THE EFFICIENCY OF CARIBBEAN STOCK MARKETS

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ABSTRACT

This paper tests the weak-form efficiency of three major stock markets in the Caribbean region, the Trinidad and Tobago Stock Exchange (TTSE), Jamaica Stock Exchange (JSE) and the Barbados Stock Exchange (BSE). The monthly closing prices of selected stocks listed on the TTSE and JSE, and the BSE monthly local price index, are examined for this purpose. The testing procedure involves four processes: tests of restrictions, autocorrelation tests, unit root tests and variance ratio tests. Empirical evidence suggests that the TTSE, JSE and BSE are characterised by weak-form efficiency.

1. Introduction

Stock markets play a critical role in the process of economic development. An *efficient* stock market implies an optimum allocation of scarce resources, which strengthens the country's economic climate. The theory of efficient capital markets has captivated the financial world for decades. Samuelson (1965), Mandelbrot (1966) and Fama (1970) popularised theories of Efficient Market Hypothesis (EMH), which sparked a continuous debate in financial literature pertaining to stock market efficiency. The EMH asserts that a stock market is efficient if security prices reflect all information available. It rests on the presumption of a rapid processing mechanism, which denies market participants an opportunity of earning an abnormal return on a consistent basis. Hence, changes in price would be serially uncorrelated and follow a random walk (the Random Walk Hypothesis). Fama (1970) categorised three forms of market efficiency: weak-form efficiency, semi strong-form efficiency and strong-form efficiency. These three forms differ in terms of the level of information incorporated by share prices.

The weak-form of the EMH has the most narrowly defined information set and implies that share prices fully reflect the information content of historical price sequences. The semi strong-form of efficiency builds on the weak-form efficiency, in that current prices rapidly adjust to incorporate all existing public market information, such as financial statements and announcements, stock splits etc. The strong-form of the EMH builds on the previous two forms and states that share prices reflect all information (public and private).

Within the last 4 decades, a large number of empirical studies have been conducted to find evidence in support of the EMH. While numerous researchers have recently begun to assess the predictions of the EMH in developing economies, there have been few studies on the issue of stock market efficiency for Caribbean economies. This study aims to present new empirical evidence with respect to weak-form efficiency of 3 major Caribbean stock exchanges, the Trinidad and Tobago Stock Exchange (TTSE), Jamaica Stock Exchange (JSE) and the Barbados Stock Exchange (BSE). None of the studies on the efficiency of Caribbean stock markets have included more than 1 exchange into their analysis. However, given the increase in stock trading activities in the Caribbean region over the past 2 decades, particularly within the TTSE, BSE and JSE, a collective efficiency study of these three exchanges is essential to ascertain and compare their abilities to optimally allocate scarce resources.

The remaining sections are organised as follows: Section 2 presents a brief overview of the 3 exchanges under investigation; Section 3 reviews the data and outlines the testing methodologies; Section 4 reports the empirical results; and conclusions are contained in Section 5.

2. Overview of the Caribbean Stock Markets

According to Kuczynski (1994), interest in emerging markets accelerated in the early 1980's as investors became increasingly aware of the of the rapid financial growth of Southeast Asian economies. However, Caribbean markets have a history of being neglected by international investors, as they are undeveloped, and highly illiquid with few listed trading companies. The major stock exchanges in the Caribbean region are the Trinidad and Tobago Stock Exchange (TTSE), Jamaica Stock Exchange (JSE), Barbados Stock Exchange (BSE) and the Eastern Caribbean Securities Exchange (ECSE). These markets cater to the strong financial position of many Caribbean companies. However, this study focuses on the first three aforementioned markets. The ESCE is not considered in this study due to the unavailability of sufficient stock data from this exchange.

Table 1: *Basic Data: Caribbean Stock Markets, 2006*

Stock Exchange	Listed Companies (2006)	Market Capitalisation ($US)	Volume of shares traded	Value Traded ($US)
Trinidad and Tobago Stock Exchange (TTSE)	34	15,384,594,142	220,836,459	396,850,361
Jamaica Stock Exchange (JSE)	45	12,109,375,692	5,639,411,775	545,101,238
Barbados Stock Exchange	27	10,106,465,556	643,431,592	1,021,119,787

Source: www.stockex.tt

The TTSE was officially established in 1981, although security-trading activities were popular since the early 1970's. Under the Securities Industry Act of 1995, the regulatory body for the TTSE is the Securities and Exchange Commission (SEC), which supervises its trading activities. Table 1 shows that at the end of 2006, there were 36 companies listed on the TTSE, which belonged to 8 sectors of the Trinidad and Tobago economy. Figure 1 indicates the sectors and market share of the listed companies.

Figure 1: *Sectors of TTSE listed companies*

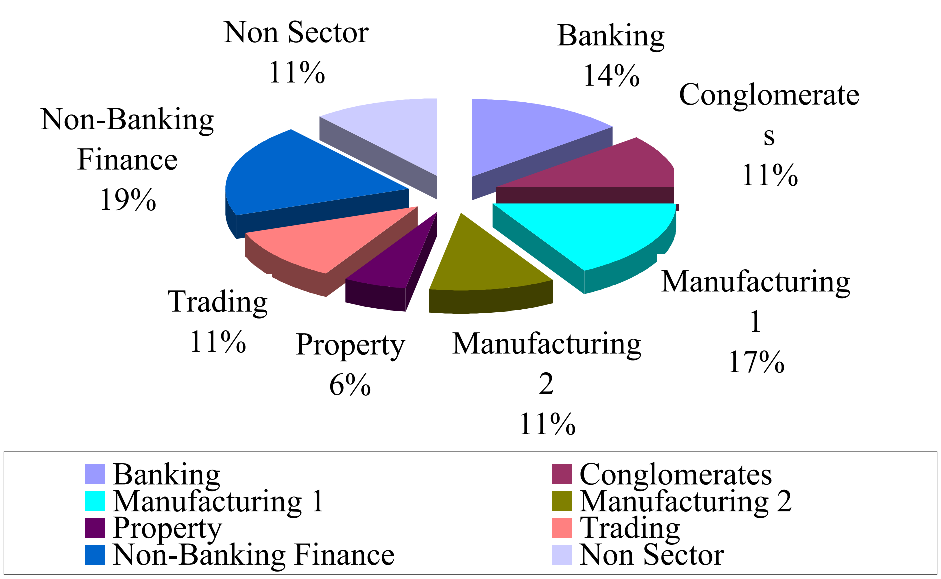

Figure 1 illustrates that the Non-Banking Finance companies command the largest portion (19%) of the various sectors. This is no surprise given the massive growth in Trinidad and Tobago's financial sector in the past two decades. As indicated by Table 1, the TTSE has the second largest number of listed companies and recorded the highest market capitalisation for 2006. However, the volume and value of traded shares in this capital market is substantially lower than that of the other two exchanges. This implies that in 2006, the TTSE had lower stock price levels and trading activities than the JSE and BSE, rendering it the least liquid market for this year.

Of the 3 markets, the JSE has been in operation for the longest period, as its trading activities officially commenced in 1969. Table 1 shows that this exchange has the highest number of listed companies (45), rendering it the largest equity market in the Caribbean. The various sectors, from which these companies are drawn, are depicted in Figure 2, and shows the bulk of stocks traded on this exchange as belonging to companies of the Finance sector.

Figure 2: *Sectors of JSE listed companies*

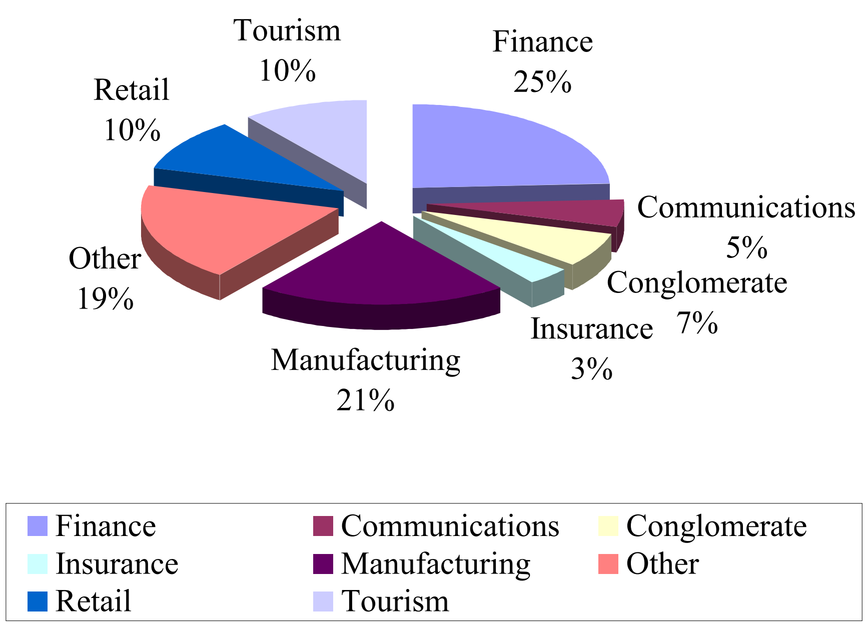

Table 1 illustrates that the JSE has a far greater volume of shares traded, which implies that it is the largest and most liquid equity market among the three. However, this exchange recorded a lower value of shares traded than that of the BSE, as its equity prices are generally lower than those of the other two stock exchanges. Due to its high degree of liquidity, the JSE manifested a higher value of shares traded than the TTSE.

The youngest of these 3 markets is the BSE, which officially commenced operations in 1987. In this market, the stocks of 27 companies are actively traded, making it the smallest stock exchange analysed in this paper. Figure 3 depicts the various economic sectors, which the listed companies belong and their individual market shares.

Figure 3: *Sectors of BSE listed companies*

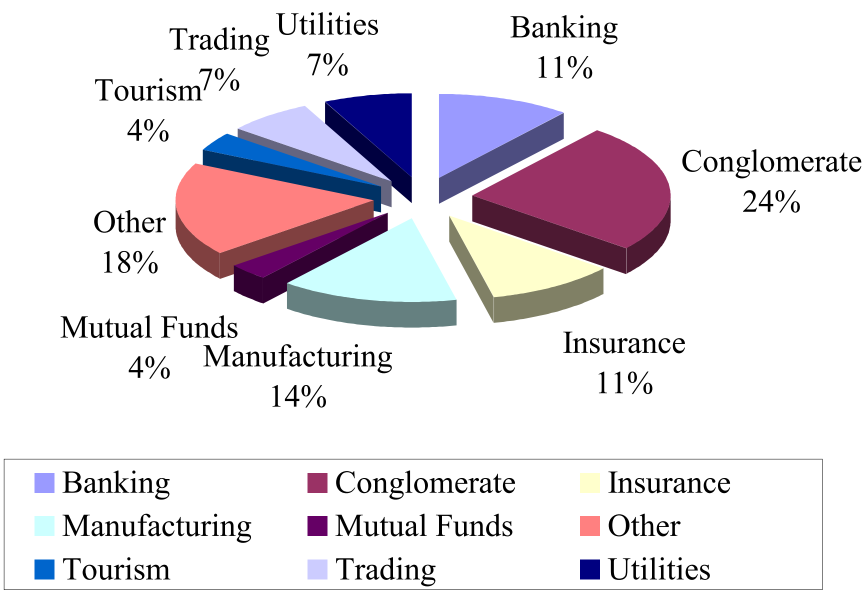

Figure 3 indicates that the bulk of companies, which trade on the BSE, are Conglomerates. Most of these Conglomerates began trading at the inception of the BSE in 1987, which is a longer period than many companies of the other sectors. **Table 1** shows that this market has the least number of listed companies, which accounted for its low market capitalisation. However, the value of equity trading for 2006 significantly exceeded those of the other 2 exchanges. This is an indication that share prices of the BSE are generally higher than those of the TTSE and JSE.

3. Literature Survey

Over the past four decades, several financial studies in the controversial area of stock market efficiency have been conducted. Such studies investigated market efficiency in both emerging markets, such as the Chinese stock market, and developed stock markets, such as the New York Stock Exchange (N.Y.S.E.). In order to ascertain whether the markets under scrutiny were efficient, these studies utilised an array of econometric techniques, which have evolved since the early tests of market efficiency, were conducted.

The preliminary groundbreaking test of market efficiency was conducted by Fama (1964). He investigated whether the N.Y.S.E. was characterised by weak-form efficiency. The econometric methodology utilised comprised of *serial correlation tests* and *runs tests*, on a sample of 30 Dow Jones Industrial stocks for the period 1962 to 1967. Fama sought to determine whether there were dependencies in the sequence of equity prices, which investors could take advantage of to earn excess returns. He however concluded that there was insufficient evidence of any sizable degree of dependence in the series of stock prices. Hence, any dependence in the series was not powerful enough to be used by investors to increase their expected returns and cause the distribution of the price changes to depart from normality. Fama therefore resolved that the N.Y.S.E. was weak-form efficient.

However, Fama cautioned that from a practical stand point, the autocorrelation test and runs test, which were popular at the time for testing dependence in price changes, were not sufficient in testing whether previous stock prices could have be used to increase expected returns for investors. This is because both tests lacked the sophistication to find complex patterns in stock prices. He also noted that the runs test completely ignored the magnitude of the observations and was too stringent when determining the duration of price movements, and may even be terminated if the price level temporarily changed direction. From a statistical perspective, these two tests can only examine dependence, which was present throughout the data, but there may be circumstances where dependence in price changes exists in special conditions. For example, large price changes can be consistently followed by large price changes of the same or opposite sign. Such circumstances cannot be handled by these tests.

Over the past three decades, in keeping with technological advancements and the advent of computerised trading, many other sophisticated econometric tests have been developed, involving the use of several statistical software packages. Some of these contemporary econometric techniques, which are used to assess stock market efficiency, include the *Variance Ratio test, the Augmented Dickey Fuller test, the Ljung-Box test* and the use of *Autoregressive Conditional Heteroscedasticity (ARCH) / Generalised ARCH in Mean (GARCH-M) Models.*

The aforementioned tests have been used in a considerable number of stock market efficiency studies. Such studies, according to Robinson (2005), are grouped into three categories: Those that focused on cross-sectional patterns in stock returns, such as market capitalisation and value versus growth; those that concentrated on time series predictability, looking either at time series predictability generally or with a particular focus on calendar turning points such as the beginning of the year, ends of the week, holidays etc; and those that integrated cross sectional and time series predictability in a broad cross section of international equity markets (developed and emerging).

While most studies pertaining to the validity of stock market efficiency have been applied to developed markets, it is equally worthwhile to search for evidence of stock market efficiency in emerging markets. Since the Caribbean stock markets fall in the category of emerging markets, the bulk of the empirical literature surveyed for this study focused on emerging markets.

Table 2 (see Appendix) illustrates that most empirical research of market efficiency in emerging markets pertains to Asian stock markets. This popular interest in the Asian stock market is possibly due to the rapid growth of the Asian financial sector in the past decade. Table 2 also shows that the majority of research on emerging markets focuses on ascertaining whether these markets are weakly efficient (whether stock prices conform to the RWH). As the table indicates, the principal tools for testing the validity of the RWH in emerging economies comprise of autocorrelation tests, runs tests, unit root tests, variance ratio tests and the GARCH-M models.

These studies depicted in Table 2 offer mixed results. It is no surprise that research on emerging markets, such as the Chinese stock market, provided evidence of inefficiency, as most emerging markets are characterised by market thinness and non-synchronous trading. Results that suggest market efficiency can be attributed to the increased frequency of investor trading, particularly in the Asian stock markets. Markets, such as the Brazilian stock market have faced increased liquidity due to an influx of international investors, which can account for the positive market efficiency findings. Abeysekera (2001) argued that the Colombo Stock Exchange was informationally inefficient due to tremendous cultural, operational, organisational and technological changes. Moustafa (2004) asserted that the evidence of market efficiency in the United Arab Emirates stock market could be attributed to steps taken by authorities to improve its operational and pricing effectiveness.

Many other researchers supported the notion that emerging stock markets behave in accordance with the EMH. Vaidyanathan and Gali (1994) tested the weak form of market efficiency in the Indian Capital Market, and found evidence to support it; Laurence, Cai and Qian (1997) acquired some proof of weak form efficiency in the Chinese Stock market (‘‘A’’ shares are weakly efficient, but not ‘‘B’’ shares); Ramasastri (1999) noted that the hypothesis of random walk in the Indian stock market cannot be rejected; and similar findings have been reported by Annuar (1991) in his results on the efficient market hypothesis in the Kuala Lumpur Stock Exchange. Also Chiwira (2001) reported that the Zimbabwean Stock Exchange was efficient in the weak sense.

However, innumerable studies have made passionate attacks against the EMH, which resulted from several empirical evidence against stock market efficiency. These include evidence of pricing anomalies, downward sloping demand, excessive volatility, delayed information response and consistent superior traders (Stout 2005).

In general, the EMH asserts that investors cannot generate excess returns, and outstrip the market predictably and consistently. Empirical evidence has proven otherwise, as many investors, such as Peter Lynch and Warren Buffet have constantly ‘beaten the market’. Peter Lynch, Fund Manager of the Magellan Fund – one of the largest hedge funds in the world, while at the helm of Magellan achieved an average annual return of 29% a year over 12 years. Defenders of the EHM assert that investors, who surpass the market, do so out of mere ‘good luck’. However, it is unreasonable to assert that investors who have earned excess returns on a consistent basis do so because they are lucky, and not due to intelligent strategy and skill.

Contrary to the EMH assumption that market efficiency is realised when information is costless, Stout (2004) asserted that information is costly to obtain and analyse. The EMH implies that prices are fully reflective of all information, but situations involving costly information can render it impossible for investors to acquire, interpret and analyse all existing information significant to valuing securities. Thus, prices do not fully reflect all existing information. Stout also contended that contrary to EMH, prices to not immediately react to information changes, as such information might be technical and difficult to understand. He maintained that such complex information may take weeks or months to be reflected in security prices, or may never be reflected at all.

Some studies have found evidence against strong-form efficiency. Investigations by Jaffe (1974) and Rozeff and Zaman (1988) attained considerable evidence that insider trading is prevalent and investors do profit from it, violating the strong-form of the EMH. Another study by Grossman and Stiglitz (1980) reported that the EMH had a theoretical ambiguity: the EHM propounds that there are no arbitrage profits in an efficient market, but the inexistence of these profits renders is worthless to search for and acquire information, as it fails to attract investor activities.

A share price anomaly known as the January Effect, where shares are seen to experience much higher return in January compared to any other time of the year, has also contradicted the EMH. A seminal paper by Rozeff and Kinney (1976) discovered significant January Effects on the N.Y.S.E. prices from 1904 to 1974. They reported a significant pattern of overreaction and abnormally high movement in share price around January. This seasonal pattern is a direct violation of weak and semi strong efficiency forms.

An increasingly popular field, Behavioural Finance, has also contested the EMH. Studies in this domain showed that investor psychology plays the key role in determining market behaviour. The concept of market efficiency is based on the assumption that investors are rational, but some studies have reported that investors sometimes take irrational approaches to decision making, breaching the concept of market efficiency. Wang and Power (2004) found the *overreaction effect* to be prevalent in the Chinese stock market. This is a situation where investors overreact to good or bad news, causing stock price disequilibrium. Another contemporary empirical study by Abarbanell and Bernard (1990) showed that financial analysts can overreact to bad news and place too much weight on recent data, which can cause an overvaluation and undervaluation of securities, resulting in market inefficiency.

While these studies investigated the issue of efficiency in emerging markets; there is a lack of such studies pertaining to the securities markets of the Caribbean. This is because stock markets in the Caribbean have not been in existence for lengthy periods (for example, the BSE was only created in 1987). This ability to conduct rigorous stock market efficiency testing has only been possible within recent times, as adequate stock data pertaining to the Caribbean is now available. This enabled some researchers to conduct efficiency studies to ascertain whether the three major stock markets in the Caribbean, the JSE, BSE and TTSE are efficient. An outline of some of these studies and its experiential results are depicted in Table 3.

The majority of investigations into Caribbean stock market efficiency pertain to the BSE, TTSE and JSE. The results of these studies are expected to be market inefficiency. This is because these markets are characterised by illiquidity and thin trading as the number of companies' listed stocks is not substantial. There is lack of market participation and low and unsteady trading volumes, while trading on these markets can be faced with transaction costs. Furthermore, there is differing investor reaction to price changes, which does not concur with the EMH assumption of homogenous reaction by investors.

However, Table 3 illustrates that 2 of the 4 selected studies on Caribbean stock markets reported that the BSE was weak-form efficient efficient. These results were quite astonishing as the BSE suffers from the aforementioned problems. Moreover, a portion of the data set included in these studies were taken from a period of manual trading, when the transmission of stock price information and changes were not swift, which would have caused delayed investor reaction to any price information and change, leading to market inefficiency. As such, any study incorporating stock price data from these early periods should produce a conclusion of inefficiency. Further, the average frequency of trading on these exchanges is not significant; causing further problems of market illiquidity.

Nonetheless, it is possible to see why some research into the BSE may conclude weak-form market efficiency as there was no indication of any price anomalies such as the January effect and the May effect. Additionally, trading on the BSE commenced after the JSE and the TTSE, hence studies on the BSE market efficiency may likely produce results, which support the EMH, as these studies would focus on a shorter data range, in comparison to the studies of the JSE and TTSE. Many opponents of the EMH argue that the studies on a short return window are biased toward positive results, as any lag in the response to price changes are short lived. They maintain that prices can adjust slowly to information, so one must examine returns over long horizons to get a full view of market efficiency. From an econometric point of view, the overall methodology employed by Robinson (2001) to establish whether there was market efficiency may have been less than appropriate. The autocorrelations test and runs test are based on the assumption of market equilibrium of a developed economy and there is a debate as to whether they are pertinent to developing economies, such as Barbados. More sophisticated tests could have also been utilised, such as the variance ratio test, to ascertain whether the findings of the autocorrelation test and the runs test hold true and therefore lend support (this was only done in Singh's study of the TTSE).

4. Data and Methodology

4.1 Data

The data that was used for the purpose of investigating the issue of weak-form efficiency on the TTSE, JSE and BSE constitute:

- The monthly closing common stock prices of a sample of 18 companies listed on the TTSE over the period January 1998 to June 2004;
- The monthly closing common stock prices of a sample of 23 companies listed on the JSE over the period January 1999 to June 2004;
- The monthly BSE local price index over the period March 1989 to June 2007.

The selected companies from the TTSE and JSE are drawn from a wide range of business sectors and the findings should be generalisable. These companies were chosen as the time series of their closing stock prices were of adequate length in comparison to those of the other companies. The BSE local price index was used for the BSE efficiency study, which focused on three periods; March 1989 to June 2007, which was divided into two sub-periods, March 1989 to December 2001 and January 2001 to June 2007. This price index was utilised due to the unavailability of stock price data. It represents the average behaviour of the local listed companies' stock prices, and is calculated using the following formulae

$\sum \frac{P_{i,t} Q_{i,t}}{B} \times M$; where $P_{i,t}$ denotes the price of stock *i* at time *t* and $Q_{i,t}$ denotes the theoretical quantity of the stock *i* on the portfolio on instant *t*, *B* refers to the base aggregate value and *M* is the multiplier. This is performed via an automated trading system known as the Horizon Trading Work Station.

4.2 Methodology

Many empirical studies, which investigate the weak-form of efficiency in emerging markets, utilise the *Random Walk Model*, as it directly tests whether these markets conform to the Random Walk Hypothesis (RWH). This model is applied in this study to test whether the JSE, TTSE and the BSE are weakly efficient and is illustrated by:

$$P_t = \mu + \beta P_{t-1} + \eta_t \,;\ E[\eta_t] = 0,\ \forall\, t$$

or equivalently, $\Delta P_t = P_t - P_{t-1} = \mu + (\beta - 1)P_{t-1} + \eta_t$

P_t denotes a stochastic process, which is the price series, μ depicts a constant drift parameter, and η_t represents the random disturbance, which is a normally distributed Gaussian White Noise process.

For the Random Walk Hypothesis to hold, β should be equal to1, such that

$$P_t = \mu + P_{t-1} + \eta_t, \text{ or } \Delta P_t = \mu + \eta_t$$

In this regard, this study proposed a number of tests on the β coefficient.

Wald test for the restriction $\beta = 1$

This test is used to determine the extent to which the Maximum Likelihood (ML) estimator of the parameter β, $\hat{\beta}$ violates the restriction $\hat{\beta} = 1$. If this restriction holds, then $\hat{\beta} - \beta = 0$ and the sequence follows a random walk. The Wald Statistic is given by:

$$\mathbf{W} = \frac{\hat{\beta} - \beta}{Var\hat{\beta}} \sim \chi^2$$

The null hypothesis of $\hat{\beta} = 1$ is only rejected when the *p*-value associated with the computed Chi-squared test statistic is lower than the 5% level of significance. Otherwise, we do not reject the null, and conclude that the series in concern follows the random walk.

Although this test is valid for investigating the random walk, it fails to consider the possibility of the presence of serial correlation and heteroscedasticity in the stock price sequences. As such, other econometric techniques, which possess stronger statistical properties, are also employed.

Autocorrelation Tests

This test utilises 3 autocorrelation tests to detect statistical dependence in the various stock price and index sequences.

The initial serial correlation test examine the autocorrelation coefficients at lags 1 to 5 for all the price series of the selected stocks from the TTSE and JSE, and the price index sequences from the BSE, for statistical significant at the 5% level. The Ljung-Box test is used to complement these results. The test statistic associated with the Ljung_Box test is denoted by:

$$Q^* = n(n = 2)\sum_{k=1}^{m}(\hat{\rho}_k^2 / n - k) \sim \chi^2$$

If the calculated Q^* statistic is significant at the chi-squared critical value, we reject the null hypothesis of no serial correlation and conclude that the RWH does not hold.

We investigated the robustness of the results of the Ljung-Box test by employing the popular Breusch-Godfrey Lagrange Multiplier (LM) test for serial correlation is also used. This is a more rigorous test in comparison to other popular serial correlation tests, particularly the Dubin-Watson (DW) test, as it allows for non-stochastic regressors (a feature of most financial time series data) and lagged regressors in the regression model. Also, the test statistic has a known asymptotic distribution. This autocorrelation test is employed to examine the assumption of the random walk model that the successive occurrences are independent.

Assume that the random walk disturbance $\eta_t = \rho_1\eta_{t-1} + ... + \rho_p\eta_{t-p} + v_t$, that is η_t is an AR(p) process. The Breusch-Godfrey testing procedure involves regressing the computed residual vector, $\hat{\eta}_t$, on the lagged price index sequence, P_{t-1} (explanatory variable) and its lagged values, $\hat{\eta}_{t-1},...,\hat{\eta}_{t-p}$, which produces an auxiliary regression. In this case, p=12 since the frequency of the data employed is monthly. The R^2 of this regression is multiplied by (n-12), where n is the sample size, to produce the test statistic:

$$R^2 \text{(n-12)} \sim \chi^2$$

If the calculated test statistic exceeds the critical chi-squared value at the chosen level of significance, the null hypothesis of zero serial correlation is rejected, which implies that the series does not follow a random walk and the stock markets under scrutiny are weakly inefficient.

However there are other rigorous econometric tests, such as unit root tests, which examine the validity of the RWH, while taking serial correlation into account.

Unit Roots Test: Augmented Dickey Fuller (ADF) and Phillips Perron (PP) Tests

Many contemporary studies have popularised unit root testing as a form of testing the validity of the RWH and whether stock markets are weakly efficient. Two of these commonly used tests are the Augmented Dickey Fuller (ADF) and the Phillips Perron (PP) unit root tests, which have the same asymptotic distribution. The benefit of the ADF and PP tests is that they control for autocorrelation by adding the lagged differenced regressors and by using nonparametric statistical methods, respectively.

To introduce these tests, consider the Random Walk Model,

$$P_t = \beta P_{t-1} + \eta_t, \quad \text{or equivalently}$$

$$\Delta P_t = P_t - P_{t-1} = (\beta - 1)P_{t-1} + \eta_t$$

where $P_t \sim AR(1)$ and $\eta_t \sim I(0)$, that is, η_t is a stationary disturbance term. The price sequence P_t is non-stationary and follows a random walk, provided that $\beta = 1$, or $\beta - 1 = 0$. If this holds, $\Delta P_t = \eta_t$, which is I(0). In order to test the null hypothesis that P_t is non stationary, ΔP_t can be regressed on P_{t-1} and the *t* statistic can be used to test $\beta = 1$. In this case the special t-statistic, known as the τ (tau) statistic, is employed, using critical values tabulated by Dickey and Fuller (1981), on the basis of Monte Carlo simulations. The ADF and PP tests are applied to the following regression, which is commonly referred to as the Random Walk Model with Drift and Trend:

$$\Delta P_t = \mu + \psi t + (\beta - 1)P_{t-1} + \alpha_i \Sigma\, \Delta P_{t-i} + \eta_t$$

where t is the time or trend variable and $\alpha_i \Sigma\, \Delta P_{t-i}$ denotes the augmented lags of the price index sequence (dependent variable), which is included to ensure that η_t is Gaussian white noise. In this regression, the hypothesis $\beta = 1$ is tested using the ADF τ distribution. If rejected, it is concluded that the series is stationary. Otherwise, the series contains a unit root and we proceed to test the joint hypothesis $\mu = \psi = 0$, given that $\beta = 1$, using the ADF τ distribution. If this is hypothesis holds true, we conclude that the sequence follows the random walk without significant trend or drift. If $\mu = \psi = 0$ is rejected, while $\beta = 1$ holds, we conclude that the series follows a random walk with significant trend and drift. When $\psi = 0$ is rejected but $\mu = 0$ and $\beta = 1$ cannot be rejected, the series follow the Random Walk with significant trend. Also, if $\beta = 1$ and $\psi = 0$ holds, but $\mu = 0$ is rejected, we conclude that the sequence follows the random walk significant drift.

The PP test is often seen as being superior to the ADF test as it guarantees white noise errors. This is because the choice of the lag length in the ADF test may not always be rigorous to autocorrelation. However, several studies, such as Hakkio (1986) and Fama and French (1988) demonstrated that in many cases, the power of these unit root tests may be compromised.

To resolve this shortcoming Lo and MacKinlay (1987) developed tests for random walk based on variance ratios.

The Variance Ratio Test (Lo and MacKinlay, 1989)

In order to test the validity of the notion that the Caribbean stock exchanges adhere to the RWH, the Variance Ratio (VR) test is also employed. This test is based on the assumption that the variance of random walk increments in a finite sample is linear in a sampling interval. The motivation behind the use of the VR test is that this is a non-parametric test and does not depend on normality of the price sequence. Additionally, the problem of a rejection of the RWH due to heteroscedasticity, which is present in almost all financial time series, does not exist, as the VR test statistic is a heteroscedastic robust test statistic. As such, the Lo and MacKinlay (1989) univariate VR test, which incorporates heteroscedasticity, is utilised to determine whether the RWH holds for the three stock exchanges under scrutiny.

According to Lo and Mackinlay (1989), the VR statistic is obtained based on the assumption that if the pricing sequence P_t is a pure random walk, the variance of its *q*th difference is equal to *q* times the variance of its first difference.

Assume the data set consisted of nq + 1 observations, $P_0, P_1, \ldots, P_{nq}$ (at equally spaced intervals). If the series is characterised by a random walk, 1/*q* of the variance of P_t, P_{t-q} is expected to be equivalent to the variance of $P_t - P_{t-1}$, that is

$$\frac{1}{q}\frac{Var(P_t - P_{t-q})}{Var(P_t - P_{t-1})} = 1$$

The Variance Ratio is given by $VR(q) = \dfrac{\hat{\sigma}_q^2}{\hat{\sigma}_1^2}$, where $\hat{\sigma}_q^2 = \dfrac{1}{m}\sum_{t=q}^{n}(P_t - P_{t-q} - q\hat{\mu})^2$ is the unbiased estimator of the variance of the *q*th difference of P_t, and $\hat{\sigma}_1^2 = \dfrac{1}{n-1}\sum_{t=q}^{n}(P_t - P_{t-q} - \hat{\mu})^2$ is the unbiased estimator of the variance of the first difference of P_t, for

$\hat{\mu} = \dfrac{1}{n}[P_n - P_0]$ and $m \equiv q(n-q+1)\left(1 - \dfrac{q}{n}\right)$

Therefore, if the process follows a random walk, $VR(q) = \dfrac{\hat{\sigma}_q^2}{\hat{\sigma}_1^2} - 1 \approx 0$.

The standard homoscedastic test statistic $\mathbf{Z}_1(q)$ is given by

$$\mathbf{Z}_1(q) = \sqrt{nq}\; VR(q)\left(\frac{2(2q-1)(q-1)}{3q}\right)^{-1/2} \xrightarrow{a} N(0,1)$$

The heteroscedasticity-consistent asymptotic variance estimator is given by

$\hat{\phi} = \sum_{j=1}^{q-1}\left[\dfrac{2(q-j)}{q}\right]^2 \hat{\delta}(j)$, where

$$\hat{\delta}(j) = \frac{\sum_{t=j+1}^{q-1} \left(P_t - P_{t-1} - \hat{\mu}^2\right)\left(P_t - P_{t-j-1} - \hat{\mu}\right)^2}{\left[\sum_{t=1}^{nq} \left(p_t - P_{t-1} - \hat{\mu}^2\right)\right]^2}$$

The heteroscedasticity-consistent standard normal test statistic $\mathbf{Z}_2(q)$ is given by

$$Z_2(q) \equiv \sqrt{nq}\; VR(q)\,\hat{\phi}^{\,-1/2}(q) \xrightarrow{a} N(0,1)$$

Therefore, we can also test the null hypothesis of a random walk process by computing the above-standardised statistics, which are asymptotically standard normal. However, the sampling distribution of the VR test statistic can exhibit a tendency to depart from normality in finite samples, which results in severe bias and right-skewness.

5. Estimation Results

In this section, the estimation results of the various econometric techniques used to ascertain whether the TTSE, BSE and JSE were weak-form efficient are presented. Each securities exchange is considered separately.

5.1 Trinidad and Tobago Stock Exchange

Wald test for the restriction $\beta = 1$

For each of the 18 selected stocks from the TTSE, the Wald test of the restriction $\beta = 1$ was carried out and the results have been summarised in Table 4 (see Appendix). These results provided *some* evidence that the TTSE was weakly efficient. The tests showed that the β coefficient attached to the lagged pricing sequence, P_{t-1} (exogenous variable of the Random Walk model), for 8 stocks in the sample significantly deviated from 1. These findings therefore imply that 55% of the sample of TTSE stocks conformed to the Random Walk.

Autocorrelation Tests

The results of the serial correlation tests are presented in Table 5 (see Appendix). The first 5 columns illustrate the initial test, which depicts the sample serial correlation coefficients for the 18 stocks for lags from 1 to 5 months. For lag 1, 6 of these coefficients are positive and 7 are statistically significant at the 5% level. For lag 2, 13 of the 18 coefficients are positive, while only 1 coefficient is significant. At lags 3 and 5, 11 coefficients are positive, but none are statistically significant. At lag 4, there are 14 positive coefficients and 1 significant coefficient at the 5% level. These results imply that at the 95% confidence interval, the extent of statistical dependence in the stock price sequences is trivial, which suggests that the TTSE is weakly efficient.

The results of the Ljung-Box and Breusch-Godfrey LM tests for serial correlation, which were employed to determine whether the results of the previous serial correlation test were valid, are also illustrated in Table 5. The eighth column of Table 4 depicts the Ljung-Box Q* statistics for the 18 selected stocks of the TTSE. These results show that a minor 28% (5) of the selected stocks are characterised by autocorrelation. Additionally, the findings of the Breusch-Godfrey autocorrelation test; depicted by the last 2 columns of Table 5, also support the null hypothesis of no serial correlation, as the LM statistics for all 18 stocks are statistically insignificant. These findings are coherent with the previous serial correlation test results and imply that the TTSE conforms to the Random Walk and is weakly efficient.

Formal Unit Root Tests: ADF and Phillips Perron(PP)Tests

The results of the ADF and PP tests are summarised in **Tables 6 and 7**(see Appendix) respectively. Both tests showed that the A.D.F. and P.P. test statistics associated with the AHL, NFM, RML and TCL stock price sequences are significant at the 5% level, which implies a rejection of the null of non-stationarity. However, the corresponding ADF and P.P. statistics of the remaining 14 stocks are insignificant at the 5% level, suggesting a non-rejection of the null hypothesis. Of these stocks, 5 exhibit a random walk pattern with significant trend, 1 follows the random walk with significant drift and 1 conforms to the random walk with significant trend and drift. Thus, the evidence suggests that the TTSE is weak-form efficient, as 83% of the sample stocks from the TTSE are I(1).

Variance Ratio (VR) Test

Table 8 (see Appendix) details the results of the VR test of random walk for the TTSE data set. The variance ratios, VR(q), the homoscedastic test statistics, Z(q), and the heteroscedastic robust statistics, Z*(q) are reported, for various investment horizons (q = 2, 6, 12, 24 and 48 months). The results show that only 6 (33.3%) of the 18 stocks had 3 to 5 variance ratios approximately equal to 1. The evidence further suggests that the notion of a random walk can be completely refuted for two stocks, CCN and FUR, as both Z(q) and Z*(q) statistics are significant at the 5% and 10% level at each investment horizon. The random walk hypothesis is also discarded on the basis of the significance of the Z(q) statistic for q = 2, 6 in AML, for q = 2 in FFL, for q = 2, 6 in LJWB, q = 2, 6, 12 in NFM, q= 2, 6 in NML, q = 2, 6 in PLD, q = 2, 6, 12 in PUB, q = 2, 6, 12 in RBL, q = 2 in RBTT, q = 2, 6, 12 in RML and q = 2, 6, 12 in TCL. However, this rejection is not supported by the heteroscedastic statistics, Z*(q), implying that the strong evidence against the random walk hypothesis by the Z(q) test was caused by the presence of heteroscedasticity in the aforementioned stocks price sequences. Thus, when the heteroscedastic disturbances are considered, the null hypothesis of a random walk is accepted for 95% (17) of the stock sample at each value of q at the 5% and 10% significance levels. Only 1 stock, GHL, switched from an acceptance to a rejection of the random walk after heteroscedasticity was accounted for, indicated by a statistically significant Z*(q) statistic at q = 2.

These econometric results advocate that the TTSE is weakly efficient. However, this does not agree with the results found by Singh (1995) in his inspection of the efficiency of the TTSE. In that study, Singh provided evidence of a significant degree of autocorrelation in the majority of the TTSE stock return series, which suggested that the TTSE was weakly inefficient.

5.2 Jamaica Stock Exchange

Wald test for the restriction β = 1

The results of the Wald test of the restriction β = 1 for each of the 23 sample stocks from the JSE are detailed in Table 9 (see Appendix). These findings illustrate that the null hypothesis of β = 1 (random walk) is not rejected for 15 of the sample stocks, as their respective *p*-values attached to the chi-square statistics are statistically significant at the 5% level, implying that 65% of the JSE sample stocks conform to the random walk. According to the Wald test results, the JSE displays a greater degree of weak-form market efficiency than the TTSE, which suggested that 55% of the sample stocks exhibit a random walk pattern.

Autocorrelation Tests

It appears from Table 10 (see Appendix), at the 95% confidence interval, the various autocorrelation tests provide evidence of an insignificant level of dependence in the successive stock price occurrences. This suggests randomness in the stock price sequences of the JSE selected stocks, which implies weak-form efficiency.

The results of the first autocorrelation test (columns 2 to 6 in Table 10) show that at lag 1, 10 of the autocorrelation coefficients are positive, while 2 coefficients are statistically significant at the 5% level. For lags 2 and 3, the majority of the autocorrelation coefficients are positive, with the coefficients of 5 and 1 stocks being significant at the 5% level for lags 2 and 3 respectively. At lags 4 and 5, 11 autocorrelation coefficients are positive and there is 1 statistically sizeable coefficient at the 5% level for each of these 2 lags. These findings of negligible serial correlation support the notion that the JSE is weakly efficient, due to the lack of statistical dependence in the series.

The results of the Ljung-Box and Breusch-Godfrey autocorrelation tests provide robust confirmation of the results of minor serial correlation. The findings of the Ljung-Box test (column 8) indicate that only 1 of the selected stocks display characteristics of autocorrelation, while the results of the Breusch-Godfrey test (columns 9 and 10) suggest that the LM statistics for the majority (18) of the sample stocks are statistically insignificant, supporting the null hypothesis of zero serial correlation. As such, this lack of serial correlation suggests that the stock price sequences from the JSE are characterised by randomness, implying that the JSE is weakly efficient

These serial correlation tests also suggest that the JSE has a superior level of weak-form efficiency than the TTSE, as the degree of autocorrelation in the TTSE, though negligible, exceeds that of the JSE.

Formal Unit Root Tests: ADF and Phillips Perron (PP) Tests

The outcome of the ADF and PP tests for unit roots in each of the 23 JSE sample stock price series is summarised in Tables 11 and 12 (see Appendix) respectively. According to the results of the ADF an PP tests, 87% (20) of the selected JSE stocks are I(1), implying that the preponderance of the stock price sequences on the JSE exhibit random walk uniqueness. Of these stocks, 4 conform to the random walk with significant trend, 2 stocks follow the random walk with significant drift and 2 stocks display random walk with significant trend and drift. These noteworthy non-stationary results imply that the JSE is efficient in the weak-form sense.

These results provide further evidence that the JSE exhibits stronger characteristics of weak-form capital market efficiency in comparison to the TTSE. The unit root tests show that the proportion of stocks on the JSE that conform to the random walk (87%) exceeds that of the TTSE (83%), implying a higher level of weak-form efficiency on the part of the JSE.

Variance Ratio (VR) Test

The results of the VR test of random walk for the JSE data set over various investment horizons (q) are reported in Table 13 (see Appendix**)**. The table shows that 8 (39%) of the 23 sample stocks had 3 to 5 variance ratios approximately equal to 1. An examination of the homoscedastic statistics, Z(q), reveals that they are statistically significant for 4 investment horizons (q) in 1 stock, for 3 investment horizons in 3 stocks, for 2 investment horizons in 7 stocks and for 1 investment horizon in 2 stocks. These statistics therefore rebut the random walk hypothesis. Hence, we apply the heteroscedasticity-consistent test statistic Z*(q). The results suggest that heteroscedasticity must have played a role, because now there is a much smaller number of rejections of the random walk hypothesis, in comparison to the Z(q) test. The null is rejected for q = 48 in Grace, q = 48 in Lascelles, q = 12, 24 in Palace and q = 2 in CMP and Courts. The first three of these stocks remained in a state of inefficiency and latter 2 stocks moved from a state of efficiency to inefficiency, after heteroscedasticity was accounted for. The null hypothesis of a random walk is now accepted for 70% (16) of the stock sample at each value of q at the 5% and 10% significance levels. Based on these findings, we can conclude that the JSE is weakly efficient.

It is evident that the presence of heteroscedasticity is greater in the stock price series of the JSE than the TTSE. This is no surprise as the market liquidity and trading frequency of the JSE exceeds that of the TTSE. As such, the JSE would definitely be faced with a higher level of price fluctuations and variability than the TTSE. This implies a greater degree of heteroscedasticity in the JSE stock price sequences.

The evidence provided by these tests suggest that the JSE is not characterised by price predictability and is weakly efficient. These results refute the findings of market inefficiency on the JSE, reported by Robinson (2005). In that study, 65% of the listed stocks on the JSE were affected by autocorrelation, which rendered the JSE weakly inefficient.

5.3 Barbados Stock Exchange

The approach to the study of the BSE market efficiency, focused on investigating the local monthly stock *indices* for randomness over three periods: March 1989 to June 2007, March 1989 to December 2001 and January 2001 to June 2007. This approach was taken in an attempt to investigate the evolution of the BSE efficiency over the years.

Wald test for the restriction $\beta = 1$

The initial investigation for randomness in the stock price indices of the BSE, incorporated the Wald test of the restriction $\beta = 1$, for all three investment periods. The results, which are presented in Table 14, suggest that the BSE is weakly efficient over the period 1989 to 2007 and 2001 to 2007, but inefficient over the period 1989 to 2001. The implication of these results is that the BSE has become weakly efficient overtime, and follows the random walk.

Autocorrelation Tests

The overall conclusions of the serial correlation tests conflicted with those of the Wald test, as depicted in Table 15. From examination of the autocorrelation coefficients, we see that at Lag 1, the coefficients for all 3 periods were statistically significant at the 5% level, but insignificant at all other lags. These results of low serial correlation imply a small degree of statistical dependence in the BSE price index series for each period in concern. However, the findings of the Ljung-Box test suggest otherwise. The Q* Statistics for all periods depict extreme significance at the 5% level; indicating a strong degree of serial correlation in the price index sequence. The statistic for the latter sub- period, 2001 to 2007, is much smaller than that of the former sub-period, which suggests that the degree of statistical dependence is reduced overtime, but is still significant. The null of no serial correlation is therefore rejected. The Breusch-Godfrey test results show that the LM statistic was statistically sizeable over the period 1989 to 2007, but insignificant for the 2 sub periods. The results of this test are accepted as it has a greater degree of robustness in larger samples than the other 2 tests. As such, over the 2 individual sub-periods, the random walk holds as there was no substantial degree of dependence among the price index occurrences; but the result of serial correlation over the collective period opposes the random walk.

Formal Unit Root Tests: ADF and Phillips Perron (PP) Tests

The ADF and PP unit root test results for each period are detailed in Tables 16 and 17. These tests both revealed that the price index sequence over the periods 1989 to 2007 and 1989 to 2001 are I(1) and conform to the random walk. On the contrary, the price index over the period 2001 to 2007 is drift stationary, I(0), and contests the random walk. These results suggest that the BSE moved from a state of efficiency to inefficiency overtime, which conflicts with the results of the previous 2 tests of market efficiency.

Variance Ratio (VR) Test

Thus far, each test of market efficiency of the BSE for the three sample periods reported conflicting results. The VR test was then conducted to reach a consensus. Table 18 reports the VR(q), Z(q) and Z*(q) statistics for the various investment horizons (q). The results show that none of the VR(q) statistics are statistically indistinguishable from 1. The homoscedastic Z(q) statistics are significant for q = 2, 6, 12 in the sample period periods 1989 to 2007 and 1989 to 2001 and for q = 2, 6, 12 and 24 in period 2001 to 2007. This evidence indicates that the random walk should be rejected for all 3 periods, as the majority of Z(q) statistics are significant at the 5% and 10 % levels. Also, the Z(q) values show that the degree of market inefficiency is stronger in the second sub-period than the first. However, upon examination of the heteroscedastic-consistent statistics, $Z^*(q)$, it is clear that when heteroscedastic disturbances are considered, the null hypothesis of a random walk is accepted for all values of q, as none of these statistics are statistically significant. These results suggest that the rejection of the random walk for the three periods under the homoscedastic test statistic is due to the presence of heteroscedasticity in the price index sequences. We can therefore conclude that the after taking heteroscedasticity into account, the BSE is weakly efficient. From closer examination of the $Z^*(q)$ statistics, we see that the $Z^*(q)$ absolute values of the latter period (2001 to 2007) are closer to the 10% critical value of 1.64, in comparison to the $Z^*(q)$ absolute values of the former period (1989 to 2001). This implies that although the findings suggest weak-form market efficiency after heteroscedasticity was taken into account, the extent of this efficiency is greater in the former sub-period than the latter.

The results of the VR tests are accepted, and we conclude that the BSE is weakly efficient. This is because the VR test is more powerful than any of the other tests, which were used in this study to investigate market efficiency, as it is robust to many forms of heteroscedasticity and non-normality of the stochastic disturbance term (see Lo and MacKinlay (1987) for further details).

This report of weak form market efficiency on the BSE for the 3 sample periods is consistent with the findings of Craigwell and Grandbois (1999), and Robinson (2005). Craigwell and Grandbois used the ADF and PP unit root tests and reported that the BSE was weakly efficient over the period 1987 to 1997. Robinson, after utilising the autocorrelation and runs test accepted the notion that the BSE was weakly efficient over the period 1992 to 2001.

5.4 Discussion

These findings of weak form market efficiency on the TTSE, JSE and the BSE are astounding. These markets are classified as emerging capital markets and are still in the initial stages of development. All 3 exchanges are characterised by illiquidity and thin trading, with the BSE at the top of the list. Each of these markets still lack investor activity and faced with low and unsteady trading frequency. Further, the number of listed stocks on these exchanges is insufficient to render them efficient. Although trading is now automated, there are still problems of considerable time lags in divulging market information to market participants, which causes delayed investor reaction and impede trading. This would impair market efficiency. Additionally, this study incorporated data from a period when trading was not automated and information was not quickly and freely disseminated, contrary to assumptions of the EMH. Information on stock price quotations, which affect investor reaction, would have reached market participants behind schedule, which impairs market efficiency. Moreover, the findings of weak-form market efficiency for the 3 exchanges are unanticipated as these markets are still plagued by heavy transaction costs and opposing investor reaction to price changes, which does not coincide with the EMH assumption of homogenous investor reaction.

However, the findings of weak-form efficiency on the three markets may be attributed to the massive investments, which were made over the past decade in an attempt to bring these stock exchanges to international standards and create modern infrastructures for trading. These institutional developments may have actually increased investor trading to the extent of rendering these markets weak-form efficient. Also, several seasonal effects and pricing anomalies, such as the Monday effect and January effect, may not have existed on these exchanges. Pricing anomalies and seasonal effects promotes price predictability as they have a tendency to create distinct patterns in stock price movements, which cause significant serial correlation in price occurrences. Since the evidence of autocorrelation in these 3 exchanges was slim, we can ascertain that there were no such pricing anomalies to cause inefficiency. Additionally, the VR test filtered the heteroscedasticity elements from the stock price sequences. The presence of heteroscedasticity can bias test results; this was evident in the study of all 3 exchanges. By accounting for heteroscedasticity the final results prove that the TTSE, JSE and BSE were in fact weakly efficient.

6. Conclusion

The EMH is concerned with whether stock prices reflect all presently available market information. The weak-form test of the EMH model focuses on the information subset of historical prices. This study examined the behaviour of stock prices on three major stock exchanges in the Caribbean region, the TTSE, JSE and BSE, to determine their consistency with the weak-form of the EMH. A variety of econometric techniques were employed for this purpose, which included the Wald test, serial correlation tests, unit root tests and variance ratio tests. These tests were applied to the closing monthly price sequences of 18 selected stocks from the TTSE over the period January 1998 to June 2004. Additionally, these econometric tests were applied to the price series of 23 sample stocks from the JSE over the period January 1999 to June 2004. The evidence suggested that both of these exchanges were weakly efficient, with the JSE showing greater characteristics of weak-form efficiency than the TTSE. The BSE was tested for weak-form efficiency using the monthly local stock price index sequence during the period March 1989 to June 2007, and for 2 sub periods, March 1989 to December 2001 and January 2001 to June 2007. The results of these investigations indicated that the BSE was weakly-efficient for these 3 periods.

The findings of weak-form efficiency on these 3 markets may be attributed to the massive investments made over the past decade to improve the trading activities on these exchanges, a lack of pricing anomalies and seasonal effects, and the heteroscedastic robustness of the variance ratio test. However, these markets possess certain characteristics, which currently impairs this level of weak-form efficiency. Such characteristics include low liquidity levels, unsteady trading frequencies, time lags in trading, differing investor reaction to market information and heavy transaction costs. The findings of this investigation therefore provide assenting and conflicting support for the results other studies of emerging markets. As such, further research, which incorporates the market qualities of these Caribbean exchanges, is necessary to reach stronger conclusions.

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Appendix

Table 2: *Summary of Selected Studies on Emerging Stock Exchanges*

AUTHORS	OBJECTIVES	METHODS	DATA SAMPLE	MAIN RESULTS
Abeysekera (2001)	Test of weak-form efficiency on the Colombo Stock Exchange (CSE)	Autocorrelation, Runs and Unit Root Tests	Monthly stock returns, January 1991-November 1996	Inefficient
Cheung and Coutts (2001)	Test of weak-form efficiency on the Hong Kong stock exchange	Lo and MacKinlay (1988) Variance Ratio test	Daily share prices from the Hang Seng index, January 1985-June 1997	Weak-form Efficient
Tabak (2003)	Test of weak-form efficiency on the São Paulo Stock Exchange, Brazil	Chow & Denning (1993) Variance Ratio test	Daily prices from the Brazilian stock exchange, 1986-1998	Weak-form Efficient
Moustafa (2004)	Test of weak-form efficiency on the United Arab Emirates (UAE) stock market	Non parametric Runs test	Daily share prices, October 2001-September 2003	Weak-form Efficient
Seddighi and Nian (2004)	Test of weak-form efficiency on the Shanghai Stock Exchange	Durbin-Watson test, Durbin 'h' test, the Lagrange Multiplier test for autocorrelation, Dickey-Fuller tests, GARCH-M (1,1)	Daily share prices from the Shanghai Security index and Shanghai Stock Exchange, January 2000- December 2000	Inefficient
Aquino (2006)	Test of weak- and semi strong-form efficiency on the Philippine stock market	Characterise stock price movements as an AR(1) process	Daily changes in share prices, July 1987-May 2004	Weak- and semi strong-form efficient
Rawashdeh and Squalli (2006)	Test of weak-form efficiency on the Amman Stock Exchange	Variance Ratio and Runs Tests	Daily sectoral indices, 1992-1994	Inefficient

Table 3: *Summary of Selected Studies on Caribbean Stock Exchanges*

AUTHORS	OBJECTIVES	METHODS	DATA SAMPLE	MAIN RESULTS
Singh (1995)	Test of weak-form efficiency on the Trinidad and Tobago Stock Exchange (TTSE)	Serial correlation, Ljung-Box, runs and rank version of the von Neuman's Ratio tests	Monthly closing prices, November 1981-October 1991	Inefficient
Craigwell and Grandbois (1999)	Tests of weak-and semi strong-form efficiency on the Barbados Stock Exchange (BSE)	Augmented Dickey Fuller (ADF) and Phillips Perron (PP) unit root tests; Johansen Cointegration test	Annual quarterly stock returns, 1987 - 1997	Weak form-efficient; semi strong inefficient
Robinson (2005)	Tests of weak form efficiency and seasonality on the Barbados Stock Exchange (BSE)	Autocorrelation and runs tests; Kruskal-Wallis (K-W) test	Monthly closing stock prices, 1998-2001	Weak-form efficient
Robinson (2005)	Tests of weak form efficiency and seasonality on the Jamaica Stock Exchange (JSE)	Autocorrelation and runs tests; Kruskal-Wallis (K-W) test	Daily stock returns, January 1992-December 2001	Inefficient

Table 4: *Results of the Wald Test for the restriction* $\beta = 1$ *on the TTSE Stock Prices (Sample Period: January 1998 to June 2004)*

TTSE STOCK	χ^2 P-VALUE
AFL	0.3131
AGL	0.0559
AHL	0.0004*
AML	0.3793
BER	0.0017*
CCN	0.0213*
FFL	0.6622
FUR	0.0552
GHL	0.5665
LJWB	0.0001*
NFM	0*
NML	0.2342
PLD	0.1327
PUB	0.0009*
RBL	0.1801
RBTT	0.7242
RML	0*
TCL	0*

Note: *Insignificant at the 5% Level

Table 5: *Autocorrelation Coefficients, results of the Ljung-Box and Breusch-Godfrey LM Tests for Autocorrelation in the TTSE Stocks (Sample Period: January 1998 to June 2004)*

TTSE STOCK	LAG 1	LAG 2	LAG 3	LAG 4	LAG 5	N	*LJUNG-BOX Q*STATISTIC*	F VALUE OF LM	CRITICAL VALUE FOR F
AFL	-0.147	0.106	0.023	-0.017	-0.02	77	2.731	0.477	3.96
AGL	0.063	0.116	-0.079	0.086	0.064	77	2.873	0.633	3.96
AHL	-0.13	-0.053	-0.116	0.056	-0.108	77	3.9269	0.506	3.96
AML	-0.174	-0.113	0.025	0.012	0.054	77	3.7808	0.951	3.96
BER	0.224*	-0.158	-0.022	-0.049	-0.033	77	6.3462	1.125	3.96
CCN	0.312*	0.24*	0.038	0.019	-0.001	77	12.604*	1.692	3.96
FFL	0.259*	-0.064	-0.041	0.046	-0.014	77	6.0211	1.536	3.96
FUR	0.37*	0.103	0.146	0.203*	0.082	77	17.59	1.585	3.96
GHL	0.124	-0.019	-0.004	-0.081	-0.127	77	3.178	0.433	3.96
LJWB	-0.28*	0.104	0.145	0.084	0.124	77	10.748	2.225	3.96
NFM	-0.065	0.117	0.107	0.089	0.095	77	3.7891	0.516	3.96
NML	-0.386	0.059	-0.006	0.087	0.026	77	12.922*	2.068	3.96
PLD	-0.277*	0.028	0.18	-0.072	-0.024	77	9.3371	1.223	3.96
PUB	-0.219*	0.056	-0.078	0.035	0.036	77	4.8009	0.789	3.96
RBL	-0.37	0.027	0.019	0.041	0.057	77	11.469*	2.701	3.96
RBTT	-0.354	0.068	0.026	0.107	0.02	77	11.173*	1.794	3.96
RML	-0.004	0.047	0.019	0.027	0.02	77	0.3032	0.062	3.96
TCL	-0.051	0.101	0.096	0.111	0.039	77	2.9445	0.408	3.96

Note: *Significant at the 5% Level; Values of each LM Stat. are lower than the critical value, indicating insignificance

Table 6: *Results of the ADF Unit Root Tests (TTSE Stocks) (Sample Period: January 1998 to June 2004)*

TTSE STOCKS	ADF P	CRITICAL VALUE	ADF ΔP	CRITICAL VALUE	RESULT
AFL	-1.506	-3.469	-11.563*	-3.471	Random Walk with trend
AGL	-0.206	-1.945	-8.511*	-1.945	Random Walk
AHL	-3.635*	-2.901	-5.604*	-2.901	Drift Stationary
AML	-0.990	-3.469	-11.776*	-3.471	Random Walk with Trend
BER	-2.421	-2.901	-4.832*	-2.901	Random Walk with Drift
CCN	0.423	-3.471	-6.098*	-3.471	Random Walk with Trend
FFL	0.896	-3.469	-6.814*	-3.471	Random Walk with Trend
FUR	1.594	-1.945	-5.107*	-1.945	Random Walk
GHL	0.764	-1.945	-7.687*	-1.945	Random Walk
LJWB	-1.341	-1.945	-9.808*	-1.945	Random Walk
NFM	-6.281*	-2.899	-9.814*	-2.901	Drift Stationary
NML	1.394	-1.945	-13.731*	-1.945	Random Walk
PLD	0.874	-1.945	-12.509*	-1.945	Random Walk
PUB	-1.531	-1.945	-12.333*	-1.945	Random Walk
RBL	-2.052	-3.471	-9.744*	-3.471	Random Walk with Drift and Trend
RBTT	-0.189	-3.472	-12.922*	-3.472	Random Walk with Trend
RML	-8.115*	-2.899	-10.112*	-2.901	Drift Stationary
TCL	-6.659*	-2.899	-9.981*	-2.901	Drift Stationary

Note: ΔP denotes first difference of P, *significant at 5% level

Table 7: *Results of the Phillips Perron (P.P.) Unit Root Tests (TTSE Stocks)*
(Sample Period: January 1998 to June 2004)

TTSE STOCKS	P. P. STAT. P	CRITICAL VALUE	P. P. STAT. ΔP	CRITICAL VALUE	RESULT
AFL	-1.316721	-3.469235	-11.25808	-3.470032	Random Walk with trend
AGL	-0.223784	-1.945081	-8.517898	-1.945139	Random Walk
AHL	-3.853424	-2.899619	-9.669619	-2.900137	Drift Stationary
AML	-0.655891	-3.469235	-11.69334	-3.470032	Random Walk with Trend
BER	-2.990578	-3.469235	-7.45779	-2.900137	Random Walk with Drift
CCN	0.638813	-3.469235	-6.098392	-3.470032	Random Walk with Trend
FFL	0.831654	-3.469235	-6.689573	-3.470032	Random Walk with Trend
FUR	2.085148	-1.945081	-5.078888	-1.945139	Random Walk
GHL	0.677298	-1.945081	-7.689487	-1.945139	Random Walk
LJWB	-1.22546	-1.945081	-16.75088	-1.945139	Random Walk
NFM	-6.462646	-2.899619	-32.89937	-2.900137	Drift Stationary
NML	1.817838	-1.945081	-14.66249	-1.945139	Random Walk
PLD	0.817926	-1.945081	-12.6235	-1.945139	Random Walk
PUB	-1.325018	-1.945081	-13.03562	-1.945139	Random Walk
RBL	-3.091842	-3.469235	-7.47865	-3.470032	Random Walk with Drift and Trend
RBTT	-0.450512	-3.470851	-13.89981	-3.472558	Random Walk with Trend
RML	-8.114192	-2.899619	-69.84626	-2.900137	Drift Stationary
TCL	-6.729444	-2.899619	-32.38775	-2.900137	Drift Stationary

Note: ΔP denotes first difference of P, *significant at 5% level

Table 8: *Estimate of Variance Ratios, Homoscedastic and Heteroscedastic Robust Test Statistics (TTSE), (Sample Period: January 1998 to June 2004)*

Numbers without brackets denote Variance Ratios
Numbers in square brackets [ ]denote Z(q) Homoscedastic Test Statistics
Numbers in circle brackets ( )denote Z*(q) Heteroscedastic Robust Test Statistics

TTSE Stock	q =2	q = 6	q = 12	q = 24	q = 48
AFL	0.918737477 [-0.713075746] (-0.562679419)	0.940862282 [-0.209918075] (-0.201777769)	1.055563711 [0.130370991] (0.152874398)	1.00461073 [0.00738335] (0.009984191)	1.321959803 [0.358758775] (0.55458252)
AGL	1.044366939 [0.389318311] (0.387563096)	1.137292596 [0.487340371] (0.520527291)	1.376532944 [0.881810173] (1.010215794)	0.869346313 [-0.209221078] (-0.263512061)	0.633059835 [-0.408880248] (-0.539143396)
AHL	0.911911069 [-0.77297723] -0.785959981)	0.882505182 [-0.417065231] (-0.534434378)	0.619960576 [-0.889508301] (-1.337117888)	0.439676285 [-0.897269219] (-1.585367866)	0.914367058 [-0.095420512] (-0.18798191)
AML	0.811778949 [-1.651633022*] (-0.611173212)	0.504884188 [-1.757486787*] (-0.918594023)	0.647906314 [-0.824099387] (-0.576548405)	0.47402883 [-0.842259089] (-0.788047766)	1.262086515 [0.292042162] (0.356606515)
BER	1.180240326 [1.581602438] (0.660538503)	0.564811088 [-1.544767396] (-0.655296997)	0.402993814 [-1.397333869] (-0.744673902)	0.356595173 [-1.030310393] (-0.732420157)	0.660488188 [-0.378316922 (-0.364665426)
CCN	1.409153499 [3.590307382**] (2.464406083**)	2.325471786 [4.704958103**] (3.915850094**)	3.197765556 [5.140208153**] (4.8082778969**)	3.141008499 [3.428484238**] (3.449837296**)	6.353238623 [5.96509661**] (7.015087902**)
FFL	1.251218452 [2.204432974**] (1.536830965)	1.369574162 [1.311858136] (1.048653395)	0.982722245 [-0.040439769] (-0.034538424)	1.398482876 [0.638106883] (0.614081498)	2.314653489 [1.464914162] (1.259943627)
FUR	1.477849636 [4.193113537**] (2.857570735**)	2.765545165 [6.267063633**] (5.125275498**)	4.170435648 [7.420621786**] (6.9982157486**)	4.199963714 [5.124232417**] (5.339624483**)	6.988510863 [6.672978428**] (7.868685324**)
GHL	1.136698122 [1.199521151] (2.257649271**)	1.156994417 [0.557274899] (0.73064503)	0.882499566 [-0.275017814] (-0.347840135)	0.76226686 [-0.380691775] (-0.456690884)	0.952532797 [-0.052892552] (0.066031743)
LJWB	0.530176867 [-4.122681259**] (-1.288122578)	0.276230135 [-2.56912816**] (-1.133922037)	0.3108993 [-1.612887387] (-0.950985783)	0.334001022 [-1.066491329] (-0.829031494)	0.256802088 [-0.828143047] (-0.828729009)
NFM	0.550776366 [-3.941921389**] (-0.973868574)	0.207596766 [-2.812752453**] (-1.029847341)	0.15009738 [-1.989255294**] (-0.996708998)	0.112846911 [-1.402634427] (-0.978525548)	0.037526668 [-1.072480944] (-1.003882645)
NML	0.56697544 [-3.799775096**] (-1.01229086)	0.339100057 [-2.345962075**] (-0.921199089)	0.355873979 [-1.507621069] (-0.810375941)	0.393926302 [-0.970530534] (-0.717069977)	0.503743394 [-0.552977143] (-0.537949833)
PLD	0.655508406 [-3.022901469**] (-0.982131445)	0.52174287 [-1.697644045**] (-0.800837972)	0.35555628 [-1.508364667] (-0.952696653)	0.41914196 [-0.930151672] (-0.767605168)	0.58287525 [-0.464840077] -0.465885633)
PUB	0.676577099 [-2.830802444**] (-1.132318198)	0.364276138 [-2.256598591**] (-1.300056551)	0.293910032 [-1.652651932*] (-1.28726291)	0.242091258 [-1.213670183] (-1.301887652)	0.427921197 [-0.637465573] (-0.930014693)
RBL	0.571566521 [-3.759488523**] (-1.182448916)	0.292428333 [-2.511630262**] (-1.166416132)	0.267325838 [-1.714874059*] (-1.086772836)	0.140513107 [-1.376331418] (-1.178819419)	0.256647859 [-0.828314904] (-0.892531313)
RBTT	0.710134741 [-2.51030678**] (-0.798628325)	0.777371312 [-0.779922894] (-0.365207073)	1.071621852 [0.165444437] (0.103312532)	0.60719393 [-0.620793592] (-0.483201697)	2.378679827 [1.516175831] (1.462832075)
RML	0.519978005 [-4.212175913**] (-1.445849499)	0.19980998 [-2.840392801**] (-1.445482402)	0.117392759 [-2.065802701**] (-1.447835466)	0.044752136 [-1.529677369] (-1.494550156)	0.032114054 [-1.078512202] (-1.201218344)
TCL	0.548943498 [-3.958004739**] (-0.935548921)	0.223169388 [-2.757475126**] (-0.965908421)	0.153172089 [-1.982058726**] (-0.952604779)	0.081212502 [-1.471291896] (-0.978042951)	0.106613664 [-0.995497526] (-0.917633134)

Note: ** denotes significance at the 5% level(1.96), * denotes significance at the 10% level (1.64)

Table 9: *Results of the Wald Test for the restriction* $\beta = 1$ *on the JSE Stock Prices (Sample Period: January 1999 to June 2004)*

JSE STOCK	χ^2 P-VALUE
BERGER PAINTS	0.026000028*
BNS	0.011523685*
CABLE & WIRELESS (JA)	0.074470765
CARIBBEAN CEMENT	0.153178712
CARRERAS	0.006747025*
CIBONEY GROUP	0*
CMP	0.245875091
COURTS	0.009394848*
D B & G LTD.	0.253946035
D&G	0*
DYOLL	0.520959055
FIRST LIFE INS.	0.74384159
GLEANER	0.009752159*
GOODYEAR	0.09859536
GRACE	0.061902971
JA BROILERS	0.151545824
JA PROD. GROUP	0.342943596
KINGSTON WHARVES	0.017917369*
LASCELLES	0.984153857
MO. FREEPORT	0.736699162
PALACE	0.289984494
PAN JAM	0.981491466
RADIO JAMAICA	0.387475591

Note: *Insignificant at the 5% Level

Table 10: *Autocorrelation Coefficients, results of the Ljung-Box and Breusch-Godfrey LM Tests for Autocorrelation in the JSE Stocks (Sample Period: January 1999 to June 2004)*

JSE STOCK	LAG 1	LAG 2	LAG 3	LAG 4	LAG 5	N	*LJUNG-BOX Q*STATISTIC*	F VALUE OF LM	CRITICAL VALUE FOR F
BERGER PAINTS	-2.35*	0.006	0.166	-0.073	-0.019	65	6.0988	1.344037	4
BNS	0.057	0.311*	0.051	-0.012	0.021	65	7.1374	1.276331	4
CABLE & WIRELESS (JA)	-0.086	0.171	-0.036	0.004	0.074	65	3.0312	0.47494	4
CARIBBEAN CEMENT	0.065	0.016	0.048	0.012	0.008	65	0.47979	3.551453	4
CARRERAS	0.036	0.257*	-0.047	0.004	-0.227*	65	8.567202	0.933498	4
CIBONEY GROUP	-0.059	-0.144	0.489*	-0.007	0.031	54	15.6641*	1.751885	4.02
CMP	0.08	-0.182	-0.129	0.053	0.021	38	2.53482	0.171703	4.08
COURTS	0.092	0.193	-0.017	-0.208*	-0.026	65	6.3102	1.321908	4
D B & G LTD.	-0.117	0.084	-0.138	-0.025	-0.055	65	3.02406	6.640579*	4
D&G	0.156	-0.274*	0.049	0.02	-0.086	65	7.5745	1.051254	4
DYOLL	-0.304*	-0.064	0.016	0.015	0.024	59	6.0612	6.821865*	4
FIRST LIFE INS.	-0.01	0.28*	-0.021	-0.009	0.01	65	5.49063	5.321593*	4
GLEANER	0.088	-0.039	0.044	-0.097	-0.042	65	1.5665	0.962257	4
GOODYEAR	-0.001	0.135	0.009	-0.06	-0.067	65	1.8382	0.757008	4
GRACE	0.068	0.238*	0.046	0.024	-0.131	65	5.6732	2.841073	4
JA BROILERS	0.076	0.253	0.049	-0.085	-0.019	65	5.5275	0.963416	4
JA PROD. GROUP	-0.058	0.15	0.032	0.024	-0.003	65	1.893	2.226483	4
KINGSTON WHARVES	-0.118	0.064	0.004	-0.023	0.014	58	1.1558	1.539542	4
LASCELLES	-0.103	0.164	0.017	0.006	0.007	65	2.6015	1.739219	4
MO. FREEPORT	-0.19	0.006	0.143	0.021	-0.004	54	3.29855	5.402565*	4.02
PALACE	0.087	0.027	0.248	0.126	0.02	32	3.233	0.571481	4.17
PAN JAM	-0.112	0.161	-0.046	-0.008	0.009	65	2.8026	6.155713*	4
RADIO JAMAICA	-0.081	-0.088	0.076	-0.038	-0.016	65	1.5161	2.173651	4

Note: *Significant at the 5% Level; Values of each LM Stat. are lower than the critical value, indicating insignificance

Table 11: *Results of the ADF Unit Root Tests (JSE Stocks)*
(Sample Period: January 1999 to June 2004)

JSE STOCKS	ADF P	CRITICAL VALUE	ADF ΔP	CRITICAL VALUE	CONCLUSION
BERGER PAINTS	-2.691764415	-3.481594574	-7.509173784	-3.482762785	Random Walk with Trend and Drift
BNS	3.388269338	-1.945903421	-3.171383397	-1.945903421	Random Walk
CABLE & WIRELESS (JA)	-0.826704064	-1.945903421	-9.236693916	-1.945903421	Random Walk
CARIB CEMENT	0.789526486	-1.946161247	-2.403010355	-1.946161247	Random Walk
CARRERAS	-2.709079092	-2.906923373	-8.41267955	-2.907659813	Random Walk with Trend and Drift
CIBONEY GROUP	-5.678099175	-3.495294856	-9.991536903	-3.496960133	Trend and Drift Stationary
CMP	-0.268526134	-1.959070954	-3.954999327	-1.966270061	Random Walk
COURTS	-2.597341465	-2.906923373	-7.937930843	-2.907659813	Random Walk with Drift
D B & G LTD.	-4.327776562	-3.48046336	-4.898939802	-3.487844633	Trend Stationary
D&G	-4.14727875	-2.906923373	-7.91243848	-2.907659813	Drift Stationary
DYOLL	1.648145257	-1.947380891	0.149613682	-1.947380891	Random Walk
FIRST LIFE INS.	2.504364637	-1.946253093	-2.808749125	-1.946348148	Random Walk
GLEANER	-2.584495451	-2.906923373	-7.851649547	-2.907659813	Random Walk with Drift
GOODYEAR	0.394499364	-1.945903421	-8.430006237	-1.945986555	Random Walk
GRACE	2.841754838	-1.945903421	-6.102913633	-1.945986555	Random Walk
JA BROILERS	0.27992616	-1.945903421	-8.016658147	-1.945986555	Random Walk
JA PROD. GROUP	-2.304961923	-3.48046336	-7.690434013	-3.482762785	Random Walk with Trend
KINGSTON WHARVES	-3.179927136	-3.489228337	-10.0102089	-3.493692421	Random Walk with Trend
LASCELLES	-3.099937142	-3.482762785	-10.26387932	-3.481594574	Random Walk with Trend
MO. FREEPORT	2.281351792	-1.947119444	-5.843182482	-1.947247516	Random Walk
PALACE	0.713741864	-1.954414108	-5.21309154	-1.9580881	Random Walk
PAN JAM	2.959916751	-1.946253093	-6.222876319	-1.946253093	Random Walk
RADIO JAMAICA	-3.234042739	-3.48046336	-7.388372779	-3.482762785	Random Walk with Trend

Note: ΔP denotes first difference of P, *significant at 5% level

Table 12: *Results of the Phillips Perron (P.P.) Unit Root Tests (TTSE Stocks)*
(Sample Period: January 1999 to June 2004)

JSE STOCKS	P. P. STAT. P	CRITICAL VALUE	P. P. STAT. ΔP	CRITICAL VALUE	DECISION
BERGER PAINTS	-3.33029586	-3.48046336	-10.45162638	-3.481594574	Random Walk with Trend and Drift
BNS	2.671584301	-1.945903421	-6.215652833	-1.945986555	Random Walk
CABLE & WIRELESS (JA)	-0.794079777	-1.945903421	-9.236693916	-1.945986555	Random Walk
CARIB CEMENT	0.885088364	-1.945903421	-9.431641301	-1.945986555	Random Walk
CARRERAS	-2.526835848	-2.906923373	-7.41267955	-2.907659813	Random Walk with Trend and Drift
CIBONEY GROUP	-5.664565918	-3.495294856	-10.36182347	-3.496960133	Trend and Drift Stationary
CMP	0.89613016	-1.94985571	-9.352617169	-1.952066429	Random Walk
COURTS	-2.856506137	-2.906923373	-7.937929031	-2.907659813	Random Walk with Drift
D B & G LTD.	-4.29668878	-3.48046336	-19.87544059	-3.481594574	Trend Stationary
D&G	-4.104665708	-2.906923373	-13.04116208	-2.907659813	Drift Stationary
DYOLL	1.754060317	-1.946446583	-10.97421433	-1.946764068	Random Walk
FIRST LIFE INS.	1.742333407	-1.945903421	-8.236313067	-1.945986555	Random Walk
GLEANER	-2.643638306	-2.906923373	-7.854108971	-2.907659813	Random Walk with Drift
GOODYEAR	0.482237587	-1.945903421	-8.426292211	-1.945986555	Random Walk
GRACE	2.542888004	-1.945903421	-6.196255193	-1.945986555	Random Walk
JA BROILERS	2.685394488	-1.946996366	-5.639508562	-1.94766492	Random Walk
JA PROD. GROUP	-2.304961923	-3.48046336	-10.51641315	-3.481594574	Random Walk with Trend
KINGSTON WHARVES	-3.231655974	-3.489228337	-10.11693814	-3.493692421	Random Walk with Trend
LASCELLES	-1.796731958	-3.48046336	-10.26387932	-3.481594574	Random Walk with Trend
MO. FREEPORT	1.889744699	-1.946996366	-9.561021406	-1.947119444	Random Walk
PALACE	0.127756721	-1.95168692	-4.236061656	-1.954414108	Random Walk
PAN JAM	1.624784679	-1.945903421	-9.291007589	-1.945986555	Random Walk
RADIO JAMAICA	-3.29704322	-3.48046336	-8.609194	-8.609194	Random Walk with Trend

Note: ΔP denotes first difference of P, *significant at 5% level

Table 13: *Estimate of Variance Ratios, Homoscedastic and Heteroscedastic Robust Test Statistics (JSE)*

Numbers without brackets denote Variance Ratios
Numbers in square brackets [ ]denote Z(q) Homoscedastic Test Statistics
Numbers in circle brackets ( )denote Z*(q) Heteroscedastic Robust Test Statistics

JSE STOCK	q =2	q = 6	q = 12	q = 24	q = 48
BERGER PAINTS	0.667093897 [-2.683974808**] (-1.142121871)	0.432963921 [-1.849299622*] (-1.12266814)	0.432964 [-1.49305] (-1.20458)	0.200817 [-1.75821*] (-1.19613)	0.152998 [-0.897155299] (-0.996785732)
BNS	1.254383802 [2.059077801**] (1.560409803)	2.100831495 [3.590190014**] (2.512457668**)	1.881119 [1.894817*] (1.58067)	1.996746 [1.466492] (1.50648)	5.3192 [4.421967475**] (5.593053249**)
CABLE & WIRELESS (JA)	0.866229681 [-1.078490788] (-1.054924092)	0.941327592 [-0.191350895] (-0.148853827)	0.791665 [-0.44802] (-0.37177)	0.56204 [-0.64436] (-0.58536)	0.537065 [-0.473949231] (-0.503726658)
CARIB CEMENT	0.765773575 [-1.888393809*] (-0.77230526)	0.472874015 [-1.719139083*] (-0.729413655)	0.42013 [-1.24699] (-0.66296)	0.525644 [-0.69791] (-0.49265)	1.57582 [0.589520972] (0.561323688)
CARRERAS	0.96234303 [-0.303600201] (-0.397603445)	0.870059661 [-0.423780123] (-0.422548792)	0.355113 [-1.38681] (-1.42169)	0.309933 [-1.01528] -1.15505	0.303054 [-0.713528035] (-0.929678114)
CIBONEY GROUP	0.694020084 [-2.248439995**] (-0.934417901)	0.182859776 [-2.429032801**] (-1.136489578)	0.131594 [-1.70214*] (-0.9784)	0.158144 [-1.12895] (-0.84801)	1.14506 [0.135362916] (0.136396814)
CMP	0.817578752 [-1.124545201] (-1.965682888**)	0.997453456 [-0.004181546] (-0.006392154)	0.997453 [-0.00419] (-0.00639)	2.119301 [1.259148] (2.23479)	1.985662 [0.771500961] (1.622185641)
COURTS	1.013416594 [0.108168042] (0.175686157*)	1.053780719 [0.175397416] (0.210345555)	0.480328 [-1.11754] (-1.15702)	0.41392 [-0.86229] (-0.88565)	0.217079 [-0.801549497] (-0.935896707)
D B & G LTD.	0.754943824 [-1.97060529**] (-0.780288403)	0.319534423 [-2.216232217**] (-1.095289946)	0.264589 [-1.58148] (-0.90421)	0.123848 [-1.28906] (-0.91241)	0.252754 [-0.765025184] (-0.694165759)
D&G	1.022393624 [0.18054317] (0.873620752)	0.452206581 [-1.785426925*] (-1.095361664)	0.202207 [-1.71563*] (-1.21833)	0.122228 [-1.29145] (-1.11845)	0.283961 [-0.733075496] (-0.795906809)
DYOLL	0.563243391 [-3.354791171**] (-1.176283001)	0.471046185 [-1.645528352*] (-0.736313591)	0.436571 [-1.15436] (-0.65285)	0.513781 [-0.68155] (-0.51228)	2.479481 [1.443081403] (1.458404778)
FIRST LIFE INS.	0.906764331 [-0.751689996] (-0.863533115)	0.834415113 [-0.540029252] (-0.270160836)	0.645189 [-0.76301] (-0.44074)	0.446157 [-0.81486] (-0.59406)	1.34108 [0.349194867] (0.332150348)
GLEANER	1.028165907 [0.227080801] (0.286885767)	0.81942163 [-0.588928153] (-0.672839291)	0.75346 [-0.53018] (-0.63971)	0.461532 [-0.79224] (-0.9643)	0.862921 [-0.14034093] (-0.178842647)
GOODYEAR	0.932591779 -0.543462452] (-0.59379413)	0.958315484 [-0.139475402] (-0.138849394)	1.087921 [0.189072] (0.210473)	0.979265 [-0.03051] (-0.03545)	2.008427 [1.032420183] (1.240920939)
GRACE	1.238627351 [1.923875207*] (1.221494366)	1.70352545 [2.294438392**] (1.484283173)	1.239477 [0.514986] (0.395181)	1.700875 [1.031182] (0.949013)	3.260445 [2.314228464**] (2.519401671**)
JA BROILERS	0.985823801 [-0.114292171] (-0.066012169)	1.255718896 [0.833987245] (0.571016388)	1.025761 [0.055399] (0.045796)	0.640918 [-0.52831] (-0.52302)	0.792202 [-0.212742271] (-0.237239804)
JA PROD. GROUP	0.858481493 [-1.140958682] (-0.655130218)	0.446858024 [-1.803986177*] (-0.947455883)	0.497029 [-1.08162] (-0.69416)	0.794012 [-0.30307] (-0.24093)	0.183936 [-0.835481098] (-0.826505427)
KINGSTON WHARVES	0.717788154 [-2.149261384**] (-0.977511052)	0.447205017 [-1.703013143*] (-1.079414701)	0.305591 [-1.14605] (-1.16061)	0.251567 [-1.04017] (-1.09449)	0.955544 [-0.042993051] (-0.054683871)
LASCELLES	0.734118403 [-2.143605967**]	0.745739839 [-0.829229811]	0.508333 [-1.05731]	0.429097 [-0.83996]	1.22939 [0.234848107]

	(-0.781051851)	(-0.378837279)	(-0.60196)	(-0.62439)	(0.22863687)
MO. FREEPORT	0.608525787 [-2.87673621**] (-1.401696399)	0.69169225 [-0.919476286] (-0.5288429083)	0.696317 [-0.59524] (-0.35651)	0.914817 [-0.11423] (-0.08893)	4.97272 [3.370715175**] (3.75683205**)
PALACE	1.111779632 [0.632310845] (0.492780309)	1.111779632 [0.663245521] (0.654003112)	2.790773 [2.702039**] (3.273283**)	7.649742 [6.864647**] (9.396393**)	0.064746 [-0.671830783] (-1.028883777)
PAN JAM	0.794790931 [-1.654484096] (-6.969890247**)	0.70724496 [-0.954774847] (-0.468810804)	0.524808 [-1.02188] (-0.57476)	0.474412 [-0.77329] (-0.5527)	1.072072 [0.073787087] (0.069783124)
RADIO JAMAICA	0.942689122 [-0.462055068] (-0.255581487)	0.59568966 [-1.318595037] (-0.934055725)	0.343447 [-1.41189] (-1.23037)	0.316195 [-1.00607] (-1.0257)	0.108127 [-0.913090556] (-1.03561496)

Note: ** denotes significance at the 5% level(1.96), * denotes significance at the 10% level (1.64*)*

Table 14: *Results of the Wald Test for the restriction* β = 1 *on the BSE Stock Indices*

BSE SAMPLE PERIOD	χ^2 P-VALUE
1989-2007	0.1437
1989-2001	0.0079*
2001 -2007	0.0571

Note: *Insignificant at the 5% Level

Table 15: *Autocorrelation Coefficients, results of the Ljung-Box and Breusch-Godfrey LM Tests for Autocorrelation in the JSE Stocks*

BSE SAMPLE PERIOD	LAG 1	LAG 2	LAG 3	LAG 4	LAG 5	N	LJUNG-BOX Q*STATISTIC	F VALUE OF LM	CRITICAL VALUE FOR F
1989-2007	-0.332*	-0.039	0.019	0.04	0.045	220	25.719*	4.311*	3.89
1989-2001	-0.327*	0	0.044	0.049	0.051	154	17.831*	3.142	3.91
2001 -2007	-0.365*	-0.004	0.054	0.057	0.062	78	11.504*	1.112	3.98

Note: *Significant at the 5% Level; Values of each LM Stat. are lower than the critical value, indicating insignificance

Table 16: *Results of the ADF Unit Root Tests (BSE Stocks)*

BSE SAMPLE PERIOD	ADF P	CRITICAL VALUE	ADF ΔP	CRITICAL VALUE	RESULT
1989-2007	-2.207471	-3.430669	-14.73213	-3.430669	Random Walk With Trend
1989-2001	-2.095792	-3.439857	-12.77886	-3.439857	Random Walk With Trend and Intercept
2001 -2007	-4.410938	-3.469235	-13.49378	-3.470032	Zero Unit Roots

Note: ΔP denotes first difference of P, *significant at 5% level

Table 17: *Results of the Phillips Perron (P.P.) Unit Root Tests (BSE Stock Indices)*

BSE SAMPLE PERIOD	P. P. STAT. P	CRITICAL VALUE	P. P. STAT. ΔP	CRITICAL VALUE	RESULT
1989-2007	-2.889958	-3.430477	-23.44867	-3.430572	Random Walk With Trend
1989-2001	-3.347794	-3.439461	-21.22609	-3.439658	Random Walk With Trend and Intercept
2001 -2007	-4.19003	-3.469235	-14.02783	-3.470032	Zero Unit Roots

Note: ΔP denotes first difference of P, *significant at 5% level

Table 18: *Estimate of Variance Ratios, Homoscedastic and Heteroscedastic Robust Test Statistics (BSE)*

Numbers without brackets denote Variance Ratios
Numbers in square brackets [ ]denote Z(q) Homoscedastic Test Statistics
Numbers in circle brackets ( )denote Z*(q) Heteroscedastic Robust Test Statistics

BSE SAMPLE PERIOD	q =2	q = 6	q = 12	q = 24	q = 48
1989-2007	0.655338 [-5.1005**] (-0.8286)	0.397532 [-3.606581**] (-0.86553019)	0.416799 [-2.3021**] (-0.75652)	0.489594 [-1.3784] (-0.615195)	0.3899 [-1.14651] (-0.68627)
1989-2001	0.618706 [-4.716345**] (-0.8423695)	0.254349 [-3.730965**] (-0.985389)	0.281064 [-2.371986**] (-0.862333)	0.329278 [-1.514002] (-0.767457)	0.235267 [-1.201188] (-0.844688)
2001 -2007	0.58766 [-3.618265**] (-0.905252)	0.294493 [-2.504301**] (-0.92642)	0.200201 [-1.871985*] (-0.948729)	0.26519 [-1.777559*] (-0.812316)	0.409845 [-0.657608] (-0.615896)

Note: ** denotes significance at the 5% level(1.96), * denotes significance at the 10% level (1.64)