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Research Article

Test of Random Walk Hypothesis in the Nigerian Stock Market

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Abstract: The paper investigates the weak-form market hypothesis in the emerging capital market of Nigeria from January 2006 to December 2011. It uses three tests of randomness based on autoregressive technique to check for the presence or otherwise of autocorrelation in daily stock prices and returns from the Nigerian Stock Market. All the tests including the Z-statistics for both stock prices and their returns show significant indications of dependence in return series and hence, of non-randomness. The overall results suggest that the emerging Nigerian Stock Market is not efficient in the weak form. The paper recommends that policy makers and regulatory authorities should enact and implement policy measures and put in place necessary market structures that would promote the efficiency of the Nigerian Stock Market.

Keywords: Autocorrelation, efficient market hypothesis, randomness, stock returns and weak-form efficiency

INTRODUCTION

The random walk theory asserts that price movements do not follow any pattern or trend; therefore, past price movements cannot be used to predict future price movements. Literarily, randomness is the trend of events, a movement of an object that occurs spontaneously and unpredictably. It is synonymous with the movement of a drunker whose steps are uncoordinated and irrational and therefore unpredictable. This describes what happens with security prices in the stock market in the context of stock return predictability (Fama, 1991). Security prices overtime have been observed to move randomly and unpredictably due to the information content of stock prices. By implication, capital market efficiency is the degree and speed with which securities reflect and incorporate all relevant information in their prices. The faster is the speed of adjustment, the more efficient are the prices of securities (Pandey, 2010).

According to Das and Pattanaik (2011), the concept of efficient market hypothesis was first introduced by Samuelson (1965). Fama (1970) then presented a formal review of theory and evidence for market efficiency where he categorized security prices into three information subsets. There are:

- **Weak form efficiency:** (How well do past prices/returns predict future prices/returns?). He asserts that the current stock prices already fully reflect all the information that is contained in the historical sequence of stock prices. Thus, if the weak form of the Efficient Market Hypothesis (EMH) (the random walk theory) is true, it is then a direct refutation of technical analysis which claims that past share prices/returns are predictable (Fischer and Jordan, 2007).
- **Semi-strong form efficiency:** (How quickly do security prices reflect public information announcements?). That is to say, current stock prices reflect all public information about stock prices and that no investor can outperform the market and earn abnormal returns from publicly available information, except such investor is privy to additional insider information that could have advantages in the market.
- **Strong form efficiency:** (Does any investors have private information that is not fully reflected in market prices?). In other words, no information that is available, be it public or "insider", can be used to earn consistently superior investment returns (Fischer and Jordan, 2007). Fama (1970) however defines an efficient capital market as one in which security prices fully reflect all available information and further revised this theory in 1991, on the basis of empirical evidences.

Fama (1991) taxonomies on market efficiency (returns predictability): Fama (1991) made some remarkable adjustments to his earlier work on market efficiency of 1970 and re-categorized efficient market into tests for return predictability, event studies and test for private information.

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Ideally, while the new work rejects the early work of old market efficiency-constant expected returns model (the weak form), it establishes that returns are predictable from past returns, dividend yields and various term-structure variables. This means that the new results run head-on into the joint-hypothesis problem of whether return predictability reflect rational variation through time in expected returns, irrational deviations of price from fundamental value, or some combination of the two? Fama (1991) however, acknowledges that returns predictability may be spurious due to data-dredging and chance sample-specific conditions. He argues further that even if we disagree on the market efficiency implications of these new results, we could agree that the tests enrich our knowledge of the behaviour of returns, across securities and through time.

With respect to the test for event study, the research implications for market efficiency are less controversial. According to Fama (1991), event studies have, however, been a growth industry during the last 20 years; and that because they come closest to allowing a break between market efficiency and equilibrium-pricing issues, event studies give the most direct supportive evidence on efficiency. On the review of the test for private information, the new results clarify earlier evidence that corporate insiders have private information that is not fully reflected in prices. The new evidence on whether professional investment managers (mutual fund and pension fund) have private information is, however not clear, as it is clouded by the joint-hypothesis problem (Fama, 1991).

In view of the above, which is a direct repudiation of the technical analysis and the aftermaths of the recent global financial meltdown, the performance of emerging capital markets has started to attract the attention of researchers and investors across the globe in recent times. The resilience shown by emerging markets provides the impetus to examine the efficient market hypothesis in the Nigerian context. To this end, the paper seeks to empirically test the weak-form efficiency of the emerging capital market of Nigeria from January 2006 to December 2011. The study is an extension of Das and Pattanaik (2011) study in India context and Mishra (2011) study of selected emerging and developed markets' context.

LITERATURE REVIEW

In the literature, there are several contradictory results with respect to the weak form efficiency in different markets across the globe. Some studies confirm the existence of the weak form efficiency while others simply refute it. For instance, Chaudhuri and Wu (2003) investigate whether stock-price indexes of seventeen emerging markets can be characterized as random walk (unit root) or mean reversion processes, using a test that accounts for structural breaks in the underlying series and more powerful than standard tests. They find that for fourteen countries, stock prices exhibit structural breaks. Furthermore, their results also indicate that ignoring structural breaks that arise from the liberalization of emerging markets can lead to incorrect inference that these indices are characterized by random walks. This is consistent with the points made by Bekaert and Harvey (2002). The findings hold true regardless of whether stock indexes are denominated in US dollar terms, in local currencies terms, or in real terms.

Ntim *et al*. (2007) empirically re-examines the weak form efficient markets hypothesis of the Ghana Stock Market using a new robust non-parametric variance-ratios test in addition to its parametric alternative. They find that stock returns are conclusively not efficient in the weak form, neither from the perspective of the strict random walk nor in the relaxed martingale difference sequence sense. Emenike (2008) examines the Weak-Form Efficient Market Hypothesis across time for the Nigerian Stock Exchange (NSE) by hypothesizing Normal Distribution and Random walk in periodic return series. The overall results from the tests suggest that the NSE is not Weak-Form efficient across the time periods of the study. The results however, show that improvements in NSE trading system have positive effect on efficiency.

However, Chigozie (2010) also seeks to know whether the Nigerian stock market (from the period 1984 to 2006) follows a random walk. To carry out the investigation, the Generalized Autoregressive Conditional Hetrosecedasticity (GARCH) was employed. The result shows that the Nigerian stock market follows a random walk and is therefore weak form efficient. Olowe (1999) provides further evidence on the weak form efficiency of the Nigerian stock market, that is, whether security prices on the Nigerian stock market adjust to historical price information. Using correlation analysis, he employs monthly stock returns data over the period January 1981-December 1992. The results provide support for the work of Samuels and Yacout (1981) and Ayadi (1983) that the Nigerian stock market appears to be efficient in the weak form.

Similarly, Osamwonyi and Anikamadu (2002) empirically examine the weak form of Efficient Market Hypothesis in the Nigerian Stock Market, using the run test econometric analysis on monthly Monday closing prices of twenty-five selected stocks in the first-tier market, with each stock having (50) cases spanning January 1990 to June 2002. The results from the empirically analysis reveal that all the securities indicated positive values, with scanty differences between the actual and expected number of runs and that the runs tests by total, actual and expected number of runs confirm dependency. By implication, the results show that stock prices in the Nigerian stock market are non-random and that inefficiencies exist in the stock market occasioned by information asymmetry, leading to insider manipulations. Afego (2012) examines the weak-form efficient markets hypothesis for the Nigerian stock market by testing for random walks in the monthly index returns over the period 1984-2009. The results of the non-parametric runs test show that index returns on the Nigerian Stock Exchange (NSE) displays a predictable component, thus suggesting that traders can earn superior returns by employing trading rules. The statistically significant deviations from randomness are also suggestive of suboptimal allocation of investment capital within the economy. The findings, in general, contradict the weak-form efficient markets hypothesis.

Frennberg and Hansson (1993) test the random walk hypothesis on a new set of monthly data for the Swedish stock market, 1919-1990. Their results suggest that Swedish stock prices have not followed a random walk in the past 72 years. For short investment horizons, one to twelve months, they find strong evidence of positively autocorrelated returns. For longer horizons, two years or more, they find indications of negative autocorrelation, so called 'mean reversion'. These results are in line with recent research on the U.S. stock market and may have several implications for the practical investor. Laurence *et al*. (1997) test for the weak-form efficiency in China two major stock exchanges, the Shanghai and the Shenzen exchanges. Each of these exchanges trades two types of shares, type "A" and type "B" shares. Type "A" shares are available to domestic investors only and type "B" shares are available to foreign investors. The results indicate the existence of:

- A weak-form efficiency in the market for "A" shares but not "B" shares,
- Statistically weak linkages between the Chinese markets
- A weak causal effect from the Hong Kong to the four Chinese markets
- A strong causal effect from U.S. stock market to all four Chinese stock markets and the Hong Kong Stock market, particularly during the second period of the sample.

Kemp and Reid (2006) empirically investigate the Random Walk Hypothesis and the recent behaviour of equity prices in Britain. They conclude that share price movements were conspicuously non-random over the period considered. Mishra (2011) test the weak form efficiency of selected emerging and developed capital markets (India, China, Brazil, South Korea, Russia, Germany, US and UK) over the sample period spanning from January 2007 to December 2010. The application of unit root test and GARCH (1, 1) model estimation provides the evidence that these markets are not weak form efficient with both positive and negative implications. Agwuegbo *et al*. (2010) on a Random Walk Model for Stock Market Prices in the Nigerian stock market, find that the stock price changes have no memory of the past history and that no investor can alter the fairness or unfairness of a stock price as defined by expectation. Al-Jafari and Altaee (2011) did not find evidence of random walk in Egypt. Shiguang and Barnes (2001) find evidence of random walk in China while Das and Pattanaik (2011) find evidence of random walk in Bombay stock market. Other studies with mixed findings include; Fama (1965), Butler and Malaikah (1992), Laurence *et al*. (1997) and Wen *et al.* (2010).

METHODOLOGY

The study uses a simple autoregressive model where the dependent variable is hypothesized to depend on its own past values. This helps to identify the presence or otherwise of autocorrelation in the model. We compute the test statistics for randomness or efficiency by means of auxiliary regression. The specified model is as follows:

$$y_t = a_0 + y_{t-i}b + e_t$$

where,

y = Daily stock prices or returns
e = The residuals.
t = Time (daily in this case)

Serial correlation LM test: This test is an alternative to the Q-statistics for testing serial correlation. The test belongs to the class of asymptotic (large sample) tests known as Lagrange Multiplier (LM) tests. Unlike the Durbin-Watson statistic for autoregressive [AR(1)] errors, the LM test may be used to test for higher order autoregressive moving average (ARMA) errors and is applicable whether or not there are lagged dependent variables. The null hypothesis of the LM test is that there is no serial correlation up to lag order p, where p is a pre-specified integer (Godfrey, 1988). The F-statistic is an omitted variable test for the joint significance of all lagged residuals. Because the omitted variables are residuals and not independent variables, the exact finite sample distribution of the F-statistic under is not known, but we still present the F-statistic for comparison purpose. The observed *R-squared statistic is the Breusch-Godfrey LM test statistic. This LM statistic is computed as the number of observations, times the (uncentred) from the test regression. Under quite general conditions, the LM test statistic is asymptotically distributed as a χ^2 (p).

The runs analysis: The runs test is a non-parametric test, in which the number is calculated and compared against its sampling distribution under the random walk hypothesis. It has been shown that the distribution of the number of runs converges to a normal distribution asymptotically when properly normalized (Campbell *et al*., 1997). The test statistic used is the standardized normal variable Z (Z ~$N(0,1)$). Positive Z indicates that there are too many runs in the sample, while negative value of Z shows that there are less runs than expected if the changes were random. The important advantages of this test are its simplicity and independence of extreme values in the sample (Bradley, 1968). We first calculate daily returns of the index of prices for the Nigerian Stock Exchange, as measured by the All Share Index from January 2006 to December, 2012. A price gain is denoted by a " +", a price drop is denoted by a "- " and "0" shows that return is zero. A run is defined as a return sequence of the same sign.

The null hypothesis is that the returns series is a random series, i.e. successive price changes or returns are independent. The null hypothesis is rejected when the Z-statistic is greater or equal to the critical value ±1.96 at the 5% level of significance or ±2.576 at 1% level.

According to Osamwonyi and Anikamadu (2002), the run test is used to ascertain when changes in price are not random. Hence, a run occurs in a series of numbers whenever the changes occurring between consecutive numbers change signs. Adding that, in a time series data like security price changes, the total numbers of runs expected in a series of random numbers can be positive, or negative; while the calculated returns are employed to ascertain if there is an increase in price (positively denoted), decrease in price (negatively signed) or a no-change/neutral situation denoted by zero. The stream: +, - and 0 denotes the runs.

Sources of data: We use daily data from the index of prices for the Nigerian Stock Exchange, as measured by the All Share Index from January 2006 to December 2012 for the study. They were sourced from the Central Bank of Nigeria Statistical Bulletin (2012) and the Nigerian Stock Exchange facts book.

EMPIRICAL ANALYSES

Auto-correlation test and Ljung- Box Q test: Empirical results from the auto-correlation test on monthly market price and returns over the whole sample period are reported in Table 1. The table shows the auto-correlation coefficients, k and the Ljung-Box Q-statistics for lag $k = 12$. As pointed out by Dickinson and Muragu (1994), past studies have sometimes drawn conclusions from serial correlation test results based on one lag, which may hinder the reliability of the analysis and it is therefore necessary to extend the investigation to more lags than one. Since there is no specified rule to decide on the appropriate number of lags, this number was chosen on the basis of past studies, like Abrosimova *et al.* (2002) and Mollah (2007).

The results in Table 1 show that no significant non-zero auto-correlation coefficients are detected for both series at different lags. First-order serial correlation coefficients are not significantly different from zero for all indices and the same applies to all the other lags. As stated by Batuo *et al.* (2009), the positive sign of the serial correlation coefficients indicates that successive monthly price changes tend to have the same sign, that is, a positive (negative) return at time t is likely to be followed by a positive (negative) change in return at time $t+1$. In the study by Worthington and Higgs (2003), this occurrence is defined as return persistence or predictability of returns whereas the case of a negative signed autocorrelation coefficient is indicator of mean reversion in returns.

All Ljung-Box Q-statistics at lag $k = 12$ are higher than the critical value at both 5 and 1% significance level, indicating serial correlation in the returns series. The absence of significant non-zero auto-correlation coefficients together with the non-significant Ljung-Box Q-statistics indicate that the random walk hypothesis has been violated. Specifically, evidence of stock market efficiency is absent in these tests. It should be recall that in the earlier work of Fama (1970) on efficient market hypothesis, he advocated very strongly that stock prices behave randomly and as such one cannot predict future prices or returns on the bases of past share prices, given that the current stock prices already fully reflect all the information that is contained in the historical sequence of stock prices. However, in his new taxonomy of 1991, instead of the weak form he now simply refers to it as 'returns predictability'-meaning that stock prices or returns are predictable. Hence, this result is also consistent with the new work of Fama (1991) which submitted that returns are predictable from past returns, dividend yields and various term-structure variables.

The LM serial correlation test: The second autocorrelation test we use in the study is the LM serial correlation test. In this test the null hypothesis of

Table 1: The test for serial correlation

	Stock prices			Stock returns		
Lag	PAC	Q-Statistic	Probability	PAC	Q-Statistic	Probability
1	0.002	0.0012	0.973	0.000	0.0001	0.992
2	0.015	0.1087	0.947	0.003	0.0044	0.998
3	-0.026	0.4479	0.930	0.003	0.0091	1.000
4	0.063	2.3993	0.663	-0.007	0.0316	1.000
5	0.032	2.8769	0.719	-0.007	0.0555	1.000
6	-0.027	3.1724	0.787	-0.029	0.4652	0.998
7	-0.026	3.5691	0.828	-0.030	0.9119	0.996
8	0.057	5.2326	0.732	0.062	2.8388	0.944
9	0.034	5.9877	0.741	0.041	3.6523	0.933
10	0.035	6.6392	0.759	0.044	4.6339	0.914
11	0.080	9.3098	0.593	0.078	7.7100	0.739
12	-0.041	9.9199	0.623	-0.048	8.8136	0.719
F-Stat (LM)	1.57			2.02		

Extracted from the Eviews 7 output

Table 2: The LM serial correlation test result

Variable	F-statistic	R^2
Share price	1.567 (0.182)	6.305 (0.178)
Returns	0.202 (0.937)	0.820 (0.936)

Result extracted from the Eviews 7 output; Probability values are in parenthesis

presence of autocorrelation in the data is tested using the F-statistic test as well as the R-squared test which approximates a Chi-square distribution. From the results in Table 2, the test values for both the F-statistic and the R-squared tests fail the significance test at the 5% level. This can be seen from the very high probability values associated with the test coefficients.

Since these probability values are much greater than 0.05, then we cannot reject the null hypothesis of serial correlation in the data series. Thus, we accept the null hypothesis implying that autocorrelation is present both in stock prices and returns over the period of the study. This result suggests that the prices are not random in nature, rather they are serially correlated. The LM test for serial correlation therefore confirms the results from the Ljung-Box Q test. This result also justifies the stock returns predictability of Fama (1991) which rejects his earlier work, old market efficiency-constant expected returns model (the weak form) of 1970.

The unit roots test: Generally, unit root test involves the test of stationarity for variables used in regression analysis. We employ both the Augmented Dickey Fuller (ADF) and the Phillips Peron (P-P) to analyze unit roots in this study. The results are in levels and first difference. This enables us determine, in comparative terms, the unit root among the time series and also to obtain more robust results. Table 3 presents results of the tests, in levels, without taking into consideration the trend in variables (because we have not carried out an explicit test of the trending pattern of the time series). In the table, the ADF and P-P test statistics for stock price index are in the first and third columns, respectively, while the 95% critical values are in the second and fourth columns, respectively. The result indicates that the ADF and P-P test values are less than their respective 95% critical values (absolute values only). The implication of this is that the time series stock prices are non-stationary in their levels.

Next, we take the first differences of the variables and perform the unit root test on the resultant time series. The rationale behind this procedure is that Box and Jenkins (1970) argue that differencing non stationary time series make them attain stationarity.

The result of the unit root test on these variables in first differences is in Table 3. From the result, we note that the ADF and P-P test statistics for each of the variables are greater than the 95 percent critical ADF (in absolute values). With this result, these variables are adjudged to be stationary. This implies that the variables are actually difference-stationary, attaining stationarity after the first differences of the variables. Thus, we would accept the hypothesis that stock prices possess unit roots. Indeed, the variables are integrated of order one (i.e., I[1]). This result further shows the non-randomness of the stock price data.

Runs test: The empirical results from the runs test over the whole sample period are in Table 4, which show the number of observations below and above the median return, the number of actual runs as well as the Z-statistic. The null hypothesis of the return series, being a random series, is rejected at one percent significance level for both stock prices and stock returns. This is because the Z-value for the two runs is greater than the respective one percent critical Z-value. For both of the indices where Z-statistics are significant at the 1 percent level, the actual number of runs is equal to the expected number, producing negative Z values. These negative values indicate that there is positive serial correlation between returns and stock prices, respectively. However, this result is different from the one shown by the results from auto-correlation test where the first-order auto-correlations are positive and not significantly different from zero for both prices and returns.

In all, the significant Z-statistics for both stock prices and their returns, are indicators of dependence in the return series and, hence, of non-randomness (full tables showing complete details of the various tests are contained in the Appendix). The non-randomness indicates that insider and other information may be harnessed to exploit the market since the prices tend to behave in a well-defined manner. These results provide evidence against the

Table 3: Unit root test for variables in levels

At Levels				First difference			
ADF		P-P		ADF		P-P	
Test Statistic	95% Critical value	Test statistic	95% Critical value	Test statistic	95% Critical value	Test statistic	95% Critical value
-1.718	-2.896	-1.701	-2.896	-6.874	-2.896	-6.833	-2.896

Result extracted from the Eviews 7.0 output

Table 4: Results of the runs test for the whole sample period (2006-2012)

Index	Cases<Median	Cases>Median	Actual run	Z = Statistic
Share price index	132	132	25	-20.09**
Stock returns	132	132	191	-5.13**

Result extracted from the E-views 7 output; The critical values for the Z-statistics are ±1.96 and ±2.576 at 5 and 1% level, respectively; **Indicates rejection of H0 at 1% level; * Indicates rejection of H0 at 5% level but acceptance at 1% level weak-form efficiency hypothesis for the Nigerian stock market.

The empirical evidence provided by the runs test is both consistent and contradictory with that presented in previous studies on African stock exchanges. In the study by Simons and Laryea (2005), the null hypothesis of independence is rejected for Egypt-EFG and Mauritius-Semdex but not for South Africa-JSE at the 1% level, over the period 1990-2003. Similar results are obtained by Batuo *et al*. (2009); more specifically, the returns series for Egypt-FTSE, Morocco-FTSE and Tunisia-Tunindex are not random whereas it is random for South Africa-JSE. Thus, results for the Nigerian market are consistent with that of Fama (1991) returns predictability and those of other African countries apart from South Africa. The highly developed nature of the South African market may have contributed to its efficiency.

CONCLUSION

The Efficient Market Hypothesis, especially its weak-form, has been a subject of several empirical investigations. However, the empirical evidences available on African stock markets are limited and they produce conflicting results. The ability of equity markets to play their critical role in channeling funds depends largely on its level of efficiency; hence, the motivation to further investigate the weak-form informational efficiency of stock exchanges in African emerging markets.

In this study, we empirically examine the weak form market efficiency hypothesis in the Nigerian Stock market based on daily transaction data for the period January, 2006 to December, 2012. We conduct three tests of randomness using the methodologies of autocorrelation test (employing the Ljung-Box Q method and the LM autocorrelation tests), unit roots test for stationarity and the non-parametric runs test. The overall results suggest that the Nigerian stock market is not efficient in the weak form.

The rejection of weak form efficiency is not only consistent with some previous studies (Fama, 1991; Akpan, 1995; Appiah-Kusi and Menyah, 2003) but also theoretically not surprising. Illiquidity and paucity of traded instruments dominate the NSE, for instance Apampa (2008) observes that of the 200 listed securities, only about 40 are liquid. Because there are so few liquid instruments, supply and demand of those instruments control prices and investment decisions more than the actual performance of the company in question. Also, associated high average cost of transaction results in limited market activity. These theoretical arguments explain the rejection of the weak form efficiency of the NSE. A major economic implication of this evidence for investors at the NSE is that stock returns are predictable from historical returns and trade volume but whether or not abnormal profit will be made is not known.

Appendix: Test of Randomness–Test Outputs

Dependent Variable: ASI
Method: Least Squares
Date: 06/26/13 Time: 00:13
Sample(adjusted): 6 1798
Included observations: 1518 after adjusting endpoints

Variable	Coefficient	SE	t-Statistic	Prob.
C	147.8162	100.8596	1.465563	0.1434
ASI(-1)	1.397711	0.045208	30.91721	0.0000
ASI(-2)	-0.532517	0.077223	-6.895811	0.0000
ASI(-3)	0.123597	0.076873	1.607804	0.1085
ASI(-4)	0.005010	0.044373	0.112903	0.9102
R-squared	0.991662	Mean dependent var		24122.72
Adjusted R-squared	0.991593	S.D. dependent var		2145.122
S.E. of regression	196.6830	Akaike info criterion		13.41122
Sum squared resid	18761841	Schwarz criterion		13.45402
Log likelihood	-3280.748	F-statistic		14420.58
Durbin-Watson stat	1.996770	Prob(F-statistic)		0.000000

Date: 06/26/13 Time: 00:32
Sample: 6 1798
Included observations: 1518

Autocorrelation	Partial correlation		AC	PAC	Q-Stat	Prob
.|. |	.|. |	1	0.002	0.002	0.0012	0.973
.|. |	.|. |	2	0.015	0.015	0.1087	0.947
.|. |	.|. |	3	-0.026	-0.026	0.4479	0.930
.|. |	.|. |	4	0.063	0.063	2.3993	0.663
.|. |	.|. |	5	0.031	0.032	2.8769	0.719
.|. |	.|. |	6	-0.024	-0.027	3.1724	0.787
.|. |	.|. |	7	-0.028	-0.026	3.5691	0.828
.|. |	.|. |	8	0.058	0.057	5.2326	0.732
.|. |	.|. |	9	0.039	0.034	5.9877	0.741
.|. |	.|. |	10	0.036	0.035	6.6392	0.759
.|* |	.|* |	11	0.073	0.080	9.3098	0.593
.|. |	.|. |	12	-0.035	-0.041	9.9199	0.623

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	1.567462	Probability	0.181772
Obs*R-squared	6.304977	Probability	0.177501

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 06/26/13 Time: 00:36

Variable	Coefficient	SE	t-Statistic	Prob.
C	564.5891	319.8954	1.764918	0.0782
ASI(-1)	-1.893235	1.128511	-1.677640	0.0941
ASI(-2)	1.723417	1.269636	1.357410	0.1753
ASI(-3)	-0.360301	0.656814	-0.548559	0.5836
ASI(-4)	0.506417	0.415700	1.218228	0.2237
RESID(-1)	1.889387	1.126061	1.677872	0.0940
RESID(-2)	0.933704	0.477511	1.955356	0.0511
RESID(-3)	0.615436	0.409139	1.504220	0.1332
RESID(-4)	0.195960	0.131836	1.486388	0.1378
R-squared	0.012867	Mean dependent var		1.16E-12
Adjusted R-squared	-0.003551	S.D. dependent var		195.8769
S.E. of regression	196.2244	Akaike info criterion		13.41459
Sum squared resid	18520427	Schwarz criterion		13.49163
Log likelihood	-3277.575	F-statistic		0.783731
Durbin-Watson stat	2.005217	Prob(F-statistic)		0.617231

Runs Test	ASI
Test Value[a]	2.47E4
Cases<Test Value	759
Cases> = Test Value	759
Total Cases	1518
Number of Runs	170
Z	-20.087
Asymp. Sig. (2-tailed)	0.000

a. Median

Dependent Variable: ASIRT
Method: Least Squares
Date: 06/26/13 Time: 06:08
Sample(adjusted): 6 1798
Included observations: 1518 after adjusting endpoints

Variable	Coefficient	SE	t-Statistic	Prob.
C	-4.63E-05	0.000364	-0.127132	0.8989
ASIRT(-1)	0.398474	0.045309	8.794648	0.0000
ASIRT(-2)	-0.110975	0.048575	-2.284594	0.0228
ASIRT(-3)	-0.044804	0.048365	-0.926390	0.3547
ASIRT(-4)	0.078024	0.044365	1.758693	0.0793
R-squared	0.145188	Mean dependent var		-6.15E-05
Adjusted R-squared	0.138124	S.D. dependent var		0.008668
S.E. of regression	0.008047	Akaike info criterion		-6.796807
Sum squared resid	0.031343	Schwarz criterion		-6.753940
Log likelihood	1666.819	F-statistic		20.55164
Durbin-Watson stat	2.000202	Prob(F-statistic)		0.000000

Date: 06/26/13 Time: 06:09
Sample: 6 1798
Included observations: 1518

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|. |	.|. |	1	0.000	0.000	0.0001	0.992
.|. |	.|. |	2	0.003	0.003	0.0044	0.998
.|. |	.|. |	3	0.003	0.003	0.0091	1.000
.|. |	.|. |	4	-0.007	-0.007	0.0316	1.000
.|. |	.|. |	5	-0.007	-0.007	0.0555	1.000
.|. |	.|. |	6	-0.029	-0.029	0.4652	0.998
.|. |	.|. |	7	-0.030	-0.030	0.9119	0.996
.|. |	.|. |	8	0.062	0.062	2.8388	0.944
.|. |	.|. |	9	0.040	0.041	3.6523	0.933
.|. |	.|. |	10	0.044	0.044	4.6339	0.914
.|* |	.|* |	11	0.078	0.078	7.7100	0.739
.|. |	.|. |	12	-0.047	-0.048	8.8136	0.719

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.201665	Probability	0.937418
Obs*R-squared	0.820408	Probability	0.935691

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 06/26/13 Time: 06:09

Variable	Coefficient	SE	t-Statistic	Prob.
C	-6.04E-05	0.000373	-0.161674	0.8716
ASIRT(-1)	-0.086897	1.513682	-0.057408	0.9542
ASIRT(-2)	-0.474164	1.241013	-0.382078	0.7026
ASIRT(-3)	-0.103549	0.469135	-0.220724	0.8254
ASIRT(-4)	-0.055323	0.343000	-0.161291	0.8719
RESID(-1)	0.085453	1.515027	0.056404	0.9550
RESID(-2)	0.511575	0.801565	0.638221	0.5236
RESID(-3)	0.299797	0.418556	0.716263	0.4742
RESID(-4)	0.106387	0.378107	0.281367	0.7785
R-squared	0.001678	Mean dependent var		8.23E-20
Adjusted R-squared	-0.014961	S.D. dependent var		0.008014
S.E. of regression	0.008074	Akaike info criterion		-6.782126
Sum squared resid	0.031290	Schwarz criterion		-6.704966
Log likelihood	1667.230	F-statistic		0.100833
Durbin-Watson stat	1.999543	Prob(F-statistic)		0.999184

Runs Test	D(ASI)
Test Value[a]	0.00
Cases<Test Value	612
Cases> = Test Value	612
Total Cases	1224
Number of Runs	137
Z	-5.134
Asymp. Sig. (2-tailed)	0.000

a. Median

Null Hypothesis: ASI has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag = 11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.717903	0.4187
Test critical values:	1% level	-3.508326	
	5% level	-2.895512	
	10% level	-2.584952	

*MacKinnon (1996) one-sided p-values

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(ASI)
Method: Least Squares
Date: 06/27/13 Time: 07:56
Sample (adjusted): 2008 2012
Included observations:1224 after adjustments

Variable	Coefficient	SE	t-Statistic	Prob.
ASI(-1)	-0.048385	0.028165	-1.717903	0.0895
D(ASI(-1))	0.303272	0.104431	2.904050	0.0047
C	654.9969	554.3020	1.181661	0.2407
R-squared	0.110047	Mean dependent var		26.47465
Adjusted R-squared	0.088603	S.D. dependent var		4008.145
S.E. of regression	3826.461	Akaike info criterion		19.37153
Sum squared resid	1.22E+09	Schwarz criterion		19.45715
Log likelihood	-829.9758	Hannan-Quinn criter.		19.40599
F-statistic	5.131691	Durbin-Watson stat		2.112571
Prob(F-statistic)	0.007920			

Null Hypothesis: D(ASI) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag = 11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.873804	0.0000
Test critical values:	1% level	-3.508326	
	5% level	-2.895512	
	10% level	-2.584952	

*MacKinnon (1996) one-sided p-values

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(ASI)
Method: Least Squares
Date: 06/27/13 Time: 07:57
Sample (adjusted): 2008 2012
Included observations: 1224 after adjustments

Variable	Coefficient	SE	t-Statistic	Prob.
D(ASI(-1))	-0.719993	0.104745	-6.873804	0.0000
C	19.16406	417.3916	0.045914	0.9635
R-squared	0.359996	Mean dependent var		0.366047
Adjusted R-squared	0.352377	S.D. dependent var		4809.749
S.E. of regression	3870.647	Akaike info criterion		19.38321
Sum squared resid	1.26E+09	Schwarz criterion		19.44029
Log likelihood	-831.4781	Hannan-Quinn criter.		19.40618
F-statistic	47.24918	Durbin-Watson stat		2.081847
Prob(F-statistic)	0.000000			

Null Hypothesis: ASI has a unit root
Exogenous: Constant
Bandwidth: 5 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.700671	0.4274
Test critical values:	1% level	-3.507394	
	5% level	-2.895109	
	10% level	-2.584738	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	15390215
HAC corrected variance (Bartlett kernel)	27452003

Phillips-Perron Test Equation
Dependent Variable: D(ASI)
Method: Least Squares
Date: 06/27/13 Time: 07:57
Sample (adjusted): 2008 2012
Included observations: 1224 after adjustments

Variable	Coefficient	SE	t-Statistic	Prob.
ASI(-1)	-0.037479	0.028843	-1.299395	0.1973
C	514.3416	567.2718	0.906693	0.3671
R-squared	0.019477	Mean dependent var		26.87609
Adjusted R-squared	0.007941	S.D. dependent var		3984.775
S.E. of regression	3968.922	Akaike info criterion		19.43310
Sum squared resid	1.34E+09	Schwarz criterion		19.48978
Log likelihood	-843.3397	Hannan-Quinn criter.		19.45592
F-statistic	1.688429	Durbin-Watson stat		1.414980
Prob(F-statistic)	0.197322			

Null Hypothesis: D(ASI) has a unit root
Exogenous: Constant
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-6.832906	0.0000
Test critical values:	1% level	-3.508326	
	5% level	-2.895512	
	10% level	-2.584952	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	14633495
HAC corrected variance (Bartlett kernel)	14034533

Phillips-Perron Test Equation
Dependent Variable: D(ASI)
Method: Least Squares
Date: 06/27/13 Time: 07:58
Sample (adjusted): 2008 2012
Included observations: 1224 after adjustments

Variable	Coefficient	SE	t-Statistic	Prob.
D(ASI(-1))	-0.719993	0.104745	-6.873804	0.0000
C	19.16406	417.3916	0.045914	0.9635
R-squared	0.359996	Mean dependent var		0.366047
Adjusted R-squared	0.352377	S.D. dependent var		4809.749
S.E. of regression	3870.647	Akaike info criterion		19.38321
Sum squared resid	1.26E+09	Schwarz criterion		19.44029
Log likelihood	-831.4781	Hannan-Quinn criter.		19.40618
F-statistic	47.24918	Durbin-Watson stat		2.081847
Prob (F-statistic)	0.000000			

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