Efficient Market Hypothesis: Evidence from the JSE equity and bond markets

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EFFICIENT MARKET HYPOTHESIS: EVIDENCE FROM THE JSE EQUITY AND BOND MARKETS

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ABSTRACT: This study investigates weak form efficiency for 4 stock and 7 bond market return under the Johannesburg Stock Exchange (JSE) using monthly data spanning from 2002 to 2016. Our empirical strategy consists of using both individual and panel based unit root testing procedures. Moreover, we split our empirical data into two sub-samples corresponding to periods before and periods subsequent to the global financial crisis. Our empirical results point to an overwhelming evidence of weak form efficiency as the integration test fail to produce convincing evidence of unit root behaviour amongst the observed time series. The study thus confirms the efficiency of equities and debt markets in South Africa in light of the global financial crisis.

Keywords: Equity markets, Bond market; Efficient market hypothesis; unit root tests; Johannesburg Stock Exchange (JSE); South Africa.

JEL Classification Code: C12; C13; C22; C23; G10; N27.

1 INTRODUCTION

After gaining independence in 1994, the newly elected democratic government was commissioned the burdensome task of eradicating the previous injustices as inherited by the former Apartheid regime. In their efforts to do so, South African policymakers have since embarked on large spending programmes which have explicitly considered the lowering of unemployment and improving of economic growth levels as ultimate policy goals. Of recent, a number of academics have argued stock market developments may play an important role in enhancing economic growth and thus making a vital contribution to long term welfare (Phiri (2015a) and Nyasha and Odhiambo (2015)). These authors particularly argued that since the financial liberalization era of the 1990's, there has been an increasing amount of capital flows into the country and companies listed on the Johannesburg Stock Exchange (JSE) have benefited from selling equities to invest further to increase profits, diversify and open in new markets which is vital for the country's prosperity. Consequentially, the regulation and stabilization of capital markets has come under tremendous scrutiny as the success of capital markets is wholly dependent on the efficiency of these stock markets.

The infamous sub-prime crisis of 2007 remains the worst financial crisis experienced since the Great Depression of 1936. Indeed the 2007 financial crisis was the result of a bursting of the US housing asset price bubble which eventually caused the bankruptcy of major investment banks in the US before the contagion effects of the crisis were spread worldwide. In fact the sub-prime crisis is solely responsible for the global recession period of 2009 as well as the sovereign debt crisis of 2010 and is widely acknowledged that the financial turmoil could have been avoided if capital markets had been better regulated. Many academics argue that the ability of capital markets to perform its role its dependent upon how efficient these markets are (Phiri, 2015a). Typically, academics have a history of testing the weak form efficiency hypothesis as a means of validating or dismissing the validity of the EMH and this generally involves testing whether a stock series follows a random walk or a unit root process. The rationale is that markets are efficient if stock returns are stationary such that all information is already incorporated into the shares. On the other hand, is stock returns contain a unit root then markets are inefficient and investors are able to create an abnormal returns based on their ability to predict future returns and hence the efficiency of capital markets is heavily compromised.

There has been ample of empirical literature conducted on the weak form efficiency for the JSE (Affleck-Graves and Money (1975), Roux and Gilberson (1978), Strebel (1978), Knight and Affleck-Graves (1983). Smith et al. (2002), Magnusson and Wydick (2002), Appaih-Kusi and Menyah (2003), Alagidede (2011), Bonga-Bonga (2012), Bonga-Bonga and Makakabule (2010) and Phiri (2015b)) with researchers utilizing different empirical techniques and hence obtaining a variety of conflicting evidences. Nevertheless, none of these aforementioned studies have investigated whether the global financial crisis of 2007 could have altered the efficiency of stock returns on the JSE. Moreover, whilst most of these studies have concentrated on equity returns none of these works have taken into consideration efficiency within the debt or bond market. We find this surprising and thought-provoking provided that the global financial crisis was triggered by a bubble in the debt market hence the investigation of the efficiency of these markets is a fruitful exercise. In this present study we investigate weak form efficiency within the equities and bond market in South Africa between 2002 and 2016. Our empirical strategy consists of splitting our data into two sub-samples corresponding to the pre and post crisis periods.

Having given the background to this study, the rest of the manuscript is structured as follows. The following section gives an overview of equity and bond markets in South Africa. The third section of the paper presents the review of previous related literature. The fourth section outlines the individual and panel unit root procedures used in the study. The fifth section presents the data and empirical results whereas the study is concluded in the sixth section of the paper.

2 BRIEF OVERVIEW OF SOUTH AFRICAN EQUITY MARKET

2.1 JSE equity market

The Johannesburg Stock Exchange was founded by Benjamin Woollan in November 1887 following the discovery of gold and the opening of some financial institutions due to the need to raise finance for gold mining ventures brought about its establishment (Correia *et al*. 2012). The JSE is currently the only stock market in South Africa as well as being the largest and most developed stock exchange in Africa, boasting close to 400 companies and trading over 900 security instruments with the stock market being regulated by the Services Act of 2004, as well by its own rules and derivatives (Phiri, 2017). On the other hand, directors of companies in the JSE are required to comply with the King III Code of Corporate Governance, the Companies Act 71 of 2008, the Financial Markets Act 19 of 2012 and other legislation that apply to the company's industry sector (Correia *et al*. 2012). The equities market of the JSE exists as an avenue for companies to raise capital for investment and project purposes through the issuing of financial assets such as shares. Generally, two types of shares can be issued out in the equity market, those being the ordinary share and preference shares. Whilst ordinary shares represent ownership in a company while preference shares pay a dividend rate and are redeemable at the issue price. The JSE lists its trading equity under four generalized stock indices, namely, i) the all share index (ALSI) ii) the top 40 index iii) the industrials index iv) the resource index (Phiri, 2018).

The stock prices on the equities market are influential in curbing investors' expectations concerning the future prospects of a listed company. IF the future prospects of a company are deemed to be positive then the firm's share price will increase in value whereas when investors are pessimistic about a company's future performance then the share price will decrease. However, in order for investors to make well-informed decisions with regards to the buying and selling of equity shares, the JSE requires that all listed firms disclose all price sensitive information to the stock exchange news service (i.e. SENS). Moreover, the JSE utilizes an information dissemination vendors, INFOWIZ, which provides data to subscribed information vendors, financial institutions and JSE members and broadcasts trade information relating to best bid and buy, mid-prices as well as details on the numbers and volume at best price (Samkange, 2010). Investors use acquired share information to trade equity securities on the JSE trading platforms, which historically can be categorized into four different platforms. The first being the initial automated trading system, the JSE equity trading (JET) system, the second being when the JSE adopted the London Stock Exchange (LSE) trading platform, the third being the JSE TradeElect trading system and the last being the Millennium exchange trading platform (Phiri, 2017, 2018).

2.2 JSE debt market

Another way for firms to raise capital on the JSE is by issuing debt instruments to investors. This occurs by the issuer entering into an agreement with the investor to pay a certain amount of money up until an agreed-upon time, similarly like a loan. Prior to listing, however, companies issuing out debt are required to attain credit ratings from credit rating agencies such as Standard & Poor's, Fitch or Moody's. In 2009 the JSE acquired the Bond Exchange of South Africa, which officially became known as the JSE debt market. The debt market list overs 375 bonds, 1600 listed debt instruments with a total nominal outstanding amount of R1.8 trillion in 2014 and mainly compromising of debt securities listed by the government (61%), state-owned enterprises (13%), and by financial institutions (17%) (Correia *et al*. 2015).

Historically, the corporate debt market was nonexistence until the late 1980's and during the 1970's and 1980's the bond market was traditionally an over-the-counter market comprising of government and quasi-government bonds (Anand and Sengupta, 2014). However, following the recommendations of the Jacob and Stals inquiry in 1987 the Bond Market Association (BMA) was formed. In particular, the commission recommended that i) the bond market by was to be self-regulated or regulated by the South African Reserve Bank (SARB) ii) Consolidation of a number of small issues into benchmark bonds iii) creation of yield curve iv) Adoption of a well communicated and structured auction system (Ojah and Pillay, 2009).

In 1989, the major clearing and bond settlements banks, along with the SARB, created Universal Exchange Corporation Limited (UNEXCor) in order to develop an electronic settlement system using a central securities depository and in 1994, UNEXCor was appointed as the clearing house for the South African bond market (Anand and Sengupta, 2014). The Bond exchange was granted a trading license in May 1996 and was subsequently re-named the Bond Exchange South Africa (BESA). And in 1997 the BESA become the first African country to achieve full compliance with G30 recommendations for clearing and settlement. The first collateralized debt obligation (CBO) was listed (INCA BOND) in BESA in 1997 (Hassan, 2013).

3 LITERATURE REVIEW

3.1 Theoretical review

The EMH states that market prices should include all available information at any time. In the previous section, the study pointed out that there are different kinds of information that influence security values. As a result, researchers categorized three versions of EMH depending on the type of information available. The first is the *weak form* EMH which postulates that current prices full includes information obtained in the past history of prices only. As a result, the theory supports the idea that investors cannot obtain abnormal profits from investing in these financial assets and no investor should be able to beat the market by analysing past prices to obtain profits or biased returns (Titan, 2015).

The second form is the *semi-strong* efficiency and it postulates that current prices fully include all publicly available information. This public information does not only include past prices but also includes data that is reflected in a company's financial statements, announced plans of merging, announcements of earnings and dividends, the financial situation of a company's competitors, expectations macroeconomic events –fir instance inflation- and so on. Information can also be in a form of research and not only finances. This form has the same assumption as that of the weak form, but is much stronger and expanded (Bhana, 1994). In the case of the semi-strong efficiency, neither technical nor fundamental analysis can determine the way investors invest their money so that these investors gain superior profits compared to other investors who invested in random portfolios (Titan, 2015).

The last form of the efficient market hypothesis is the *strong form* efficiency which asserts that current prices fully include all existing information both public and private. Under this hypothesis, no investors should be able generate profits even if trading on information is not publicly known at the time. In other words, company's management team is not able to gain systematically from inside information. For example, investors cannot buy shares shortly after the company decided before the information is announced publicly. This form attempts to maintain an unbiased "sum game" (Mobarek and Fiorante, 2014).

3.2 Empirical review

Empirically, the EMH has been a subject of much debate among financial economists and extensive research has been undertaken in all major stock markets on the theory. Various studies agree that little research was undertaken on share prices before the theory of efficient markets was developed. It is argued that the stock market had minimal economic order such that share prices then, were not described in economic terms but rather in statistical terms (Bhana, 1994). However, following the introduction of efficient market hypothesis, some studies argue that the theory deviates from what is standard and expected and as a result, market inefficiencies have damaged the reputation of the EMH (LeRoy, 1989). Nevertheless, there have been many studies in the literature which have attempted to evaluate the weak-form efficiency for different stock exchanges worldwide (Lo and MacKinlay (1988), Fama and French (1988), Poterba and Summers (1986) Lee (1992), Poshakwale (1996), Greib and Reyes (1999), Gupta and Basu (2007), Sunde and Zivanomoyo (2008) and Okpara (2010).

In light of the abundance of empirical works existing in the literature and for the sake of relevance, this section of the paper is specifically concerned with reviewing former studies which have investigated the efficient market hypothesis for the JSE. The list of these studies can be narrowed down to the studies of Affleck-Graves and Money (1975), Roux and Gilberson (1978), Strebel (1978), Knight and Affleck-Graves (1983). Smith et al. (2002), Magnusson and

Wydick (2002), Appaih-Kusi and Menyah (2003), Alagidede (2011), Bonga-Bonga (2012), Bonga-Bonga and Makakabule (2010) and Phiri (2015b).

We begin our review with the study of Affleck-Graves and Money (1975) who estimate a random walk (autocorrelation) model for 50 shares on the JSE and established very little evidence of autocorrelation in the JSE stock series hence indicating market efficiency within the share prices. In a separate study, Roux and Gilberson (1978) ran a *runs test* to determine whether or not the share prices of the New York Stock Exchange (NYSE) and JSE are dependent and found that price changes were not completely random. They further postulated that the fact that JSE has attributes of inefficiency does not necessarily mean an investor could consistently achieve higher returns.

In his study, Strebel (1978) states that only half of shares listed on the JSE can be regarded to be consistent with the EMH. Such companies are those with high share trading volumes with averages not below a quarter million shares per year and those share prices behave randomly. The opposite is true for low-volume shares. The authors further noted that for highly traded shares, there is a risk-return relationship and the opposite is yet again true for thinly traded shares. Knight and Affleck-Graves (1983) conducted a study to evaluate efficiency of the JSE by monitoring price movements of 21 listed companies that announced a change from FIFO to LIFO (the cost layering methods used to value the cost of goods sold and the ending inventory). They concluded that the aforementioned change affected the share prices negatively in the short run hence confirming the efficiency of the stock returns under investigation.

In a panel study of African stock markets, Smith et al. (2002) apply the multiple variance test and find that the JSE stock index follows a random walk hence confirming weak-form efficiency. Similarly, Magnusson and Wydick (2002) investigate market efficiency in African stock markets inclusive of the JSE using partial correlation analysis and discover that South African markets are weak-form efficiency although this evidence is not altogether inconclusive.

In a different study, Appaih-Kusi and Menyah (2003) investigate the efficiency of stock markets in Africa using an exponential generalized autoregressive conditional heteroscedasticity (EGARCH) model and establish that the JSE is not weak-form efficient prior to the democratic elections of 1994 and only becomes efficient from 2000 onwards. In a unique study, Alagidede (2011) challenges pervious findings buy challenging the notion of a random walk in African stock prices and establishes long memory processes in African stock markets inclusive of the South Africa stock exchange by using a fractional integrated generalized autoregressive conditional heteroscedasticity (FIGARCH).

Bonga-Bonga (2012) investigates the efficiency of the JSE using a time varying and fixed effects GARCH model and mutually finds that the JSE is an efficient market in the weak-from sense. However, in an earlier study, Bonga-Bonga and Makakabule (2010) use a smooth transition regression (STR) model to establish the JSE violates the tests for weak-form and semi-weak form efficiency. Chitenderu et al. (2014) use unit root tests, autocorrelation and ARIMA models to investigate weak-form efficiency within the JSE and confirm weak-form efficiency within the market. In applying a battery off linear and nonlinear unit root tests, Phiri (2015b) discovers that under the assumption of linearity, JSE stock indices are found to stationary whereas when nonlinear unit root tests are used the stock indices are found to be non-stationary.

4 METHODOLOGY

Unit roots have been the standard method used in investigating weak-form efficiency within stock returns. The underlying idea is that an efficient market is one whose equity and debt markets consists of securities instruments which follow a stationary process. This would imply that speculators cannot gain superior returns on the basis of prior information henceforth ensure the stability of capital markets. In our study, we employ a battery of individual and panel based unit root procedures to examine the efficiency of the JSE equity and debt markets.

4.1 Individual unit root tests

The Augmented Dickey- Fuller (ADF) test is the most commonly used testing procedure found in the literature. Assuming that stock returns (i.e. sr) evolves as the following time series process:

$$\Delta sr_t = \beta' T_t + \psi_i\, sr_{t-1} + \sum_{i=1}^{p} \alpha\, \Delta sr_{t-1} + u_t \qquad (1)$$

Where Δ is a first difference operator, the lags 'soak up' any dynamic structure in the dependent variable sr and u_t is a white noise process. The null hypothesis, H_0: $\psi_i = 0$ that is, the process contains a unit root and is therefore nonstationary is tested against an alternative hypothesis, H_1: $\psi_i < 0$ that is, the process does not contain a unit root and is therefore stationary. The unit root null hypothesis is tested using the following ADF tests statistic:

$$ADF_t = (\phi\text{-}1)/SE(\phi) \qquad (2)$$

The test static is compared against the critical values reported in McKinnon (1991) of which when the test statistic is greater than the tabulated critical value, the unit root null hypothesis cannot be rejected whilst when the statistics is of lower value than the critical value, then the unit root hypothesis is rejected. However, the ADF test has come under considerable criticism owing to the determination of the number of lags included within the test. If one includes too few lags will not remove all of the autocorrelations and this would lead to biased results. At another extreme, including too many lags will increase the coefficient standard errors because the increased number of parameters uses up degrees of freedom and therefore widens the standard errors. On the other hand, the PP tests ignore any correct for any serial correlation and heteroscedasticity in the test regression where the ADF tests use a parametric autoregression to approximate autoregressive moving average (ARMA) structure of the errors in the test regression:

$$\Delta sr_t = \beta' D_t + \psi \, sr_{t-1} + u_t \qquad (3)$$

Where under the PP test regression the linear trend is replaced by a time centred variable, $\beta' D_t$. In similarity to the ADF test, the unit root null hypothesis is tested as (i.e. H_0: $\psi_i = 0$) against the alternative of an otherwise stationary process. The PP test statistics are computed as:

$$Z_t = \left(\frac{\sigma^2}{\lambda^2}\right)^2 t_{\psi=0} - \frac{1}{2}\left(\frac{\lambda^2-\sigma^2}{\lambda^2}\right)^2 . \left(\frac{T.SE(\psi)}{\sigma^2}\right) \qquad (4)$$

$$Z_\psi = T\psi - \frac{1}{2}\left(\frac{T^2.SE(\psi)}{\sigma^2}\right)(\lambda^2 - \sigma^2) \qquad (5)$$

Where σ^2 and λ^2 are consistent estimates of the variance parameters. However, both ADF and PP tests exert low testing power when distinguishing between unit root and near-unit root processes. The DF-GLS test of Elliot et al. (1996) overcomes this shortcoming by de-trending the observed time series before testing for unit roots. The de-trending transformation by removing a trend from time series:

$$sr^*_t = sr_t - \beta_0 \qquad (6)$$

β_0 is estimated by least squares method and used to remove constant from the time series sr_t. The DF-GLS test regression is specified as:

$$\Delta sr^*_t = \beta' D_t + \psi_i \, sr^*_{t-1} + \sum_{i=1}^{p} \alpha \, \Delta sr^*_{t-1} + u_t \qquad (7)$$

And the authors compute the test statistic for testing the unit root null hypothesis (i.e.) which the authors argue has the asymptotic distribution as the regular ADF test but higher asymptotic power. Perron and Ng (1996, 2001) build upon Elliot et al. (1996) by using the de-trended time series from the DF-GLS test and create efficient versions of the ADF and PP tests.

The test constructs four test statistics namely MZ, MZt, MSB and MPT which are computed as:

$$\overline{MZ_{\alpha}} = (T^{-1}y_T^d - \lambda^2)(2T^{-2}\sum_{i=1}^{T} y_{i-1}^d \tag{8}$$

$$\overline{MSB} = (T^{-2}\sum_{i=1}^{T} y_{i-1}^d / \lambda^2)^{0.5} \tag{9}$$

$$\overline{MZ_t} = \overline{MZ_{\alpha}} \times \overline{MSB} \tag{10}$$

Where $\overline{MZ_t}$ and MZ_{α} are efficient versions of the PP Z_{α} and Z_t test statistics. Whilst the ADF, PP, DF-GLS and Ng-Perron tests test the null hypothesis that a time series is I(1) against the stationary alternative, stationary tests, on the other hand, test the null hypothesis of a stationary process against the alternative of a unit root. The KKPs test of Kwiatkowski et al. (1992) is popular stationary test whose test regression takes the following function form:

$$sr_t = \beta' D_t + \mu_t + u_t,\ u_t = \mu_{t-1} + \varepsilon_t,\ \ N(0, \sigma_e^2) \tag{7}$$

Where D_t contains deterministic components (constant or constant plus time trend), u_t is I(0) and may be heteroscedastic. μ_t is a pure random walk with innovation variance σ_e^2. The null hypothesis is formulated as H_0: $\sigma_e^2 = 0$, that is I(0), which implies that $\mu_t$is a constant. The KPSS statistic can be denoted as:

$$\text{KPSS} = (T^{-2}\sum_{t=0}^{T} S_t{}^2) / \text{ɮ}2 \tag{8}$$

Where $S_t = \sum_{j=1}^{t} u_j$, u_t is the residual of a regression of sr_t on D_t and ɮ2 is a consistent estimate of the long-run variance of u_t (Kwiatkowski, Phillips, Schmidt & Shin, 1992).

4.2 *Panel unit root tests*

The literature suggests that panel unit root tests are more powerful testing tools compared to individual unit root tests and hence have been heavily utilized within the literature. The study conducts four types of panel unit root tests, namely, Levin et al. (2002), Im, Pesaran and Shin (2003), Fisher-type tests using ADF and PP tests (Maddala and Wu, 1999); and Hadri (2000) panel tests. These tests are multiple-series unit root tests that have been applied to panel data structures. Whilst Hadri (2000) and Levin et al. (2002) test represent panel test with a common unit root process, the Im et al. (2003) and Fisher type tests are panel test with individual unit root process. Levin, Lin, and Chu (LLC), and Hadri (2000) tests assume that there is a common unit root process so that autoregreesive coeffecint in the tests is identical across cross-sections. The Levin et al. (2000) test employs a null hypothesis of a unit root while the Hadri (2000) test uses a null of no unit root. In particular, Levin et al. (2000) considers the following basic ADF specification:

$$\Delta sr_t = \beta' T_t + \psi_i \, sr_{t-1} + \sum_{i=1}^{p} \alpha \, \Delta sr_{t-1} + X'_{it}\delta + u_t \qquad (9)$$

Where we assume a common ψ_i, but allow the lag order for the difference terms, p_i, to vary across cross-sections. The null of a unit root is tested as H_0: $\psi_i = 0$ and is tested against the stationary alternative (H_0: $\psi_i < 0$). On the other hand, the Hadri (2000) panel unit root test is similar to the KPSS unit root test, and has a null hypothesis of no unit root in any of the series in the panel. Like the KPSS test, the Hadri test is based on the residuals from the individual OLS regressions of srt on a constant, or on a constant and a trend. If, for instance, the test includes both the constant and a trend, then estimates can be derived from:

$$sr_{it} = \delta_i + \eta_i t + e_{it} \qquad (10)$$

Given the residuals e_{it} from the individual regressions, we form the LM statistic:

$$LM_1 = \frac{1}{N}\left(\sum_{i=1}^{N}\left(\sum_{t} S_i(t)^2 / T^2\right) / \bar{f}_0\right) \tag{11}$$

where $S_i(t)$ are the cumulative sums of the residuals, and $\bar{f}_0$ is the average of the individual estimators of the residual spectrum at frequency zero. On the other hand, The Im et al. (2003) and the Fisher-ADF and PP tests all allow for individual unit root processes so that ρ_i may vary across cross-sections. The tests are all characterized by the combining of individual unit root tests to derive a panel-specific result. Im et al. (2003) begin by specifying a separate ADF regression for each cross section similar to that specified in regression (9) and test the null hypothesis as:

$$H_0: \psi_i = 0, \text{ for all I} \tag{12}$$

While the alternative hypothesis is given by:

$$H_1 \begin{cases} \psi_i = 0 & for\ i = 1, 2, \dots, N \\ \psi_i < 0 & for\ i = N+1, N+2, \dots, N \end{cases} \tag{13}$$

After estimating the separate ADF regressions, the average of the *t-statistic*s for ψ_i from the individual ADF regressions, $t_{iT_i}(p_i)$:

$$\overline{t_{NT}} = \left(\sum_{i=1}^{N} t_{iT_i}(p_i)\right) / N \tag{14}$$

An alternative approach to panel unit root tests uses Fisher's (1932) results to derive tests that combine the *p-value*s from individual unit root tests where the null hypothesis is that of a unit root against an alternative hypothesis of no unit root. This idea has been proposed by Maddala and Wu, and by Choi. If π_i is defined as the *p-value* from any individual unit root test for cross-section i, then under the null of unit root for all N cross-sections, we have the asymptotic result that:

$$-2 \sum_{i=1}^{N} \log(\pi_i) \rightarrow \chi^2_{2N} \tag{15}$$

The Z-statistic can be expressed as:

$$Z = \frac{1}{\sqrt{N}} \sum_{i=1}^{N} \Phi^{-1}(\pi_i) \rightarrow N(0, 1) \tag{16}$$

5 DATA AND EMPIRICAL RESULTS

5.1 Data description

The data used in our study has been collected from various online sources. For instance, we collect 4 equity indices, namely the all-share index (ALSI), top 4 0 index (TOP_40), industrials index (INDU) and resource index (RES). On the other hand, we collect 7 debt instruments namely, central government bonds (CEN), municipal bonds (MUN), public enterprises - i.e. state owned enterprises bonds (PUB), bank bonds (BAN), bank securitization bonds (SEC) and other corporate bonds (OTH). Both equity and bond time series has been transformed into returns using the following continuous compounded returns formulae:

$$R = \log(p_t) - \log(p_{t-1}) \qquad ()$$

Where R is the compounded returns, p_t is the price index and p_{t-1} is the price index in the previous period. The summary statistics of the equity and debt returns, respectively, are respectively provided in Tables 1 and 2. As can be observed during the pre-crisis all four equity returns average negative returns with the resources sector producing the least negative returns at -0.82 and the industrials sector producing the most negative returns at -0.95. Coincidentally, the standard deviations show that the resource sector exerts the most volatility (i.e. 2.93) whilst the returns to industrial index is least volatile (i.e. 1.86). The summary statistics for equity return in the post-crisis as reported in Panel B of Table point to similar inferences with industrials averaging the lowest returns at -0.80 and resources providing the only positive returns of 0.26 over the sample period. Overall, we note that the averages of all equity returns improved from the pre to the post crisis. However, in the post crisis period, resources are still the most volatile with a standard deviation of 2.50 whilst the all-share returns are the least volatile with a standard deviation of 1.80.

Table 1: Descriptive statistics for equity returns

	ALSI	TOP_40	INDU	RES
Panel A: Pre-crisis				
Mean	-0.86	-0.84	-0.95	-0.82
Median	-0.83	-0.81	-1.09	-0.60
Maximum	3.90	4.09	4.88	4.04
Minimum	-5.70	-5.94	-4.45	-7.78
Std. Dev.	1.90	2.00	1.86	2.93
Jarque-Bera	0.20	0.18	3.13	1.25
Probability	0.90	0.91	0.20	0.53
Panel B: Post-crisis				
Mean	-0.41	-0.40	-0.80	0.26
Median	-0.53	-0.50	-0.73	0.44
Maximum	2.59	3.04	2.22	6.31
Minimum	-3.74	-4.28	-4.74	-5.08
Std. Dev.	1.30	1.47	1.38	2.50
Jarque-Bera	0.25	1.00	2.28	0.36
Probability	0.88	0.60	0.31	0.83

On the other hand, the summary statistics for the bond returns are reported in Table 2. As can be observed from Panel A of Table 2, municipal bonds averaged the highest returns of 2.46 in the pre-crisis whereas the central government bonds averaged the lowest returns of 0.23. We also note that whilst the having the highest returns, municipal bonds also had the lowest volatility in the pre-crisis with a very high standard deviation of 14.25 whereas central government bonds maintain the lowest volatility of 1.10 in the pre-crisis. However, the summary statistics for the bond returns in the post-crisis paint an entire different picture. For instance, 'other corporate' bonds now average the highest returns at 0.78 whilst bank securitization bonds average the lowest returns at 0.03. Surprisingly, central government bonds have the lowest standard deviations at 0.83 whilst municipal bonds are remains with the highest volatility with a standard deviation of 1.68. Collectively, we note that between the pre and post crisis periods, there has been a decrease in returns to bank, other corporate, state owned enterprises and bank securitization bonds whereas returns in the central government and public bonds have improved.

Table 2: Descriptive statistics for bond returns

	BAN	CEN	MUN	OTH	PUB	SEC
Panel A: Pre-crisis						
Mean	0.62	0.23	2.46	0.80	0.43	1.34
Median	0.77	0.40	0.39	0.38	0.34	0.44
Maximum	6.02	2.02	104.63	7.99	8.81	13.89
Minimum	-10.45	-3.85	-16.83	-3.65	-2.67	-17.17
Std. Dev.	2.10	1.10	14.25	2.41	1.65	3.79
Jarque-Bera	391.53	32.45988	4975.99	14.57	300.83	257.16
Probability	0.00	0.00	0.00	0.00	0.00	0.00
Panel B: Post-crisis						
Mean	0.51	0.59	0.40	0.78	0.49	0.03
Median	0.62	0.73	0.20	0.61	0.31	-0.27
Maximum	2.93	2.87	7.30	6.70	4.68	4.23
Minimum	-2.06	-1.96	-4.32	-0.86	-1.71	-4.00
Std. Dev.	0.92	0.83	1.68	1.20	1.10	1.49
Jarque-Bera	3.12	8.84	104.63	255.95	28.00024	9.89
Probability	0.20	0.01	0.00	0.00	0.00	0.00

5.2 *Empirical results*

Table 3 present the unit root tests results for the equity returns for both sub-sample periods. Panels A presents the individual unit root test results whilst those for the panel tests are provided in Panel B of Table 3. AS can be readily seen, an overwhelming majority of the reported evidence points to stationary processes in the all categories equity returns although the levels of significance for all equity returns in both sub-samples and for the remaining unit root tests the significance levels fluctuate between 5 percent and 10 percent. However, we note three exceptional cases to this notion of stationarity of the series and those are for the MSB static when the Ng-Perron test is performed with a trend during the pre-crisis for ALSI, top 40 and industrials returns. Nevertheless, we conclude these empirical results with a 'majority of rule' and view equity markets on the JSE as being highly efficient in the weak sense form.

Table 3: Unit root test results for equity returns

		ALSI		TOP_40		INDU		RES	
Panel A: INDIVIDUAL UNIT ROOT TESTS		Pre-crisis	Post-crisis	Pre-crisis	Post-crisis	Pre-crisis	Post-crisis	Pre-crisis	Post-crisis
ADF	Intercept	-8.33***	-9.32***	-8.76***	-9.50***	-6.73***	-9.49***	-9.43***	-7.83***
	Trend	-8.25***	-9.24***	-8.67***	-9.41***	-6.70***	-9.39***	-9.41***	-7.75***
PP	Intercept	-8.33***	-9.21***	-8.76***	-9.29***	-6.73***	-9.94***	-9.56***	-7.75***
	Trend	-8.25***	-9.13***	-8.67***	-9.21***	-6.70***	-9.82***	-9.54***	-7.68***
ERS	Intercept	-2.13**	-8.70***	-2.13**	-8.60***	-1.63*	-9.57***	-7.79***	-6.50***
	Trend	-7.22***	-9.09***	-7.62***	-9.18***	-5.24***	-9.53***	-9.20***	-7.53***
KPSS	Intercept	0.11	0.07	0.11	0.11	0.08	0.14	0.19	0.09
	Trend	0.10	0.07	0.10	0.10	0.08	0.13	0.11	0.09
NG-Perron tests									
MZa	Intercept	-6.03*	-22.01***	-5.75*	-22.13***	-4.71	-20.85***	-29.42***	-23.32***
	Trend	-29.15***	-21.55**	-29.25***	-21.42**	-25.16***	-20.95**	-28.40***	-23.12**
MZt	Intercept	-1.73*	-3.31***	-1.69*	-3.31***	-1.52	-3.21***	-3.83***	-3.41***
	Trend	-3.80***	-3.29**	-3.81***	-3.27***	-3.53***	-3.23**	-3.76***	-3.40**
MSB	Intercept	0.29	0.15***	0.29	0.15***	0.32	0.15***	0.13***	0.15***
	Trend	0.13***	0.15**	0.13***	0.15**	0.14***	0.15**	0.13***	0.15**

Panel B: PANEL UNIT ROOT TESTS		Pre-crisis	Post-crisis
Levin, Lin & Chu	Intercept	-10.47***	-17.90***
	Trend	-10.17***	-17.22***
Im, Pesaran and Shin W-stat	Intercept	-11.19***	-17.19***
	Trend	-10.46***	-16.93***
ADF – Fisher χ^2	Intercept	116.10***	163.09***
	Trend	101.11***	167.47***
PP – Fisher χ^2	Intercept	162.03***	162.92***
	Trend	143.403***	168.53***
Hadri	Intercept	-0.44	-0.96
	Trend	1.69	1.14

Note: *** indicates significance at 1%, ** indicates significance at 5% and * indicates significance at 10%. First difference is reported in parenthesis ().

Table 4 present the unit root tests results for the 6 bond returns series for both sub-sample periods with Panel A reporting the individual unit root test results and Panel B reporting the panel based test results. In differing from the results obtained from the pre-crisis we observe that both individual and panel unit root tests all reject the unit root hypothesis for all-time series in both sub-samples regardless of whether the test are performed with an intercept or a trend. In particular, we note that the ADF, PP, DF-GLS and KPSS tests all reject the unit root null hypothesis at all significance levels whereas the significance of the remaining Ng-Perron tests statistic fluctuate between 1 and 5 percent critical levels. Nevertheless, provided with the overwhelming evidence of stationarity within the bond series for both sub-samples we are obliged to conclude on weak-form efficiency within the South African Bond markets. The conclusions and policy implications of the study are thus given in the next section of the paper.

Table 4: Unit root test results for bond returns

		CEN		MUN		PUB		BAN		SEC		OTH	
		Pre-crisis	Post-crisis	Pre-crisis	Post-crisis	Pre-crisis	Post-crisis	Pre-crisis	Post-crisis	Pre-crisis	Post-crisis	Pre-crisis	Post-crisis
Panel A: INDIVIDUAL UNIT ROOT TESTS													
ADF	Intercept	-7.08***	-7.02***	-7.74***	-9.40***	-7.97***	-7.18***	-7.53***	-6.12***	-7.41***	-7.84***	-8.66***	-6.92***
	Trend	-7.31***	-7.16***	-7.76***	-9.44***	-7.90***	-7.11***	-7.46***	-7.42***	-7.38***	-8.38***	-8.60***	-7.40***
PP	Intercept	-7.05***	-7.03***	-7.75***	-9.40***	-7.98***	-7.19***	-10.70***	-6.23***	-9.13***	-7.84***	-8.66***	-6.92***
	Trend	-7.71***	-7.16***	-7.78***	-9.44***	-7.91***	-7.11***	-10.51***	-7.40***	-9.12***	-8.74***	-8.60***	-8.67***
ERS	Intercept	-7.05***	-6.05***	-7.73***	-9.15***	-7.92***	-6.88***	-7.48***	-5.76***	-6.92***	-7.92***	-8.43***	-6.34***
	Trend	-7.26***	-6.92***	-7.83***	-9.51***	-7.99***	-7.17***	-7.52***	-6.80***	-7.30***	-8.45***	-8.71***	-7.03***
KPSS	Intercept	0.29	0.22	0.15	0.14	0.06	0.06	0.19	0.56	0.07	0.42	0.07	0.38
	Trend	0.05	0.08	0.07	0.06	0.06	0.05	0.19	0.10	0.07	0.08	0.06	0.13
NG-Perron tests													
MZa	Intercept	-29.32***	-23.20***	-29.49***	-21.45***	-29.44***	-23.47***	-29.48***	-22.85***	-59.79***	-22.93***	-29.18***	-23.34***
	Trend	-29.40***	-23.27**	-29.46***	-20.92**	-29.43***	-23.38**	-29.45***	-23.22**	-63.94***	-22.37**	-28.96***	-23.28**
MZt	Intercept	-3.83***	-3.37***	-3.84***	-3.26***	-3.83***	-3.42***	-3.83***	-3.38***	-5.47***	-3.38***	-3.82***	-3.41***
	Trend	-3.83***	-3.36**	-3.84***	-3.22**	-3.84***	-3.41**	-3.84***	-3.41**	-5.65***	-3.34**	-3.80***	-3.41**
MSB	Intercept	0.13***	0.15***	0.13***	0.15***	0.13***	0.15***	0.13***	0.15***	0.09***	0.15***	0.13***	0.15**
	Trend	0.13***	0.14***	0.13***	0.15**	0.13***	0.15**	0.13***	0.15**	0.09***	0.15**	0.13***	0.15**
MPT	Intercept	0.84***	1.18***	0.83***	1.19***	0.84***	1.05***	0.86***	1.09***	0.41***	1.09***	0.84***	1.05***
	Trend	3.10***	4.23**	3.09***	4.44**	3.10***	3.94***	3.11***	3.93***	1.44***	4.08**	3.16***	3.93***

Panel B: PANEL UNIT ROOT TESTS		Pre-crisis	Post-crisis
Levin, Lin & Chu	Intercept	-16.35***	-12.38***
	Trend	-16.42***	-10.67***
Im, Pesaran and Shin W-stat	Intercept	-14.82***	-13.72***
	Trend	-14.25***	-19.26***
ADF – Fisher χ^2	Intercept	183.24***	54.00***
	Trend	158.56***	110.84***
PP – Fisher χ^2	Intercept	248.52***	195.10***
	Trend	225.78***	209.46***
Hadri	Intercept	-0.37	0.53
	Trend	0.34	0.73

Note: *** indicates significance at 1%, ** indicates significance at 5% and * indicates significance at 10%. First difference is reported in parenthesis ().

6 CONCLUSION

Since the financial liberalization periods of the 1990's much emphasis has been placed on international capital flowed to developing and emerging economies as an engine of economic prosperity. However, the catastrophic effects of the failure of capital markets was extensively demonstrated by the global financial crisis of 2007 hence placing urgency on financial regulators to be concerned with the efficiency of equity and bond markets. In our current study, we investigate the weak-form efficiency hypothesis for 4 disaggregated equity and 6 disaggregated bond market returns using a wide range of individual and panel based unit root testing procedures. The data is collected over a period of 2003 to 2015 and is further split into two sub-samples corresponding to the pre and post crisis periods.

Our empirical analysis reveals a number of interesting phenomenon. For starters, the failure to establish any evidence of unit root behaviour amongst all equity and bond market returns across the two sub-samples strongly highlights the efficiency of the JSE in regulating their markets. This result is not all together surprising since South Africa, by classification, is an emerging Sub Saharan African (SSA) economy with a highly sophisticated financial markets and appears to have recuperated quite efficiently from the contagion effects of the financial crisis on capital markets. Furthermore, in 2014, the JSE was recognized by the World Economic Forum (WEF) as the most efficiently regulated stock market worldwide and has since adopted high frequency trading platforms, being the first and only African country to do so. The efficiency of capital markets in precedence to the to the adoption of these high frequency trading platforms remains a topic for future research but for now we urge policymakers to take advantage of the efficiency of domestic capital markets as avenues to achieving their long run socioeconomic goals.

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