only after the 1960s, did this theory begin to be widely explored. Fama (1970) supported the theory of random walk based on empirical studies. Also, Kendall and Hill (1953) supported the character of a random walk in the prices of financial assets. After this period, around the 1980s, an idea took shape regarding behavioural finance. This new theory began to contradict the theory of random walk by emphasizing the influences of investor behaviour. Some of the authors who

opposed random walk in their articles were Lo and MacKinlay (1999) and Conrad and Kaul (1988), who found that stock returns had positive autocorrelation for short periods of time. Bodie et al. (2014) mention that some other authors who also did not support the hypothesis were Lo et al. (2000), Jegadeesh and Titman (1993), De Bondt and Thaler (1985), and Chopra et al. (1992), where the latter found evidence that stocks that perform poorly in one period have a strong tendency to perform well in other periods and vice versa.

Fama (1970), in addition to the definition of efficient markets, also distinguishes between three forms of efficiency, denominated as weak, semi-strong and strong forms of market efficiency. The first one suggests that prices reflect all information where the benefits of using it do not outweigh the costs of gathering it (Beechey et al., 2000). Thus, technical analysis cannot provide a market advantage, as such information is already widely known (Bodie et al., 2014). The second one asserts that all public information, including firm data and forecasts, is reflected in stock prices (Bodie et al., 2014). Consequently, no investor can earn abnormal returns using publicly available information, making both fundamental and technical analysis ineffective (Beechey et al., 2000). The last one posits that prices incorporate all available information, including historical data, public information, and private insider information Ţiţan (2015). At this highest level of efficiency, no investor, regardless of having private or public information, can achieve abnormal returns. While the semi-strong form excludes the effectiveness of both technical and fundamental analysis, the strong form suggests even insiders cannot gain excess returns. Studies by Chowdhury et al. (1993) and Drew and Noland (2000) challenged EMH, showing abnormal returns for insiders and fund managers. However, Malkiel (2003) affirmed that markets are generally more efficient and less predictable than some studies suggest, reinforcing EMH as a foundational theory in financial economics.

The EMH was first tested in the stock market. However, this theory soon began to be used to test the foreign exchange market as well. Exchange rates between different currencies have always shown large fluctuations. This fluctuation of exchange rates is a constant concern of government policies, and their explanation is a challenge to theories of foreign exchange market behaviour (Frenkel & Mussa, 1980). According to EMH, there is no room for abnormal returns on financial market contracts. An efficient foreign exchange market means that adjustments in this part of the financial sector are useless and moreover these adjustments would be impossible. Makovský (2014), stated that the result of efficient markets means that the more liberal the financial markets, the more productive the real economy. Makovský (2014) emphasizes that the additional motivation for conducting the fundamental analysis of exchange rates came from the monetary policy transmission mechanism and the exchange rate model. Studies conducted to test this hypothesis in the exchange rate market by Hasen and Hodrick (1980), Goodhart (1988) and Frankel and Chinn (1993) show that through a wide range of currencies and time periods, the previous exchange rate has been a predictor of the future exchange rate.

Allen and Taylor (1990) report that over 90% of foreign exchange traders in London have used technical analysis to inform their forecasts one to four weeks in advance. It is difficult to understand this almost universal use of technical analysis if the foreign exchange market is efficient (Beechey et al., 2000). Price distortion should be a serious problem in the foreign exchange market. The almost complete inability of economists to explain fluctuating exchange rate movements in the short and medium term, in economic terms, has led to the rejection of the EMH (Beechey et al., 2000). But this fact has led many other authors to conclude on the efficiency of the foreign exchange market. In his work, Crowder (1994) mentions among others these authors: C. S. Hakkio and M. Rush, R. MacDonald, and M. Taylor, who have investigated the trends that may exist between different currencies. They did not find evidence showing the co-integration of the studied currencies, assessing this situation as the efficiency of foreign exchange markets.

In overall, evidence suggests that financial market returns are partly predictable, in ways that sometimes conflict with EMH. From all the studies conducted, no conclusion can be drawn about EMH, as almost half of the studies support the hypothesis and the rest reject it, at least in terms of its weak form. Whereas, for the semi-strong and strong form, the researchers for the most part agree that the markets in general are far from being efficient in these two forms.

2.2. Foreign exchange market in Albania

Albania started to have an open economy after the 90s, therefore market liberalization is not highly developed. However, Albania has an open economy and a free exchange rate regime. Hence, ALL, in relation to other currencies is freely determined in the foreign exchange market, through supply-demand. Albania has a high volume of import exports from foreign countries. This free movement of goods and capital in trade and financial exchanges is reflected in exchange rate fluctuations, therefore affecting all other prices in the economy.

The exchange rate is the external value of a country's currency against the currencies of its most important partners. Thus, the exchange rate is an indicator of the price of money and the most used indicator for measuring competition in international trade. Having such an important role, the exchange rate is a strong point that we must evaluate very carefully. There are two primary reasons for studying the exchange rate. The first pertains to its impact on the domestic price level, while the second concerns its influence on the real economy and the balance of payments, driven by changes in the relative prices of tradable and non-tradable goods and services (Vika et al., 2015).

Studying the exchange rate is almost a challenge, as it is closely related to the macroeconomic indicators of an economy while carrying the typical uncertainty of a financial indicator. Further, Velaj and Nexhipi (2022) find a significant and positive relationship between the exchange rate and the stock of debt and merchandise trade.

Although the exchange rate has been studied earlier, the contemporary foundations of its valuation are attributed to G. Cassel's theory of

purchasing power parity (Kadochnikov, 2013). Purchasing power parity is a condition that says that, if we ignore transportation costs, tax changes and trade restrictions, due to arbitrage tradable goods and services should have the same price in both countries, after we convert their prices into a common currency. G. Cassel set out a theoretical framework for exchange rate modelling stating that prices in all economies should be the same when expressed in the same currency.

Various studies on the exchange rate provide evidence that there have been fluctuations in this market, i.e., with periods of depreciation or appreciation (Rusi, 2016). The EMH as opposed to the empirical results suggests that market prices are properly adjusted to reflect any available information on the asset.

Sánchez-Granero et al. (2020) found that the Latin American market scores for a weak form of efficiency, leading to possible arbitrage opportunities. This article seeks to evaluate such a statement for Albania. On the other side, Khan et al. (2021) find that a weak form of EMH is not valid in the USA. The historical data can predict short-term future price movements. Having these different patterns of EMH, this article aims to address this research question:

RQ2: How efficient is the forex market in Albania, in the sense that exchange rate fluctuations can be predicted, or do they follow a random walk?

Many studies have been conducted to test the random walk and weak form of the EMH and the results of the authors vary. This paper hypothesises whether the foreign exchange market, in a small and developing country such as Albania, is expected to be inefficient according to EMH, most of the time.

3. RESEARCH METHODOLOGY

3.1. Research method

Since the introduction of the EMH theory in 1970 numerous studies have been conducted to test the efficiency of the securities and foreign exchange markets. We have enough data for the foreign exchange market to consider because this market is very liquid and with many transactions. Different tests have been applied to different exchange rates at different time periods in other countries, but these tests have failed to reach a consensus on the foreign exchange market efficiency hypothesis. Some of the methods we can mention are "Spectral analysis", "Hurst analysis", "Detrended fluctuation analysis", "Dickey-Fuller", "Phillips-Perron", "Detrended cross-correlation analysis", centred moving average (CMA), method and a modified detrended fluctuation analysis (MDFA).

Bashan et al. (2008) discovered that when comparing standard DFA to MDFA, DFA generally demonstrates slightly superior performance across the examples examined. They explored the impact of various types of trends on different DFA methods. For weak trends, the new methods show comparable performance to DFA. However, when the functional form of the trend is unknown beforehand, DFA remains the preferred method. For this purpose, this paper will utilize DFA. DFA was first introduced by Peng et al. (1994) and has been widely used to test whether long-term financial relationships exist between asset prices in the market. The DFA method introduces a root mean square analysis of a random walking term (Peng et al., 1994). Sin (2023) states that DFA is a method for determining the statistical self-affinity of a signal.

This method is simpler than many other methods, but there are some advantages over them. The advantages of this method compared to other methods are that it allows the evaluation of long-term relationships embedded in seemingly non-stationary time series and avoids the erroneous detection of seemingly long-term relationships that emerge as the object of non-stationarity. According to Peng et al. (1994), this method has been proven in the control of time series consisting of long-term correlations with the overlap of a non-stationary external trend.

Foreign exchange market efficiency analysis in Albania using volatility analysis, DFA is based on the daily ALL/EUR exchange rate. All data that we will consider constitute the interval with length *N*. These data are expressed as a function of time *y(t)*, where $t = 1, 2, \ldots N$.

Then we divide the data with this length into N / n groups with an equal number of data (n), assuring that the groups have no overlap between them, and that n is an integer. For each set of lengths n we find the local trend function:

$$z(t) = at + b \tag{1}$$

where, *z(t)* can be applied using the usual least squares method for each of the data in each group. Then we remove the trend from the data *y(t)* by subtracting *z(t)* for each data set. The detrended fluctuation function, *F(n)*, is calculated as:

$$\sqrt{F^2(n) = \frac{1}{n}\sum_{t=kn+1}^{(k+1)n} |y(t) - z(t)|^2} \tag{2}$$

where, $k = 0, 1, 2, \ldots, (N / n - 1)$.

This calculation is repeated for each time data in each of the data sets to test a relationship between *F(n)* and *n*, i.e. between the mean of the fluctuations, which is expressed as a function of the group size, and the group size itself, *n*. Normally, *F(n)* should increase with increasing group size, *n*. The relationship between *F(n)* and n is expected to be:

$$[F^2(n)]^{\frac{1}{2}} \sim n^{\alpha} \tag{3}$$

The delineation to successfully calculate the DFA method and the α coefficient is summarized below.

1) First, integrate the time series by adding and subtracting the mean creating a zero-centre signal.

2) Then define time series with length *N* and divide them into several groups of equal length and where the groups have no overlap between them. So, data that belongs to one group does not belong to any of the other groups.

3) Determine the trend for each segment, the mean square root of the variance between time series *X*, and the small squares for each segment, *ys(i).*

4) We repeat the second and third steps for the time series of each segment. It is noted that rapid fluctuations in series will affect *F(n)* for small-size segments, while slow fluctuations will affect *F(n)* for large-size segments.

5) Set *F(n)* versus *n*, finding the logarithms with base 10 and calculating the slope of the line, α, constructing a simple linear regression equation. In this equation, we define the dependent variable *LogF(n)* and the independent variable *Log n*.

6) α is the exponent of the scaling or slope of the regression line and can be interpreted as:

- If $\alpha = 0.5$, the time series are independent, there is no relationship between them, and the time series represents a random walk. This is otherwise called "white noise" and time series follow a random walk.
- If $0.5 < \alpha < 1$, we have continuous long-term relationships in time series. This means that, if the series has been up or down in the previous period, then the chances are that these will continue to be up or down in the next period, respectively.
- If $0 < \alpha < 0.5$, we have continuous negative long-run relationships in time series. This means that, if the series has been up in the previous period, then the chances are that they will decrease in the next period and vice versa.

If there is a short-run correlation between series, the exponent may be different from 0.5, but α will approach 0.5 for groups with large data sets.

A special case is $\alpha = 1$ which can be interpreted as a "compromise" between the complete unpredictability of "white noise" and the softer model of "Brownian noise". Brownian noise is an integration of "white noise" (Peng et al., 1994) and refers to a random walk, where the probability that time series go either up or down is equal.

1. For ($\alpha \geq 1$) there are connections, but they do not correspond to a form of the law of power.

2. $\alpha = 1.5$ is "Brownian noise", so we have a random gait.

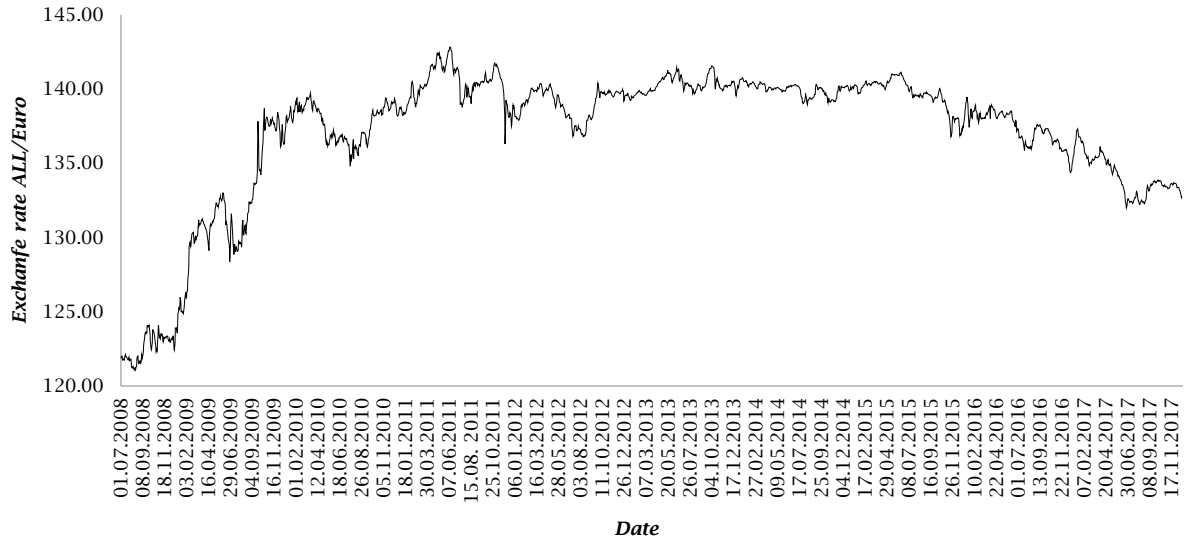
The larger the α, the "quieter" or "softened" the time series are. The presence of long-term continuous links shows evidence of a component for future returns and devalues the weak form of EMH.

3.2. Data description

This section presents the data used in this paper. The data used for the implementation of the DFA model are daily data of the exchange rate between ALL/EUR from July 1, 2008, to December 27, 2017. It is important to note that the data does not include exchange rates for holidays and official holidays, even though transactions occur, and exchange rates fluctuate on those days. The data was sourced from the exchange rate archive on the official website of the Bank of Albania in May 2019.

Figure 1 shows how the ALL/EUR exchange rate fluctuated during the years 2008–2017. The graph indicates that the ALL currency was significantly overvalued during the global crisis of 2008–2009. From the latter half of 2009 to the first half of 2012, exchange rate fluctuations were moderate. Between 2012 and 2015, the exchange rate remained quite stable. Towards the end of 2015, the onset of euroization in Albania led to the appreciation of the lek against the euro, reflected in a decrease in the exchange rate from 2015 to 2017. However, the graph alone is insufficient to assess the efficiency of the foreign exchange market, as it does not provide insight into repetitive exchange rate behaviour.

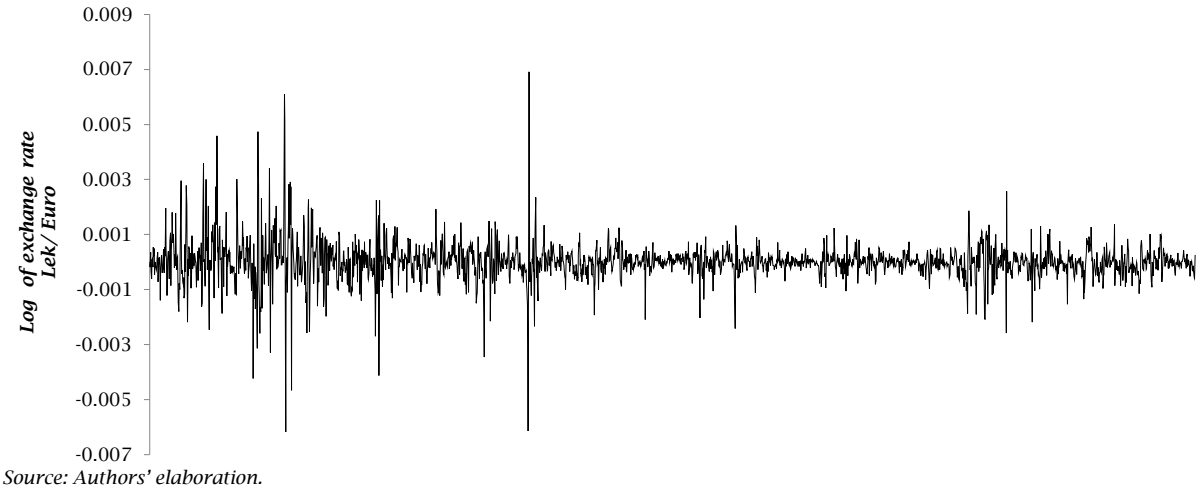
Figure 1. ALL/EUR exchange rate movements during the period from July 1, 2008, to December 27, 2017



Source: Authors' elaboration.

According to Abounoori et al. (2012), in a similar study on exchange rates, the return r_t at time t is calculated as the logarithm of the ratio between successive daily exchange rates. The following results from marking with y_t the exchange rate ALL/EUR at time t.

Figure 2. Log of exchange rate return ALL/EUR in the period from July 1, 2008, to December 27, 2017



Source: Authors' elaboration.

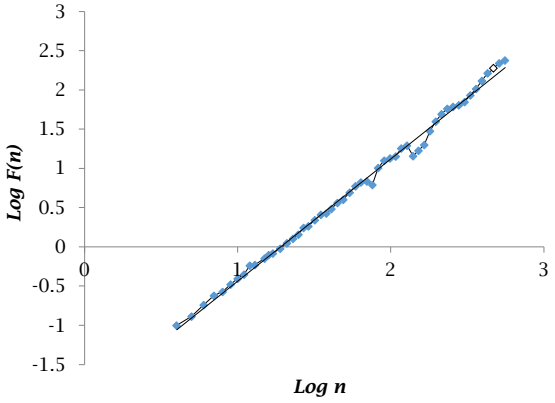
Referring to Figure 2 it is difficult to say that there are repeated patterns in the ALL/EUR exchange rate return logarithm. A careful examination of the figure shows that the exchange rate is quite stable over the period under consideration, except for some extreme fluctuations on certain days and greater fluctuations during the period 2008–2009. It appears that during certain short periods, a significant decrease in the exchange rate has been followed by a notable increase. However, this pattern has not consistently repeated over time, preventing us from identifying repetitive behaviours in specific periods. As a result, this observation alone does not provide a definitive answer regarding the efficiency of the foreign exchange market. Therefore, the following presents the results obtained from implementing the DFA model.

4. RESULTS AND DISCUSSION

The technician helps to give a quantitative measurement of the scaling coefficients. The time series used in the model contains $N = 2376$ data, which means that t varies from $t = 1$ to $t = 2376$. This data is divided into four segments or groups with an equal number of data, so each segment contains 594 daily data. For each segment $F(n)$ is estimated, which is compared to n^{α}. Next, logs on both sides, respectively $F(n)$ and $Log\ n$ are calculated. To estimate the coefficient α, a linear regression equation is performed, whereas independent variable we use $Log\ n$ and the dependent variable $Log\ F(n)$. The coefficient α represents the slope of the calculated regression line and is crucial for interpreting exchange rate efficiency. Additionally, following Abounoori et al. (2012), we employ the Wald test to assess the significance level of the observed parameter. The null or zero hypothesis we are testing is $\alpha = 1.5$. The Wald test can be calculated as $W = ((\alpha - 1.5)/\sigma^{\alpha})^2$ and has a Chi-square distribution with one degree of freedom.

In Figure 3, the scaling exponent, represented as the slope of the regression line from the DFA technique, indicates a relationship but does not follow a power law form. The scaling exponent, or α, from the estimated regression equation, is $\alpha \geq 1 \alpha \geq 1$ for the entire period under consideration. Specifically, $\alpha = 1.5577$ suggests a "Brownian noise" pattern, implying that the oscillations follow a random walk. Therefore, we can conclude that from 2008 to 2017, the foreign exchange market exhibited an almost efficient behaviour with a consistent, though not constant, random trend. This aligns with the weak form of the EMH, indicating that time series data are independent and current exchange rates cannot predict future exchange rates.

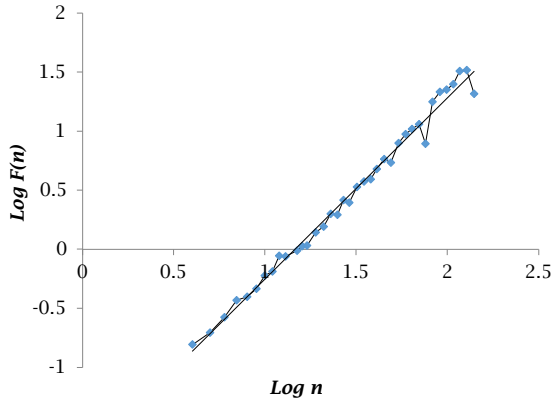
Figure 3. Scaling exponent from the DFA technique for the period from July 1, 2008, to December 27, 2017



Note: LogF(n) = 1.5577, Log n = 1.9919, R^2 = 0.9955.
Source: Authors' elaboration.

To assess this issue in deeper detail and to determine efficiency changes over time, we have divided the period into four subperiods: July 1, 2008–November 12, 2010, November 15, 2010–March 26, 2013, March 27, 2013–August 3, 2015, and August 4, 2015–December 27, 2017. The number of time series in each subperiod or group is 594 and for each group, the DFA function is performed, and the scaling exponent is found, α, constructing a simple linear regression equation. The results are presented in the graphs below, respectively in Figures 4–7. Also, the estimates for the coefficients in each group and for the period are presented together with the Wald test and the corresponding p-value in Table 1.

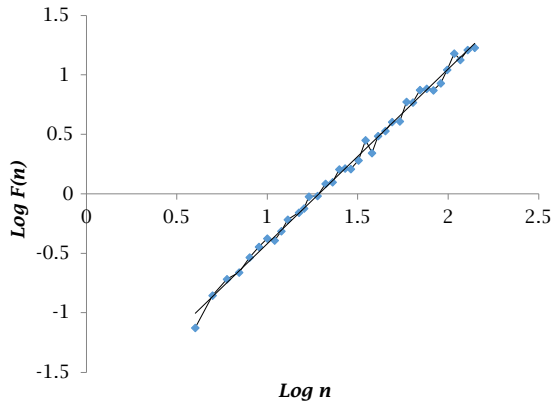
Figure 4. Scaling exponent from DFA — First period, from July 1, 2008, to November 12, 2010



Note: LogF(n) = 1.5359, Log n = 1.7881, R^2 = 0.9892.
Source: Authors' elaboration.

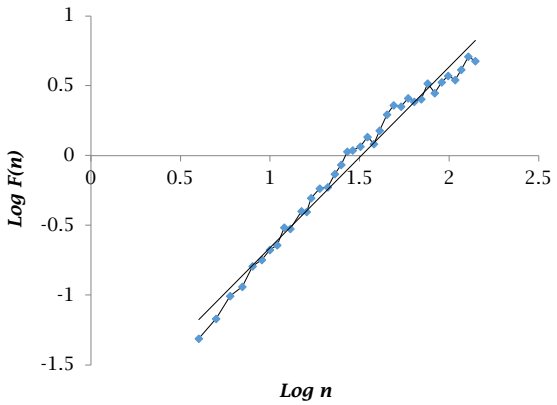
Figure 4 indicates that the exponent of the scaling for the first period is 1.5359, so it is very close to the value 1.5. This means that the time series in the first period follow a random course, they are independent and unrelated to each other. The foreign exchange market during this period has been efficient in its weak form.

Figure 5. Scaling exponent from DFA — Second period, from November 15, 2010, to March 26, 2013



Note: LogF(n) = 1.4684, Log n = 1.8874, R^2 = 0.9951.
Source: Authors' elaboration.

Figure 6. Scaling exponent from DFA — Third period, from March 27, 2013, to August 3, 2015

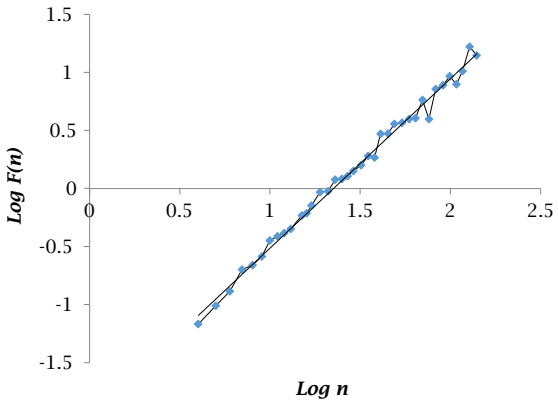


Note: LogF(n) = 1.2953, Log n = 1.9546, R^2 = 0.9813.
Source: Authors' elaboration.

Figure 5 shows the coefficient α for the second period under consideration. The estimated regression equation gives us an $\alpha = 1.4684$, which is very close to the value 1.5, indicating a "Brownian noise", random gait. Referring to the value 1.5 as an extreme case, we can say that the coefficient for the second period temporarily approaches the random walk or can be approached with this extreme condition as a limiting case.

Figure 6 presents the estimation of the scaling exponent by the DFA technique for the third period. The linear regression gives us an estimate of $\alpha = 1.2953$. As seen, this estimate of α is slightly further away from the value of 1.5 than in the case of the other periods considered. Examining the foreign exchange market from 2013 to 2015 (see Figure 1), exchange rates were quite stable during this period. This stability can lead to repetitive behaviours, allowing investors to make predictions. As a result, exchange rates fluctuated randomly.

Figure 7. Scaling exponent from DFA — Fourth period, from August 4, 2015, to December 27, 2017



Note: LogF(n) = 1.4589, Log n = 1.97, R^2 = 0.9923.
Source: Authors' elaboration.

The scaling exponent for the fourth period is 1.4589, which is close to 1.5. While this suggests that the market nearly follows a random walk, it does not imply that this behaviour is consistent throughout. The occasional random walk behaviour appears only temporarily or as a limiting result. Nevertheless, an α value close to 1.5 indicates that the market was almost efficient during the period from August 2015 to December 2017.

Table 1. Results of the DFA technique and the corresponding Wald test: Time period scaling exponent from DFA Wald test (p-value)

Time period	*Scaling exponent from DFA*	*Wald test (p-value)*
01.07.2008–27.12.2017	1.557 ± 0.044	11250.96 (0.0)
01.07.2008–12.11.2010	1.535 ± 0.074	3194.11 (0.0)
15.11.2010–26.03.2013	1.468 ± 0.047	7149.03 (0.0)
27.03.2013–03.08.2015	1.295 ± 0.082	1833.18 (0.0)
04.08.2015–27.12.2017	1.458 ± 0.059	4527.85 (0.0)

Table 1 provides a summary of the scaling exponents from the DFA technique, as well as the Wald test results and corresponding p-values for assessing the significance of the parameters. A p-value of 0.0 indicates that the parameter is statistically significant.

The data suggest that exchange rates fluctuate randomly, but there is no track of an extreme case where the series consistently follows a random walk. This implies that the market during this period was not as efficient as in other periods, based on theoretical evidence of the EMH.

Despite theoretical expectations of an inefficient market, the results show that the market is closer to efficiency than anticipated. While these findings do not fully confirm the EMH, which posits that market prices follow a random walk, they do indicate that financial data may support the EMH in the long run.

5. CONCLUSION

The aim of this paper was to assess the efficiency of the foreign exchange market in Albania, specifically evaluating whether future exchange rates can be predicted or if they follow a random trend. The analysis demonstrated that Albanian exchange rate data are very close to a random walk. Using volatility analysis and DFA, it was found that the market often approached a random walk but deviated from a strictly random pattern, although these deviations might be attributed to chance or short-term fluctuations.

The hypothesis suggested that the Albanian foreign exchange market could be inefficient, given the limited transparency in information transmission for a small, open, and developing economy. However, the results indicated that, contrary to theoretical expectations of inefficiency, the market is closer to efficiency than anticipated. While these findings do not fully validate the EMH, which posits that market prices follow a random walk, they suggest that the hypothesis may be supported by financial data over the long run.

As a result, price irregularities and predictable patterns may appear over time and may even persist for short periods of time. Moreover, markets may not be completely efficient, otherwise, there would be no incentive for professionals to disclose information, which is then reflected very quickly in market prices (Grossman & Stiglitz, 1980).

EMH is simple in theory, but it has proven to be very difficult to test and have accurate results. There is no consensus among economists on each of the three forms of EMH. Many well-known researchers even point out that this is because the models used to test it themselves are biased and can give erroneous results (Ţiţan, 2015).

The paper highlighted two key reasons for studying exchange rates: their impact on domestic price levels and their influence on the real economy and balance of payments. An efficient foreign exchange market ensures that market prices are well-regulated and accurately reflect the state of the economy. Since exchange rates affect all other prices, effective monetary and fiscal policies can then support economic development. However, the challenge remains: how can we drive markets toward greater efficiency? Providing a definitive answer is complex. Many researchers argue that markets tend to self-regulate and become more efficient over the long term while identifying and addressing inefficiency factors in the short term is more challenging.

Like any other paper, this paper has its limitations, which must be considered when used to draw conclusions on various issues. Below are some recommendations for the model used that may be valid for other studies to be conducted on the same topic. First, the necessary data for conducting the study are daily time series, but the data found in the exchange rate archive of the Bank of Albania lack exchange rates for days that are official holidays or holidays, days in which the Bank of Albania has not published the relevant norms. Second, time series are influenced by trends, seasonality, cycles, and irregularities. The model used only considers the effect of the trend and removes it to study exchange rate volatility. So, this method leaves out of the study the other effects that affect time series.

It is recommended that if a study is conducted on the efficiency of the foreign exchange market through the volatility analysis, DFA, the two recommendations set out above should be considered. Furthermore, it would be preferable to use quadratic or cubic functions rather than simple linear regression, which could not be incorporated into this paper due to the scope of the study.

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