Are interest rates unit root in Ghana? An Empirical Assessment

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ABSTRACT

The paper examines the hypothesis of unit roots in interest rates [Proxied by Treasury bill-T-bill- rates (91-day T-bill rate, 182-day T-bill rate, and 1-year T-bill rate] for Ghana for the period 2007 to 2013, using monthly data. The test was performed by employing the Augmented Dickey-Fuller (ADF) test and the Kwiatkwski, Phillips, Schmidt and shin (KPSS). The results of the tests indicate T-bill rates have unit root in levels supporting the unit root hypothesis for Ghana.

Keywords: Treasury bill rate; Interest rate, Unit Root
Jel Codes: E43, E44, G12

1 INTRODUCTION

The issue of unit roots in interest rates has gained the attention of researchers in economics and finance for a lot of time because of the role of interest rate in the economic growth and development as a policy variable (Okyere & Nanga, 2014; Hsing, 2015; Akram & Li, 2016). The findings of the empirical studies of the unit root in interest rate hypothesis are found in the various studies of researchers (Hall, Anderson & Granger, 1992; Wu & Zhang, 1997; Rahman & Mustafa, 2009; Cerrato, Kim, & MacDonald, 2010 Logubayom, Nasiru, & Luguterah, 2013; Takele, 2013; Logubayom & Luguterah, 2014; Okyere & Nanga, 2014; Hsing, 2015; Akram & Li, 2016).

For example, Hall et al. (1992) examined the cointegration properties of U.S. Treasury bills maturity and provided evidence for a unit root in the interest rate for the U.S. Their study supported the unit root hypothesis in interest rate. Wu and Zhang (1997) analysed a panel of cross-maturity Treasury-bill yield series by employing a panel-based test. The findings of the study indicated that the null hypothesis that each yield series contains a unit root does not hold.

Rahman and Mustafa (2009) examined the unit root properties of U.S. treasury securities (10-year T-bonds and 3-month T-bills) using monthly data for the period 1973-1999. The findings of the study suggest that the U.S. exchange rate, 3-month T-bill rates and 10-year T-bond yields are nonstationary both in real and nominal terms at 5 percent level of significance, with the trend and without.

Cerrato et al. (2013) investigated the unit root properties of Canada and the U.S. for different interest rates (25) including T-Bill rates with different maturity rates. The findings of the study indicated that the rates were stationary in levels supporting the null hypothesis of the non-unit root hypothesis.

Logubayom et al. (2013) examined the unit root properties for the 91-day Treasury bill rate and 182-day Treasury bill rate and reported that both rates are unit root in levels using annual time series and the ADF test. However, the rates attained stationarity on first differenced supporting the unit root hypothesis for Ghana.

Takele (2013) studied the stationarity properties of the T-bill rate for Ethiopia using quarterly data for the period 2000 to 2010. The test was based on the ADF, Phillips-Perron Unit Root Tests (PP), and KPSS tests. The results showed that the T-bills are not the unit root.

Logubayom and Luguterah (2014) investigated the stationarity properties of the 91-day Treasury bill (T-bill) and 182-day Treasury bill (T-bill) using data for Ghana for the period 2000 to 2012, employing the ADF test and the PP unit root tests. The findings of both tests indicated that the rates are unit root in levels with constant, without constant, and with trends.

Okyere and Nanga (2014) paper investigated the stationarity features of the 91-day T-Bill rate for Ghana using the ADF and KPSS tests using weekly time series data. The results suggest the variable is stationary in levels and support the stationarity properties for the period under discussion.

Hsing (2015) studied the unit root properties of Spain short-term T-bill rates for the period 1999 to 2014 using quarterly data (1999.Q1 to 2014.Q2) using the ADF test. At 5%, level of significance the null hypothesis of nonstationary could not be rejected in levels but their first differences.

Akram and Li (2016) examined the unit root properties of US long-term and short-term interest rates and reported that at a 5% level of significance, the interest rates were unit root in levels. The rates attained stationarity in the first differences indicating that the rates are integrated of order one. The test was based on both ADF and PP tests.

The review of the empirical verification of the unit root in T-bill rates indicates that unit root hypothesis is supported in some studies whereas in some other empirical studies the hypothesis is not supported. Thus, the empirical investigation of the unit root hypothesis has yielded inconsistent results in the literature. This is the motivation of the current studies to add to the empirical literature.

The paper contributes to the body of knowledge in the literature in the area of macroeconomic and international finance by empirically investigating the nature of unit root properties of T-bill rates. The study specifically investigates whether T-bill rates are stationary in levels in Ghana for the period 2007-2016. The paper provides an answer to a question that is, are T-bill rates stationary in levels? The Hypothesis behind the paper is that T-bill rates are unit root in levels in Ghana for the period under discussion.

The data used are secondary data from the Bank of Ghana database, and the data is subject to all challenges of secondary data. The findings are limited by the challenges of the ADF test and KPSS test. The rest of the paper looks at the methodology, the empirical results, and policy implications.

2 METHODOLOGY

2.1 Data

The data for the empirical verification of the hypothesis is based on monthly secondary data on the interest rate (T-Bill rates) for Ghana for the period 2007-2016. The source of the data is the Bank of Ghana. The sample size for the study is 118.

Table 1 Data Description, Proxies and Sources

Data Description	Source
1Year T-Bill Rate (TB1)	Bank of Ghana
182-Day T-Bill Rate (TB182)	
91-Day T-Bill Rate (TB91)	

2.2 Data Analysis method

The ADF test and KPSS test are used for the analysis.

2.2.1 The ADF Test and the KPSS Test

The stationarity test is performed to determine whether the variable in the model is stationary. If the variable is non-stationary, it is made stationary by differencing. For the present study, the unit root test is performed using the Augmented Dickey-Fuller (1981) (ADF) and Kwiatkowski et al. (1992, KPSS). The stationarity test results provide information on the order of integration of the variable (order zero; zero or higher order of two or three). The ADF test is based on the null assumption that the series are integrated of order one I (1). The KPSS test is based on the assumption that the series are integrated of order zero I (0). The ADF test unlike the KPSS is considered to have low power of tests and might accept a false null hypothesis. The null assumption (H_o) is that there is a unit root in levels. The alternative hypothesis (H_1) is that the series is stationary in levels. Since there is an enormous literature on the ADF and KPSS tests, the models are not provided in the current study.

2.2.2 Conceptual Framework

The theoretical framework is that when the T-bill rates are stationary in levels the presence of shock to T-bill rate remains permanent and not temporary.

3 EMPIRICAL RESULTS

The empirical results on descriptive statistic; ADF test results and KPSS are presented and discussed in this section of the paper.

3.1 Descriptive Statistics

The results of the summary statistics of the variables are reported in Table 2. The degree of variations in the variables under-investigated is measure by the maximum and minimum values. TB1 falls as low as 10.1300 and rises as high as 827.0700. The TB182 falls as low as 9.8500 and rises as high as 36.2000. The TB91 falls as low as 9.1300 and rises as high as 27.8000. The central tendency of the series variables is measured by the mean and the values indicate a good fit. The coefficient of variation is used to measure the volatility of the variable. The TB1 (3.0000) is more volatile followed by TB182 (0.3377) and then TB91 (0.3285). The coefficient of skewness is used to measure the nature of the distribution of the variables. The range of the coefficient of skewness is between positive one (1) and a negative one (-1). The TB1 is positively skewed whereas that of TB182 and TB91 is negatively skewed. The coefficient of kurtosis was used to measure the peaks of the series variables. The coefficient value of kurtosis of the series variables is more than unity (1) which indicates less flat-topped distribution.

Table 2 Summary Statistics

Using the observations 2007:10 - 2017:07				
Variable	**Mean**	**Median**	**Minimum**	**Maximum**
TB1	30.8619	20.0000	10.1300	827.0700
TB182	19.6691	22.0900	9.8500	36.2000
TB91	18.9774	22.7000	9.1300	27.8000
Variable	**Std. Dev.**	**C.V.**	**Skewness**	**Ex. kurtosis**
TB1	92.5870	3.0000	7.6356	57.9909
TB182	6.6420	0.3377	-0.1728	-1.3188
TB91	6.2339	0.3285	-0.4017	-1.5549

Source: Author's Computation, February 2017

3.2 Results of Unit Root Tests

Two main unit root tests were used in the present study. They are the Augmented Dickey-Fuller test (ADF) and Kwiatkowski, Phillips, Schmidt and Shin (KPSS).

3.2 Time Series Plots

The Time series plots of the variables are shown in Figure 1 to Figure 6. The plots in levels indicate the variables are not stationary in levels (Figure 1, 2, and 3). However, the variables attained stationarity on first differenced (Figure 4, 5, and Figure 6).

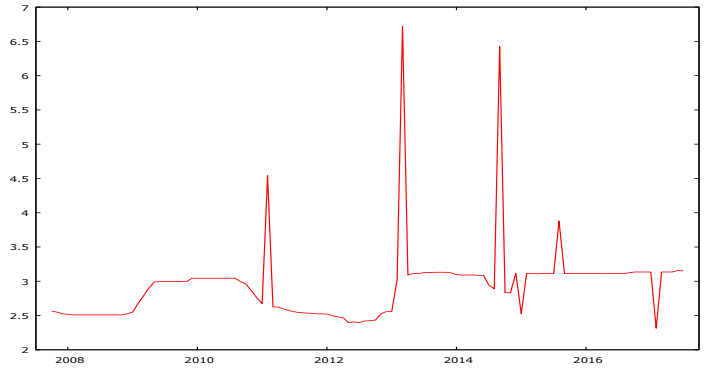

Figure 1. The plot of 1-Year Interest Rate (levels)

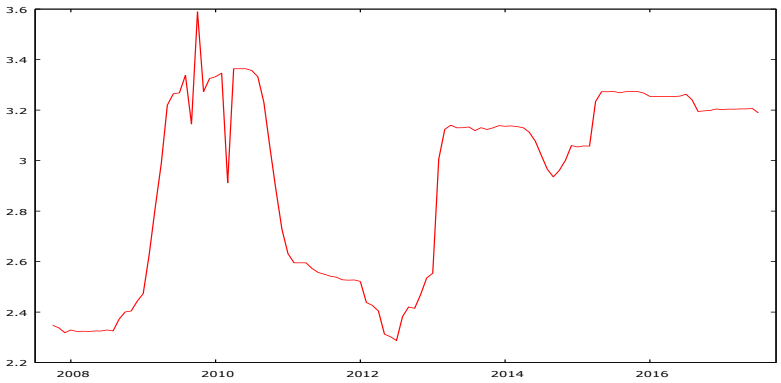

Figure 2. The plot of 182-Day Interest Rate (levels)

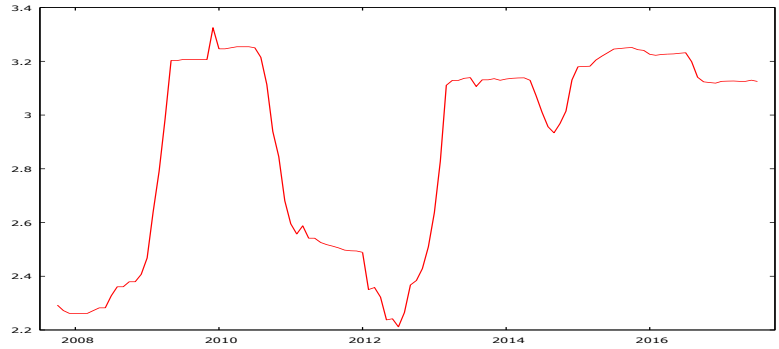

Figure 3. The plot of 91-Day interest Rate (levels)

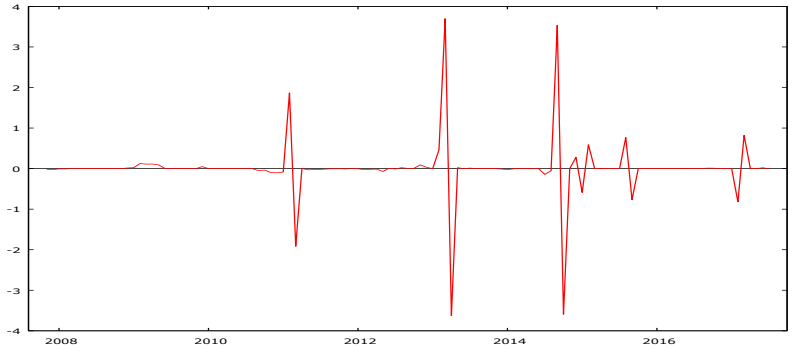

Figure 4. The plot of 1-Year Interest Rate (1st difference)

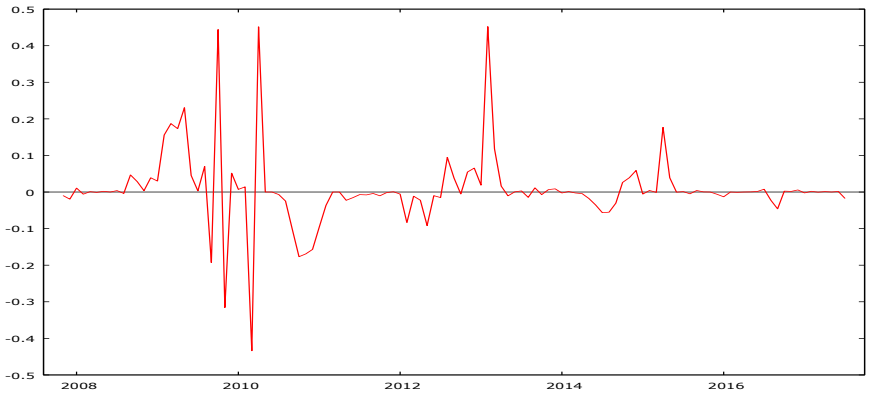

Figure 5. The plot of 182-Day Interest Rate (1st difference)

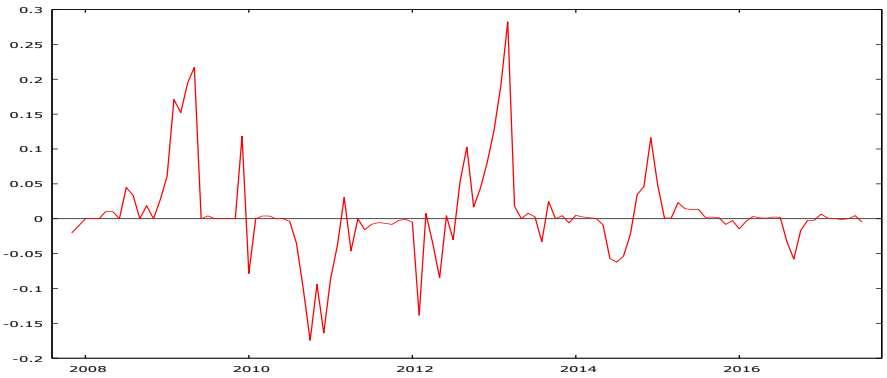

Figure 6. The plot of 91-Day interest Rate (1st difference)

3.2.2 The ADF Test

The ADF test was used to investigate the stationarity properties of the variables with constant and time trend in log-linear form. Table 3 reports the results. The results of the ADF test indicate that the T-Bill rate for one year (lnTB1) is not unit root in both levels and on the first difference. The null hypothesis of the unit root was not accepted. The rest of the interest rates (182-day interest rate, and 91-day interest rate) were not stationary in levels. However, the variables attained stationarity on the first difference. The null hypothesis of the unit root was not rejected in levels. The null hypothesis of the unit root was rejected on the first difference. These results indicate that the series exhibit unit root processes.

Table 3 ADF stationarity test results with a constant and Time Trend

Variables (Levels)	t-Estimated	t-Critical	ADF P-Value	Results	Lag length
lnTB1	-0.8848	-9.5102	0.0000	Not Unit Root	12
lnTB1-1st diff.	-2.8829	-8.7829	0.0000	Not Unit Root	12
lnTB182	-0.0939	-2.3486	0.4069	Unit Root	12
lnTB182-1st diff.	-0.8047	-4.3868	0.0022	Not Unit Root	12
lnTB91 (level)	-0.0509	-2.9314	0.1524	Unit Root	12
lnTB91-1st diff.	-0.3807	-5.1665	0.0001	Not Unit Root	12

Source: Author's computation, 2017

4.2.2 The KPSS Test

The KPSS test is based on the null assumption (H_o) that the variables under examination are stationary against the alternative hypothesis (H_1) that the variables are not stationary. The test results are shown in Table 4. The variables were examined in levels and the first difference in log-linear form. The one-year T-Bill (TB1) rate is stationary in both levels and first difference. The results indicate that the one-year T-Bill rate is integrated of order zero, I(0). The rest of the T-Bill rates (TB182, and TB91) are unit root in levels. However, they attained stationarity on first difference indicating that the variables are integrated of order one, I(1).

Table 4 KPSS stationarity test results with a constant and Time Trend

Variables (Levels)	t-Estimated	Results	Lag length
lnTB1	0.0788	Not Unit Root	4
lnTB1-1st diff.	0.0230	Not Unit Root	4
lnTB182	0.1395	Unit Root	4
lnTB182-1st diff.	0.0686	Not Unit Root	4
lnTB91 (level)	0.1373	Unit Root	4
lnTB91-1st diff.	0.0785	Not Unit Root	4
1% Critical value: 0.216			

Source: Author's computation, 2017

4 CONCLUSION AND POLICY IMPLICATIONS

The objective of the paper has been attained. The findings of the study from both the ADF and the KPSS tests show that interest rates under discussion (182-day T-Bill, and 91-day T-Bill rate) exhibit unit root processes and are integrated of order one, I(1). The detection of unit roots in interest rate indicates that shocks to 182-day T-Bill rate and 91-day T-Bill rate will have permanent effects and not transitory effects. The one-year T-bill rate does not exhibit unit root processes.

The rejection of the unit root hypothesis for the one-year T-bill rate (TB1) is consistent with the findings of previous studies that rejected the unit root hypothesis. The studies are Wu and Zhang (1997), Cerrato et al. (2010), Takele (2013), Okyere and Nanga (2014). However, the acceptance of the unit root hypothesis in 182-day T-bill rate and 91-day T-bill rate is in support of the studies of researchers such as Hall et al. (1992), Rahman and Mustafa (2009), Logubayom et al. (2013), Hsing (2015), and Akram and Li (2016) whose studies supported the unit root hypothesis in T-bill rates. The findings on the 182-day T-bill rate and 91-day T-bill rate are not in agreement with that of Wu and Zhang (1997), Cerrato et al. (2010), Takele (2013), Okyere and Nanga (2014) who reported that T-bill rates are stationary in levels.

The implication is that policies on the interest rate will have a limited effect. Policymaker should take into consideration these findings in designing their interest rate policies to achieve sustainable economic growth. The findings of the study indicate that time-series studies using interest rate (182-day T-Bill rate, and 91-day T-bill rate) should take into account unit root properties to avoid spurious results. The use of other estimation methods such as fractional integration, ADF-GLS test, and the panel unit-roots to determine if the findings of the current study will be replicated. The current study did not consider the issue of structural breaks in the unit root, which is worth considering in further studies.

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