Has the South African Reserve Bank responded to equity prices since the sub-prime crisis? An asymmetric convergence approach

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HAS THE SOUTH AFRICAN RESERVE BANK RESPONDED TO EQUITY RETURNS SINCE THE SUB-PRIME CRISIS? AN ASYMMETRIC CONVERGENCE APPROACH

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ABSTRACT: The global financial crisis of 2008 sparked an ongoing debate concerning the interlink between monetary policy and equity returns. This study contributes to the debate by examining whether the South African Reserve Bank (SARB) repo rate responds asymmetrically to changes in the returns on four equity indices on the Johannesburg Stock Exchange (JSE). Our empirical model is the momentum threshold autoregressive (MTAR) model which is applied to monthly data corresponding to periods before the financial crisis (2002:01 - 2008:08) and periods after the crisis (2008:08 - 2016:12). There are three main findings which can be derived from our empirical analysis. Firstly, we significant negative relationship between equity prices to the repo rate before the crisis and this relationship turns insignificant in periods after the crisis. Secondly, we find that the Reserve Bank mainly monitored positive disturbances to equity indices before the crisis whereas after the crisis the Reserve Bank appears to be more responsive to negative equity deviations. Lastly, we find significant error correcting behaviour in periods before the crisis but not afterwards. Overall, our results indicate that the SARB appears to have been responsive to equity returns prior to the crisis but not for subsequent periods.

Keywords: Repo rate; Stock market returns; Monetary Policy; South African Reserve Bank (SARB); Johannesburg Stock Exchange (JSE); Financial crisis; South Africa.

JEL Classification Code: C22, C51; C52; E52, G10.

1 INTRODUCTION

The recent global financial crisis of 2008-2009, caused by a crash of the US financial system, has been dubbed as the worst financial crisis experienced since the Great Depression. The US Federal Reserve responded to the crisis by adopting quantitative easing monetary policies in which interest rates were gradually lowered to what is popularly known as the 'zero lower bound'. In December 2015, the Feds announced it's first raise in interest rates in over 9 years and it is anticipated that the Federal Reserve will continue to do so in the near future. Due to increasing levels of global financial integration it is expected that the increase in the Federal rate will propagate into financial markets in both developed and emerging economies. Phiri (2016) has recently shown that future increases in the federal fund rates will eventually propagate towards stock market activity for 5 SSA countries inclusive of South Africa. Following this line of thought, it would be interesting to know whether or not the South African Reserve Bank (SARB) will in turn responds to changes in equity returns. So far, the theoretical literature has identified two channels through which changes in interest rates are linked with the stock market (Moya-Martinez et. al., 2015). Firstly, interest rates are directly linked to the discount rate which is used for equity evaluation purposes. Secondly, interest rate movements are linked to a firms' expectations about future cash flows by altering the cost of financing.

Numerous empirical studies have been conducted which examine the correlation between monetary policy instrument and equity returns and these studies are inclusive of Das (2005) for India, Pakistan and Bangladesh; Faff et. al. (2005) for Australia; Hatemi-J and Roca (2008) for Australia, the US, the UK and Canada; Laopodis (2010) for the US; Kasman et. al. (2011) for Turkey and Moya-Martinez et. al. (2015) for Spain. Notably, most of these studies use linear empirical frameworks and have been conducted for European, Asian and North American economies with a limited amount of contemporary literature concerning African countries, and in particular Sub-Saharan African (SSA) countries (see Adjasi and Biekpe (2006) for a rare case study of South Africa, Kenya, Egypt, Ghana, Nigeria, Tunisia and Mauritius). Of recent, advances in econometric estimation techniques have enabled researchers to model the transmission of monetary policy actions through to the stock market as a nonlinear process. Evidence of interest rates-stock returns nonlinearity is documented in the works of Arango et. al. (2002) for Columbia; Chen (2007) for the US; Ballester et. al. (2011); Akbas (2013) for Turkey and Sheng-Yeh et. al. (2014) for G8 countries. Such documented nonlinearity can be treated as being theoretically plausible since financial markets are complex systems characterized by various heterogeneous agents who do not behave simultaneously but collectively determine aggregate market behaviour (Moya-Martinez et. al., 2015). Once again, we note that the evidence of nonlinearity between interest rates and stock returns is abundant for other international economies with none existing for SSA countries.

We observe that the aforementioned previous nonlinear studies do not consider the possibility of nonlinear convergence between interest rates and equity returns. However, it is well known from Engle and Granger's (1987) cointegration theorem that establishing the presence of long-run equilibrium adjustment between time series variables is important for avoiding the problem of spurious regressions obtained from estimating any long-run equations formed from nonstationary time series. It is thus important for studies investigating nonlinearities to account for asymmetric equilibrium convergence between the time series. Moreover, previous nonlinear studies strictly rely on aggregated measures of stock market development which robs them of distinguishing the varying effects which monetary policy instruments exert on different sectors of a stock exchange. This importance of using disaggregated measures of stock returns is demonstrated in the study of Geyser and Lowies (2001) who find that inflation is positively related with mining equities of the Johannesburg Stock Exchange (JSE) and yet negatively related with other equities listed under other sectors. Inevitably, such evidence indicates that while equities listed under the JSE are correlated with monetary policy outcomes, the degree of correlation differs from one sector to the next.

In our study, we investigate the nonlinear equilibrium adjustment mechanics between the repo rate and five main stock market indices on the Johannesburg Stock Exchange (JSE) returns using monthly data collected from 2002:01 to 2016:12 which is further disseminated into data corresponding to periods before (2002:01 - 2008:08) and periods after the crisis (2008:08 - 2016:12). The four generalized JSE stock indices covered in the study are the All

Share index (ALSI), the top 40 index, the industrials index and the resource index. Methodologically, we rely on the momentum threshold autoregressive (MTAR) model which has been successful used in describing the asymmetric adjustment behaviour between interest rates and other financial variables such as between interest rates and inflation (Maki, 2005), between interest rates and commercial bank rates (Matemilola et. al., 2015); between interest rates and mortgage prices (Becker et. al., 2012) as well as between the term structure of interest rates (Iyke, 2015). What is most recommendable about the MTAR model is that it allows for differing responses in equilibrium adjustment behaviour depending on whether deviations of equilibrium errors from the steady-state are negative or positive. This is particularly important when financial market rigidities exist in the transmission of policy instrument towards capital markets. For instance, monetary authorities might be more tolerant of falling interest rates than rising ones and this will have varying effects on financial markets depending on whether interest rates are below or above their steady-state equilibrium (Enders and Silkos, 2001). Ultimately, this assumption is consistent with the notion of asymmetric monetary policy conduct which has been already been documented for the SARB in the study of Kasai and Naraidoo (2012). However, it is yet to be proven as to whether the SARB policy instrument (i.e. the repo rate) and disaggregated stock returns adjust to a common market-clearing equilibrium in an asymmetric fashion. Our research efforts intend on empirically addressing this issue.

Our manuscript is divided into six sections which have been written as follows. The background to our study has been given in this first section of the paper. The next section provides an overview of developments in the South African stock market as well as an overview of monetary policy instrument used by the Reserve Bank. A review of the associated literature is presented in the third section of the article. In the fourth section we detail our empirical model and present the empirical data. The empirical study is conducted in section five whereas the study is concluded in the sixth section of the paper.

2 OVERVIEW OF STOCK MARKET DEVELOPMENT AND MONETARY POLICY INSTRUMENT IN SOUTH AFRICA

2.1 An overview of stock market development in South Africa

The Johannesburg Stock Exchange (JSE) is South Africa's sole stock exchange and was formed in 1887 thus rendering it as Africa's second oldest stock exchange after the Egyptian Stock Exchange (EGX). The JSE was established following the discovery of gold deposits in Witwatersrand reef between 1884 and 1886, and the stock exchange was used to facilitate for the large capital investments injected into the then growing mining industry. Currently, the JSE operates in equity, derivative and debt markets, trades over 900 securities and is the 17th largest stock exchange in the world with a market capitalization of 11.9 trillion ZAR in 2014. Also as of 2014, 394 firms were listed on the JSE, with 331 listed on the JSE main board and the remaining 62 firms being the AltX board, with the latter being designed to provide capital for small and medium sized firms. In addition to this, the JSE cross-lists a number of firms on her exchange and also conducts trades on international platforms such as in London, New York, Frankfurt and Zurich (Nyasha and Odhiambo, 2015). Categorically, the stock exchange can be grouped into eleven broad sectors namely, i) resources ii) basic industries iii) general industries iv) cyclical consumer goods v) non-cyclical consumer goods vi) cyclical services vii) non-cyclical services viii) utilities ix) financials x) information technology xi) specialist securities. The JSE also lists its trading equity stocks under four generalized stock indices i.e. the All Share index (ALSI), the top 40 index, the industrials index and the resource index.

Since the historic political reformation of the South African economy into a democratic state in 1994, the JSE experienced her most significant changes in the trading platform used by the stock exchange. For convenience sake, one can identify four transitional shifts in the trading mechanisms or platforms for trading equity stocks on the JSE since 1994. The first change took place in 1996 when the stock exchange gradually phased out tradition open outcry auctions and replaced this with a fully automated trading system, the JSE Equity Trading (JET) system. The second change took place in 2001, when the JSE adopted the London Stock Exchange (LSE) trading platform, the LSE Stock Exchange electronic trading system (SETS) and started conducting all equity trading activity under this trading platform. The third change came about in 2007, when the LSE leased yet another trading platform to JSE, the JSE TradeElect trading system. The fourth change came in 2013, when the JSE decided on moving the trading platform from London to back to Johannesburg under a new trading platform, the Millennium exchange trading platform (Yartley, 2008). It is under the Millennium exchange trading platform that the JSE introduced collation facilities as a trading option on the stock exchange. This has resulted in the most significant development in the JSE in terms efficiency and effectiveness of equity trading and this evident since the operational speed of which transactions are executed under collation is approximately 400 times faster than before.

2.2 An overview of monetary policy instrument in South Africa

Currently, the South African Reserve Bank (SARB) adheres to an inflation target regime of 3 to 6 percent, which it adopted in 2002, and uses the repo rate as a short-term policy instrument to keep inflation within it's designated target range. The inflation index which the Reserve Bank targets is the CPIX and this is defined as an annual percentage change in the consumer price index (CPI) exclusive of the changes in the interest costs of mortgage bonds. When CPIX inflation breaches the 6 percent upper boundary of the target range, the Reserve Bank will raise its repo rate to curb inflation expectations as well as to make it more expensive for the banks to borrow money and thus restrict banking activities (Matemilola et. al., 2015). This, in turn, lowers consumption and investment activities by economic entities, which then lowers aggregate demand and ultimately causes a reduction in the inflation rate. On the other hand, when inflation is below the lower limit of the inflation target (i.e. 3 percent), then the Reserve Bank will lower the repo rate as a means of inducing expansionary monetary policy, and the effects are transmitted through the economy in an opposite fashion to the mechanism previously described. The Monetary Policy Committee (MPC) of the Reserve Bank, which consists of seven members, inclusive of and headed by the Reserve Bank governor, has been delegated direct responsibility for ensuring that inflation remains within it's set target. The

MPC meets six times a year to discuss developments and after projecting inflation forecasts, the committee decides on whether to make any adjustments on the repo rate or not. As a means of enhancing Central Bank transparency, the SARB's produces inflation forecasts of a horizon up to 24 months which are then published in the Monetary Policy Review (MPR). This publication is released bi-annually in June and November and is easily accessible from the Reserve Banks website online.

However, it should be noted that the Reserve Bank did not start to place emphasis on interest rates as a direct policy instrument until 1985 following recommendations by the De Kok Commission which influenced the SARB to adopt monetary supply targets as an official policy mandate. Under the money supply targeting framework, the Reserve Bank's maintained a market oriented approach to policy conduct and redefined the role of the discount rate as the main policy instrument. The discount rate was used to influence the cost of overnight collaterized lending and ultimately affect market interest rates (Naraidoo and Gupta, 2007). By creating a persistent money market shortage and setting the bank rate at a relatively high level, the commercial bank rates were typically closely linked to the bank rate (Aron and Meullbauer, 2007). And yet the usefulness of money supply targets were diminished following extensive financial liberalization in the 1980's and a more open capital account from 1994 onwards (Phiri, 2016). Hereafter, the Reserve Bank switched to money supply guidelines which were similar to money supply targets except that the focus was on keeping M3 money supply within a predetermined target and this policy was later supplemented by an eclectic set of broad economic indicators including changes in bank credit extension, overall liquidity in the banking system, the yield curve, the overall balance-of-payments position, the exchange rate and movement in the rate of inflation (Van der Merwe, 2004). And yet, the SARB reached a milestone in it's approach to policy conduct in 1998 by introducing a system of monetary accommodation. Under this framework the Reserve Bank conducts monetary policy by engaging in tenders of liquidity through repurchase transactions (Aron and Meullbauer, 2007). This system of 'repo transactions' would completely phase out money supply guidelines and officially usher in the current inflation targeting regime.

In practice, the repo rate is the rate at which the SARB buys back securities it had previously sold in the money markets to commercial banks and is also the rate at which the Reserve Bank lends or discounts eligible papers for deposit money banks (Matemilola et. al., 2015). As part of it's operational mandate, the Reserve Bank engages in daily transactions which involves the buying of securities from commercial banks in return for funds. These borrowed funds are made against an obligation to purchase back these securities at a fixed price at a future date, which is currently set at seven days after the purchase of the securities has taken place (Dube and Zhou, 2013). In order to maintain a healthy profit margin, commercial banks then charge a higher interest to their customers than the repo rate charged by the Reserve Bank and the interest rate used between the banks and their customers is known as the prime lending rate. The interbank market, which is a market for loans and deposits amongst commercial banks, also plays a key role in the SARB monetary transmission mechanism because the interbank interest rates, along with other money market interest rates, respond immediately to any adjustments in the repo rate (Aziakpono et. al., 2007). When necessary, the Reserve Bank can also engage in other types of discrete auctions with commercial banks as a means of stabilizing interbank rates and accommodating liquidity requirements (Fadiran and Edun, 2013). All-in-all, the repo transactions system used by the SARB is intended to provide continuous signals to the banking institutions concerning the amount of liquidity that the Reserve Bank is willing to make available on a daily tendering basis.

3 LITERATURE REVIEW

The investigation into the relationship between interest rates and stock markets has been primarily dominated by studies which rely on linear analytical frameworks. In early studies, such as in Keim and Stambaugh (1986), Kandel and Stambaugh (1990), Thorbecke (1997) and Patelis (1997), a consensus had been drawn which contended for a positive relationship between the time series variables. However, following the global financial crisis of 2007-2008, an increasing number of authors have since advocated for a negative relationship between the variables (Farka (2009), Li et. al. (2010), Kasman et. al. (2011), Pirovano (2012), Moya-Martinez et. al. (2015)). And even more recent, it has been speculated that the relationship between interest rates and stock market development is most likely nonlinear. This nonlinear relationship between interest rates and stock markets is reminiscent of imperfect markets existing in the finance constrained theory (Bui, 2015). Empirically, there are three main groups of research studies advocating for a nonlinear interest rate-stock returns relationship. Firstly, are studies which find that the effects of monetary policy stance on the stock exchange depends on whether a stock exchange is in a 'bulls' or 'bears' phase of the market. Belonging to this cluster of studies are the works of Perez-Quiros and Timmermann for the US (2000), Arango et. al. (2002), Chen (2007) for the US; Henry (2009) for the UK; Konrad (2009) for Germany; Jansen and Tsai (2010) for the US; Kurov (2010) for the US; Zare et. al. (2013) for ASEAN5 countries (i.e. Malaysia, Indonesia, Singapore, the Philippines and Thailand), Ravn (2014) for the US; Han. et. al. (2015) for China, Li (2015) for China and also Bui (2015) for ASEAN5 countries. Incidentally, the aforementioned studies indicate that monetary policy exerts a larger effect on stock market development during periods of bear markets and has smaller effects during bull periods albeit for differing economies, using different econometric techniques and different measures of monetary policy stance as well as stock market development in reaching this conclusion.

The second group of nonlinear studies argue that the interest rate-stock returns relationship varies during different phases of the business cycle. Inclusive of these studies are the works of Guo (2004), Anderson et. al. (2007), Basistha and Kurov (2008), Hess et. al. (2008) and Vahamaa and Aijo (2011). Notably, the empirical results obtained from this cluster of studies appears to be more ambiguous in nature. For instance, Guo (2004) investigates the effect of the federal funds rate on large firms and small firms between two sample periods; 1974-1979 (i.e. bad business conditions) and 1988-2000 (i.e. good business conditions) using simple OLS regressions. The authors find that stocks from small firms were more sensitive to the federal funds rate than stocks from large firms during periods of bad business conditions whereas these effects disappear altogether during periods good business conditions. On the other hand, Anderson et. al. (2007) examine the effects of changes in monetary policy stance on bond and equity markets in the US, German and the UK from 1992-2002 and find that bad macroeconomic news has a negative effect on stock markets during contractionary periods and this effect turns positive during expansionary periods. Conversely, the authors find that 'good news' during expansions has a negative impact on stock returns and a positive effect during contractions. Using firm level-data, Basistha and Kurov (2008) find that effect of an unexpected or 'surprise' change in the feds funds target rate is twice as large during recessions in comparison to responses during expansionary periods. The authors also show that financial constrained firms are more sensitive to monetary shocks during recessions in comparison to those exhibited by financially unconstrained firms. In another study, Hess et. al. (2008) find that the US stock markets respond positively to news about inflation and real activity during recessions whereas no significant reactions are found to exist during expansionary periods. In taking a different approach, Vahamaa and Aijo (2011) investigate the impact of both scheduled (unsurprised) and unscheduled (surprise) monetary policy announcements on the US stock market and find that the effects both types of monetary policy announcements are more prolonged during expansions than contractionary periods.

The third group of nonlinear studies are those which examine the effects of monetary policy instrument on stock returns depending upon the direction of monetary policy developments. Research conducted by Lobo (2002), Bernanke and Kuttner (2005), Chulia-Soler et. al. (2010) and Laopodis (2013) all belong to this criteria of empirical studies. Lobo (2002) studies the effects of monetary policy surprises on stock price volatility and discovers that a surprise announcement of an interest rate hike by the Fed's results in an immediate increase in stock market volatility, with the increase in volatility quickly reverting back to it's 'pre-announcement' level on the day following the announcement. Similarly, Bernanke and Kuttner (2005) observe that an unanticipated decrease in the federal funds rate will have a positive impact on the US stock market. In particular, the authors find that a 'surprise' 25-basis-points reduction in the federal funds rate will result in a 1 percentage increase in aggregate stock price returns. On the other hand, Chulia-Soler et. al. (2010) find that a surprise increase in federal funds rate of 25 basis-points will lead to an increase in volatility in the US stock market returns by 113 basis points and this change in stock price volatility will occur in less than 5 minutes. Furthermore, the empirical study also reveals that surprises hikes in interest rates will lead to stronger decrease in stock price returns in comparison to an increase in stock price as caused by a surprise reduction in interest rates. Laopodis (2013) investigates the effects of monetary policy on stock market performance during three monetary policy regimes in the US i.e. Burns (1970-1978), Volcker (1979-1987) and Greenspan (1988-2003) and finds that the relationship between monetary policy and stock returns has been different in each of the aforementioned regimes. Nevertheless, Laopodis (2013) finds that the effects of monetary policy on stock market performance was more pronounced during periods of bear markets than in periods of bull markets.

4 EMPIRICAL FRAMEWORK

In investigating the relationship between the SARB monetary policy instrument and stock price returns in South Africa, we use the momentum threshold autoregressive (MTAR) model framework of Enders and Granger (1998) and Enders and Silkos (2001). Traditional cointegration techniques of Engle and Granger (1987) and Johansen (1991) assume symmetric adjustment to the long-run equilibrium and thus cannot differentiate between negative and positive shocks which can be best captured as asymmetric adjustments. The MTAR model allows for such asymmetric cointegration relations which, in our study, is derived from the following bi-variate long-run cointegration equation:

$$repo_t = \alpha_0 + \alpha_0 smr_t + \mu_t \qquad (1)$$

Where $repo_t$ is the repo rate, smr_t is the return on the stock market index and μ_t is a well-behaved equilibrium error term. To instigate asymmetric cointegration, the long run residuals are modelled as the following threshold process:

$$\Delta\mu_t = \rho_1 I_t \varepsilon_{t-1} + \rho_2 I_t \varepsilon_{t-1} + \xi_t \qquad (2)$$

Where ρ_1 and ρ_2, are coefficients of threshold equilibrium errors, I_t. is a Heaviside indicator function which dictates regime switching behaviour for the threshold equilibrium error terms and ξ_t ~ I.I.D. $(0, \sigma^2)$. The absolute values of the coefficients ρ_1 and ρ_2 measure the speed of adjustment back to the long-run equilibrium after positive and negative shock, respectively. Enders and Siklos (2001) further propose that asymmetric cointegration can take the form of two possible functional forms. Firstly, there exists TAR cointegration in which the indicator function I_t assumes the following functional forms:

$$I_t = \begin{cases} 1 \; if \; \mu_{t-1} \geq \tau \\ 0 \; if \; \mu_{t-1} < \tau \end{cases} \qquad (4)$$

Secondly, there is MTAR cointegration in which the indictor function is specified in terms of the first differences of the threshold error terms hence allowing a variable to display varying amounts of autoregressive decay depending on whether it is increasing or decreasing:

$$I_t = \begin{cases} 1 \; if \; \Delta\mu_{t-1} \geq \tau \\ 0 \; if \; \Delta\mu_{t-1} < \tau \end{cases} \qquad (5)$$

Where Δ is a first difference operator. The threshold estimate τ is unknown a-prior and it's consistent estimate is obtained using Hansen's (1999) methodology of searching over possible threshold values to minimize the residual sum of squares (RSS) from the fitted model. After obtaining the true threshold values, it is possible to estimate the TAR and MTAR cointegration models by respectively plugging equations (4) and (5) into (3). However, prior to doing so we must first verify convergence effects in these regressions. This occurs in a three-staged process.

i) Firstly, we visually inspect whether the following convergence condition has been satisfied: $\rho_1 < 0$, $\rho_2 < 0$ and $(1 + \rho_1)(1 + \rho_2) < 0$. If this condition holds then the least squares estimates of ρ_1 and ρ_2 have an asymptotic multivariate distribution.
ii) Secondly, we use standard F-statistics to test the null hypothesis of no convergence effects as H_{10}: $\rho_1 = \rho_2 = 0$ and this is tested against the alternative of significant

cointegration effects i.e. $\rho_1 \neq \rho_2 \neq 0$. The statistics are denoted as F-Max* for the TAR model and F-Max*(M) for the MTAR model.

iii) Lastly, we use modified F-statistics to test null of linear cointegration effects (i.e. H_{20}: $\rho_1 = \rho_2$) and this is tested against the alternative of threshold cointegration effects (i.e. $\rho_1 \neq \rho_2$). These statistics are denoted as Φ^* and $\Phi^*(M)$ for the TAR and MTAR model, respectively.

Since the distribution of the F-statistics testing $\rho_1 = \rho_2 = 0$ and $\rho_1 = \rho_2$ are nonstandard, Enders and Siklos (2001) tabulate consistent critical values for this test. Once the absolute values of the F-statistics exceed their tabulated critical values reported in Enders and Siklos (2001), then one can proceed to model short-run and long-run cointegration relations as well as conduct causality tests based on the following threshold error correction (TEC):

$$\Delta smr_t = \alpha + \gamma_{11}\eta_t^- + \gamma_{12}\eta_t^+ + \sum_{i=1}^{k}\alpha_{1i}\Delta er_{t-i} + \sum_{i=1}^{k}\Psi_{1i}\Delta repo_{t-i} + e_t \qquad (6)$$

$$\Delta repo_t = \alpha + \gamma_{2i}\eta_t^+ + \gamma_{22}\eta_t^+ + \sum_{i=1}^{k}\alpha_{2i}\Delta er_{t-i} + \sum_{i=1}^{k}\Psi_{2i}\Delta repo_{t-i} + e_t \qquad (7)$$

Where Δ is a first difference operator, $Z_t^- = I_t\mu_{t-1}$ and $Z_t^+ = (1 - I_t)\mu_{t-1}$. From equations (6) and (7), the null hypothesis of no threshold error correction effects can be tested as H_{30}: $\gamma_{1i}\eta_t^- = \gamma_{2i}\eta_t^+$ against the alternative of threshold cointegration effects i.e. $\gamma_{1i}\eta_t^- \neq \gamma_{2i}\eta_t^+$. The F-statistic testing the TEC effects hypothesis is denoted as F_{TEC}. We also perform causality analysis for the time series by testing two causality hypotheses. The first null hypothesis of the return on the stock market index not leading the repo rate (i.e. H_{40}: $\alpha_i = 0$) whereas the second null test the hypothesis of the repo rate not causing return on the stock market index (i.e. H_{50}: $\Psi_i = 0$). The F-statistics which are responsible for granger causality are denoted as $F[H_{40}]$ and $F[H_{50}]$, respectively.

5 DATA AND EMPIRICAL ANALYSIS

5.1 Data properties and unit root tests

The empirical data used in our empirical study has been retrieved from the McGregor BFA online database and consists of monthly data collected for the FTSE/JSE All share index ($ALSI_t$), FTSE/JSE Top 40 index ($Top.40_t$), FTSE/JSE Industrial 25 index ($Ind.25_t$), the FTSE/JSE Resource 10 index ($Res.10_t$) and the repo rate (i_t). All empirical data has been collected for the post-inflation targeting era of 2002:01 to 2016:12 and is further disseminated/propagated into two sub-groups representative of periods before the sub-prime crisis (i.e. 2002:01 to 2008:08) and for periods subsequent to the crisis (i.e. 2008:08 to 2016:12). Since our stock data is provided as an index we compute our equity returns (er_t) variable for all stock market indices (smi_t) as:

$$er_t = \frac{smi_t - smi_{t-1}}{smi_{t-1}} \times 100 \tag{6}$$

Where t is a time subscript. The descriptive statistics of our empirical data is provided in Table 1. As can be observed from Table 1, the repo rate had higher values of the mean [9.9], median [10], minimum [7], maximum [13.5] and standard deviation [2.1] in the pre-crisis compared to those in the post crisis i.e. mean [6.2], median [5.8], minimum [5], maximum [12] and standard deviation values [1.5]. This generally implies that the SARB has leaned more towards a less restrictive monetary policy approach in periods following the financial crisis. Similarly for the returns to all four share indices we find that the means, medians, minimum and maximum values are lower in the post-crisis period in comparison to the pre-crisis period. We also note that returns on the on the all share index has the highest mean [1.3], median [1.7], maximum [10] and the lowest minimum [-13.3] and standard deviation [5.5] in the pre-crisis period. However in the post crisis period, the returns on the industrial index had the highest mean [1.4], median [1.2] and maximum [0.3] values whilst also having the lowest minimum [-13.9] and standard deviation [4.4] values.

Table 1: Summary statistics of time series

	time series	mean	median	minimum	maximum	std. dev.
	repo	9.9	10	7	13.5	2.1
	all.share	1.3	1.7	-13.3	10.0	5.5
Pre-crisis	top.40	1.3	1.2	-14.3	14.7	5.7
	ind.25	0.9	1.4	-13.9	11.7	5.7
	res.10	1.9	1.7	-19.1	21.4	8.1
	repo	6.2	5.8	5	12	1.5
	all.share	0.8	1.0	-13.9	0.3	4.4
Post-crisis	top.40	0.7	0.5	-14.9	11.7	4.7
	ind.25	1.4	1.2	-10.9	11.6	4.1
	res.10	-0.4	-0.8	-22.6	16.4	7.4

Source: Authors' own computations

Before we can make any analytical use of the time series it is imperative that we test for unit roots within the variables. Conventional unit root tests such as ADF and PP unit root tests may not suffice for this purpose since they are unable to discriminate between stationary and unit root processes. Therefore, a suitable alternative is the DF-GLS unit root test of Elliot et. al. (1996) which is a modification of the ADF test using generalized least squares (GLS) approach. In our study, the DF-GLS unit root test is performed on each of the time series for periods before and after the financial crisis and the tests are performed with i) a constant and ii) with trend; and the results of this empirical exercise are reported in Table 2. As is evident in Table 2, in both sub-periods all the time series are first difference stationary variables. In particular, for both sub-periods all the time series cannot reject the null hypothesis of a unit root at all significance levels regardless of whether the test is performed with a drift or a trend. However, in their first differences, the time series reject the null hypothesis at a significance level of at least 10 percent for all the time series for periods prior to the crisis whereas the unit root null is reject at all critical levels for periods subsequent to the crisis. Overall, these unit root test results verify that the variables are integrated of order I(1) and thus permits us to proceed with formal threshold cointegration analysis.

Table 2: DF-GLS unit root tests

	pre-crisis		post-crisis		decision
	drift	trend	drift	trend	
$repo_t$	-1.88	-2.04	-0.90	-1.34	I(1)
	[-2.96]***	[-2.99]***	[-2.83]***	[-3.60]***	
$ALSI_t$	-0.68	-1.23	-0.76	-0.49	I(1)
	[-3.48]***	[-5.55]***	[-2.77]***	[-4.44]***	
$Top.40_t$	-0.66	-1.30	-0.21	-0.02	I(1)
	[-2.64]***	[-4.53]***	[-2.96]***	[-4.73]***	
$Ind.25_t$	-1.94	-1.96	-0.32	-0.45	I(1)
	[-2.61]**	[4.93]***	[-4.54]***	[-6.88]***	
$Res.10_t$	-0.73	-1.55	-1.48	-1.05	I(1)
	[-1.71]*	[-3.39]**	[-2.66]***	[-5.86]***	

Note: "***', '**' and '*' represent 1, 5 and 10 percent critical levels, respectively. First difference statistics reported in [].

5.2 Cointegration analysis

Having confirmed first difference stationary in the time series, we proceed to carry out our empirical estimations of the TAR and MTAR models between the repo rate and the return on the stock market indices. However, prior to estimating any of these models we need to verify which of the threshold models contain significant asymmetric convergence effects. To recall, there are three prescribed hypotheses which are performed to this end. Firstly, we test the null hypothesis of no cointegration effects (i.e. H_{10}: $\rho_1 = \rho_2 = 0$) and this hypothesis is tested using the t-Max* and t-Max*(M) statistics for the TAR and MTAR models, respectively. Secondly, we test the null of no threshold cointegration effects (i.e. H_{20}: $\rho_1 = \rho_2$) using the Φ^* and $\Phi^*(M)$ statistics for the TAR and MTAR models, respectively. Lastly, there is the null of no TEC effects (i.e. H_{30}: $\gamma_{1i}\eta_t^- = \gamma_{2i}\eta_t^+$) using the F_{TEC} and $F_{TEC}(M)$ statistics for the TAR and MTAR models, respectively. The thumb of rule is that only if the three hypotheses are rejected are we able proceed to estimate the TAR/MTAR models with their corresponding TEC components.

Therefore we only provide a discussion for those regressions which manage to reject all three null hypotheses. Our empirical strategy involves testing these hypotheses on the time series data for i) periods before the crisis, and ii) periods after the crisis. The results of the empirical exercise are reported in Table 3 below.

Table 3: Threshold cointegration and error correction test results

	TAR			MTAR		
	t-Max*	Φ*	F_{TEC}	t-Max*(M)	Φ*(M)	F_{TEC}(M)
Pre-crisis						
$ALSI_t$	3.41	4.62	8.42	1.20	0.22	0.24
	(0.04)*	(0.03)*	(0.00)***	(0.31)	(0.59)	(0.63)
$Top.40_t$	3.11	4.11	8.44	2.41	2.73	3.09
	(0.05)*	(0.05)*	(0.00)***	(0.09)*	(0.10)	(0.08)*
$Ind.25_t$	3.05	3.55	8.01	2.12	1.74	2.29
	(0.05)*	(0.06)*	(0.00)***	(0.13)	(0.19)	(0.13)
$Res.10_t$	1.96	2.43	5.70	2.55	3.59	3.99
	(0.15)	(0.12)	(0.02)**	(0.08)*	(0.06)*	(0.04)**
Post-crisis						
$ALSI_t$	7.71	9.13	4.88	7.16	8.09	1.60
	(0.00)***	(0.00)***	(0.03)**	(0.00)***	(0.00)***	(0.21)
$Top.40_t$	7.87	8.57	3.03	7.62	8.11	1.02
	(0.00)***	(0.00)***	(0.08)*	(0.00)***	(0.00)***	(0.32)
$Ind.25_t$	9.61	9.32	1.84	5.05	1.02	0.14
	(0.00)***	(0.00)***	(0.18)	(0.00)***	(0.31)	(0.71)
$Res.10_t$	7.57	7.51	2.12	6.91	6.28	2.12
	(0.00)***	(0.00)***	(0.09)*	(0.00)***	(0.00)***	(0.09)*

Notes: "****", "**", "*" denote the 1, 5 and 10 percent significance levels, respectively. P-values reported in ().

The top panel of Table 3 reports the results for the pre-crisis period whereas the bottom panel reports the results for the post-crisis period. From the top panel it is evident that TAR models best describe the cointegration relationship between the repo rate and the returns on the all-share index, the top 40 index and the industrial 25 index whereas we find a MTAR relationship between the repo rate and returns on the resource 10 index. In particular, for the TAR specifications, we obtain t-Max* statistics of 3.41 (ALSI), 3.11 (Top.40), 3.05 (Ind.25) which are significant at a 10 percent critical level; Φ* statistics of 4.62 (ALSI), 4.11 (Top.40), 3.55 (Ind.25) which are also significant at a 10 percent critical level; and F_{TEC} statistics of 8.42 (ALSI), 8.44 (Top.40), 8.01 (Ind.25) which are significant at all critical levels. On the other hand, for the MTAR model between the repo rate and the returns on the resource 10 index, we find t-Max*(M) statistic of 2.55 and Φ*(M) statistic of 3.59, which are both significant at all critical levels whereas the F_{TEC}(M) statistic of 3.00 exceed it's 1 percent critical value. Overall, the empirical results confirm four estimation regressions for periods before the crisis.

In the bottom panel of Table 3 we also find four significant threshold estimation regressions. The first three are TAR cointegration relations between the repo rate and returns on the all-share index, the top 40 index. The fourth is a MTAR regression between the repo rate and returns on the resource 10 index. Particularly, for the TAR regression we manage to obtain t-Max* statistics of 7.71 (ALSI), 7.87 (Top.40), 7.57 (Res.10) which are significant at all critical levels; Φ* statistics of 9.13 (ALSI), 8.57 (Top.40), 7.51 (Res.10) which are also significant at all critical levels and F_{TEC} statistics of 4.88 (ALSI), 3.03 (Top.40), 2.12 (Res.10) which are significant at a critical level of at least 10 percent. For the MTAR cointegration regression between the repo rate and returns on the Resource 10 index we find t-Max*(M) statistic of 6.91 and Φ*(M) statistic of 6.28 which are both significant at all critical levels; whereas the F_{TEC}(M) statistic produces a value of 2.21 which is significant at a 10 percent critical level.

Collectively, the results reported in Table 3 point to at least one form of threshold convergence between the monetary policy instrument and returns on all four stock market indices whereas after the crisis there exist threshold convergence between the repo and returns on three disaggregated indices. This finding provides preliminary evidence of the global financial crisis altering convergence dynamics between the SARB policy instrument and JSE stock market returns. Bearing this in mind, we proceed to estimate the relevant TAR and MTAR regressions in order to assess the extent which the financial crisis altered the dynamic long-run and short-run convergence relations between the repo rate and returns to stock market indices.

5.3 Cointegration analysis and error correction estimates

The left panel of Table 4 reports the results for periods before the crisis whereas the right panel reports the results for periods after the financial crisis. For periods prior to the financial crisis, we find significant long-run regression coefficients (α_1) estimates of -0.10(ALSI), -0.11(Top.40), -0.12(Ind.25), and – 0.05(Res.10) and the coefficients on the first three indices are significant at all critical levels whereas the coefficient on the last index is only significant at a 10 percent critical level. For periods subsequent to the crisis the long-run coefficients for the indices (i.e. ALSI, Top.40 and Res.10) is at a much lower value of -0.01 albeit these estimates being insignificant.

Concerning the threshold equilibrium error terms, ρ_1 and ρ_2, for periods before the crisis, we obtain ρ_1 estimates of -0.24(ALSI), -0.21(Top.40), -0.26(Ind.25) and -0.05(Res.10) whereas the values of ρ_2 are -0.01(ALSI), -0.01(Top.40), -0.04(Ind.25) and -0.16(Res.10). Since the absolute values of ρ_1 are larger than those of ρ_2 for the ALSI, Top.40 and Ind.25 variables, we conclude that for these indices positive deviations from the equilibrium are eradicated at a quicker rate than negative ones whereas for the Res.10 variable negative deviations are eradicated at a quicker rate than positive deviations. This means that for the pre-crisis period the SARB reacted quicker to a bulls market in the ALSI, Top 40 and Ind. 25 sectors whereas the Reserve Bank reacted quicker to a bears market for the Res. 10 sector.

For periods subsequent to the financial crisis the absolute values of ρ_1 (i.e. -0.06(ALSI) and -0.07(Top.40),) are smaller than those for ρ_2 (i.e. -0.15(ALSI) and -0.15(Top.40), whereas for the Res.10 variable absolute values of ρ_1 in the TAR (-0.07) and MTAR (-0.06) model remain smaller than their corresponding ρ_2 values of -0.08 and -0,21 for the TAR and MTAR model, respectively. Therefore, for periods after the crisis the repo rate reacted quicker to bears market as opposed to a bulls market in the ALSI and Top.40 sectors whereas the opposite happens in the Res.10 sector where the repo rate responds quicker to bulls markets. We further note, that for both periods before and subsequent to the financial crisis the threshold error terms satisfy the convergence condition of $\rho_1 < 0$, $\rho_2 < 0$ and $(1 + \rho_1)(1 + \rho_2) < 0$ thus verifying threshold convergence effects between the observed time series.

Table 4: Estimation of TAR/MTAR models

	Pre-crisis				Post-crisis			
model type	TAR	TAR	TAR	MTAR	TAR	TAR	TAR	MTAR
independent variable	$ALSI_t$	$Top.40_t$	$Ind.25_t$	$Res.10_t$	$ALSI_t$	$Top.40_t$	$Res.10_t$	$Res.10_t$
α_0	10.11	10.10	10.08	10.05	6.76	6.73	6.54	6.54
	(0.00)***	(0.00)***	(0.00)***	(0.00)***	(0.00)***	(0.00)***	(0.00)***	(0.00)***
α_1	-0.11	-0.10	-0.12	-0.05	-0.01	-0.01	-0.01	-0.01
	(0.00)***	(0.00)***	(0.00)***	(0.07)*	(0.12)	(0.14)	(0.42)	(0.42)
τ	1.77	1.65	1.85	-0.47	-0.45	-0.72	-0.79	-0.19
$\rho_1\varepsilon_{t-1}$	-0.24	-0.21	-0.26	-0.03	-0.06	-0.07	-0.07	-0.06
	(0.00)***	(0.00)***	(0.00)***	(0.43)	(0.09)*	(0.07)*	(0.01)* *	(0.01)**
$\rho_2\varepsilon_{t-1}$	-0.01	-0.01	-0.04	-0.16	-0.15	-0.15	-0.08	-0.21
	(0.98)	(0.98)	(0.53)	(0.03)*	(0.04)*	(0.03)*	(0.17)	(0.02)*

Notes: "****", "**", "*" denote the 1, 5 and 10 percent significance levels, respectively. P-values reported in ().

The estimation of our TEC models as well as the associated causality tests are reported in Table 5. We find that during positive shock to the equity returns in periods before the crisis, the error correction term produces the correct negative and highly significant coefficients for the ALSI(-1.75), Top.40(-1.89) and Ind.25(-1.79) variables whereas during negative shocks only the Res.10 variable produces a negative and significant error correction coefficient of -2.26. As eloquently explained by Burke and Hunter (2005), error correction terms can be interpreted with meaning if the associated coefficient is significant and lies between the values of 0 and -2. In the case in which the error correction coefficient lies between -1 and -2, then self-correcting convergence after a period of disequilibrium occurs within the data frequency of the time series. Bearing this in mind, we conclude that for periods before the crisis significant equilibrium correcting behaviour occurred only during negative shocks to the ALSI, Top.40 and Ind.25 variables and such equilibrium correcting behaviour occurred within the data frequency of one month. Conversely, during periods subsequent to the crisis all negative and significant error correction terms are produced for negative shocks to equity returns i.e. ALSI(-16.48), Top.40(-12.62), Res.10(-10.83 and -18.67 for TAR and MTAR models, respectively). However, we note that the aforementioned TEC coefficients surplus their cut-off point of -2, hence these coefficients cannot be interpreted with any purposeful meaning.

All-in-all, our empirical estimates of TEC models imply that for periods prior to the financial crisis the Reserve Bank seemed to be mainly concerned (or monitored) with positive shocks (i.e. bulls market) to equity returns whereas subsequent to the crisis the Reserve Bank has mainly monitored negative shocks to the equity returns (i.e. bears market). We note that this result is in coherence with those obtained from our long-run regression estimates in which we found that for the pre-crisis period positive deviations where eradicated faster than negative ones whereas after the crisis the opposite happens. We also note that significant and negative error correction estimates are obtained for the return to stock index variable in both sub-sample periods thus indicating that equity returns are weakly exogenous in the system. This finding is re-iterated and strengthened by the causality tests reported at the bottom of Table 5. As can be observed from Table 5, in testing the null that stock returns do not granger cause interest rates for periods before the crisis, we obtain F-statistics of 11.59 (ALSI), 12.94 (Top.40), 10.27 (Ind.25) and 15.45 (Res.10) and all these statistics manage to reject the tested null at all levels of significance. Similarly, in testing the same null that stock returns do not lead to interest rates for periods subsequent to the crisis, we obtain F-statistics of 21.21 (ALSI), 22.05 (Top.40), 17.40 (Res.10 (TAR)) and 15.45 (Res.10 (MTAR)) and all these statistics manage to reject the tested null at all critical levels. On the other hand, we are unable to find any evidence that interest rates lead to equity returns in both sample periods as the F-statistics testing the null that interest rates do not lead equity returns cannot be rejected and we attribute this unconventional finding to our long-run model specification which is particularly designed to assess the effects of equity returns on the repo rate and not vice versa (i.e. repo rate is the dependent variable in the long run regression).

Table 5: TEC estimates and causality tests

	Pre-crisis							
	TAR		TAR		TAR		MTAR	
	$\Delta repo_t$	$\Delta ALSI_t$	$\Delta repo_t$	$\Delta Top.40_t$	$\Delta repo_t$	$\Delta Ind.25_t$	$\Delta repo_t$	$\Delta Res.10_t$
$\eta^{+}\varepsilon_{t-1}$	-0.05	-1.75	-0.07	-1.89	-0.04	-1.79	-0.03	0.23
	(0.17)	(0.00)***	(0.08)*	(0.00)***	(0.36)	(0.00)***	(0.17)	(0.66)
$\eta^{-}\varepsilon_{t-1}$	-0.02	0.74	-0.01	1.01	-0.03	0.64	-0.04	-2.26
	(0.43)	(0.09)*	(0.75)	(0.18)	(0.27)	(0.18)	(0.43)	(0.05)*
H_{04}		11.59		12.94		10.27		15.45
		(0.00)***		(0.00)***		(0.00)***		(0.00)***
H_{05}		1.04		1.29		1.53		0.87
		(0.36)		(0.28)		(0.22)		(0.42)
R^2	0.09	0.33	0.11	0.33	0.06	0.31	0.10	0.30
DW	2.17	2.13	2.17	2.12	2.12	2.12	2.13	2.15
LB	0.01	0.00	0.07	0.00	0.01	0.00	0.00	0.00
	Post-crisis							
	TAR		TAR		TAR		MTAR	
	$repo_t$	$ALSI_t$	$repo_t$	$Top.40_t$	$repo_t$	$Res.10_t$	$repo_t$	$Res.10_t$
$\eta^{+}\varepsilon_{t-1}$	0.07	3.30	0.07	1.66	0.07	0.71	0.06	-0.41
	(0.02)*	(0.34)	(0.02)**	(0.60)	(0.00)***	(0.83)	(0.01)*	(0.89)
$\eta^{-}\varepsilon_{t-1}$	0.04	-16.48	0.05	-12.62	0.03	-10.83	0.09	-18.67
	(0.53)	(0.02)**	(0.40)	(0.05)**	(0.63)	(0.09)*	(0.36)	(0.09)*
$F[H_{04}]$		21.21		22.05		17.40		11.97
		(0.00)***		(0.00)***		(0.00)***		(0.00)***
$F[H_{05}]$		2.01		2.02		1.06		0.45
		(0.14)		(0.11)		(0.35)		(0.64)
R^2	0.18	0.41	0.20	0.46	0.18	0.41	0.18	0.49
DW	2.00	2.02	2.03	2.04	2.00	2.01	1.94	2.00
LB	0.01	0.02	0.02	0.04	0.01	0.02	0.01	0.03

Notes: "****", "**", "*" denote the 1, 5 and 10 percent significance levels, respectively. P-values reported in (). DW and LB represent the Durbin-Watson and Ljung-Box diagnostic test statistics for autocorrelation and both statistics indicate that all estimated regressions are free of serial correlation.

6 CONCLUSIONS

The primary objective of this study was to examine how the SARB has responded to changes in equity returns for periods prior and subsequent to the global financial crisis of 2008. To do so, we made use of the MTAR cointegration framework, and applied the model to two monthly datasets, one corresponding to periods before the crisis (i.e. 2002:01 - 2008:08) and the other corresponding to periods subsequent to the crisis (i.e. 2008:08 - 2016:12). Our empirical analysis reveals a number of interesting phenomenon. For one, we note a negative and significant long-run relationship between interest rates and equity returns for periods before the financial crisis whereas this relationship turns insignificant in periods subsequent to the crisis. Furthermore, our empirical results also reveal that prior to the crisis, interest rates responded quicker to positive discrepancies in most equity returns whereas for periods subsequent to the crisis, the repo responded quicker to negative divergences in equity returns. Finally, in terms of granger causality, we find that equity returns lead to interest rate in both subsample periods.

From a policy perspective, we firstly highlight the evidence of the Reserve Bank responding to equity returns in both sample periods even though a significant long-run relationship is only established between the two variables for periods prior to the financial crisis. This result is plausible seeing that since the adoption of the inflation targeting regime in 2002, the SARB has placed some emphasis on monitoring asset prices, due to the fact that changes in asset prices contribute to domestic levels of inflation. Thus, despite conventional claims that the SARB was not concerned with asset price movements before the crisis, our empirical result indicate that the Reserve Bank was concerned with monitoring equity returns in the interest of keeping inflation within it's target. Note that our empirical results simply imply that the SARB monitored equity returns but did not necessarily target these returns. Our results further show that, prior to the crisis, the Reserve Bank has been more responsive to bulls markets than bears markets and this result is also plausible because rapidly escalating bulls markets are a foretelling sign of bubbles in equity prices.

However, following the advent of the financial crisis and the resulting global recession period, the role of monetary policy has been primarily managing the cyclical down turn. This has caused the SARB to be pre-occupied with lowering inflation to it's designated target as well as on closing the negative output gap via countercyclical policies. Therefore, there appears to have been little role for monetary authorities in monitoring equity prices and henceforth in the post-crisis period, we empirically find an insignificant relationship between the repo rate and equity returns. Nonetheless, the financial crisis has re-ignited concerns around the extent to which monetary policy should react to movement in asset prices. Currently, the SARB has increased emphasis on macropudential policy which requires that monetary policy should focuses on endogenous risks such asset price growth. However, there has been little indication on whether the Reserve Bank will directly incorporate asset prices into their policy reaction function. The fact still remains that, in the post-crisis period, it is important that the Reserve Bank should at least be monitoring equity returns since they reflect developments in the financial and real sectors of the economy.

REFERENCES

Adjasi C. and Biekpe N. (2006), "Interest rate and stock market returns", *The African Finance Journal*, 8(2), 12-30.

Akbas Y. (2013), "The analysis of the relationship between the rate of stock return and interest rate with nonlinear methods: The case of Turkey", *Business and Economics Research Journal*, 4(3), 21-40.

Anderson T., Bollerslev T., Diebold F. and Vega C. (2007), "Real-time price discovery in global stock, bond, and foreign exchange markets", *Journal of International Economics*, 73, 251-277.

Arango L., Gonzalez A and Posada C. (2002), "Returns and interest rate: A nonlinear relationship in the Bogota stock market", *Applied Financial Economics*, 12(11), 835-842.

Aron J. and Meullbauer J. (2007), "Review of monetary policy in South Africa since 1994". *African Journal of Economies*, 19(5), 705-744.

Aziakpono M., Wilson M. and Manuel J. (2007), "Adjustment of commercial bank's interest rates and the effectiveness of monetary policy in South Africa", *The African Finance Journal*, 9(1), 1-20.

Ballester L., Ferrer R. and Gonzalez C. (2011), "Linear and nonlinear interest rate sensitivity of Spanish banks", *Spanish Review of Financial Economics*, 9, 35-48.

Basistha A. and Kurov A. (2008), "Macroeconomic cycles and the stock market's reaction to monetary policy", *Journal of Banking and Finance*, 32(12), 2606-2616.

Becker R., Osborn D. and Yildirim D. (2012), "A threshold cointegration analysis of interest rate pass-through to UK mortgage rates", *Economic Modelling*, 29, 2504-2513.

Bernanke B. and Kuttner K. (2005), "What explains stock market's reaction to Federal Reserve policy?", *The Journal of Finance*, 60(3), 1221-1257.

Bui T. (2015), "Asymmetric effect of monetary policy on stock market volatility in ASEAN5", *Eurasian Journal of Business and Economics*, 8(15), 185-197.

Burke S. and Hunter J. (2005), "*Modelling non-stationary economic time series: A multivariate approach*", Palgrave, Basingstoke.

Chen S. (2007), "Does monetary policy have asymmetric effects on stock returns?", *Journal of Money, Credit and Banking*, 39, 667-688.

Chulia-Soler H., Martens M. and Dijk D. (2010), "Asymmetric effects of federal funds target rate changes on S&P stock returns, volatilities and correlations", *Journal of Banking and Finance*, 34(4), 834-839.

Das A. (2005), "Do stock prices and interest rates possess a common trend?", *Recherches economiques de Louvain*, 71, 383-390.

Dube S. and Zhou Y. (2013), "South Africa's short and long term interest rates: A threshold coitnegration analysis", *Business and Economic Research*, 3(1), 187-211.

Elliot G., Rothenburg T. and Stock J. (1996), "Efficient tests for an autoregressive time series with a unit root", *Econometrica*, 64, 813-836/

Enders W. and Silkos P. (2001), "Cointegration and threshold adjustment", *Journal of Business and Economic Statistics*, 19(2), 166-176.

Engle, R. and Granger, C. (1987) "Co-integration and error correction: Representation, estimation, and testing" *Econometrica*, 55, 369-384.

Fadiran G. and Edun A. (2013), "An overview of the repo rate in an inflation targeting economy", *African Development Review*, 25(4), 621-635.

Faff R., Hodgson A. and Kremmer M. (2005), "An investigation of the impact of interest rates and interest rate volatility on Australian financial sector stock return distributions", *Journal of Business Finance and Accounting*, 32, 1001-1032.

Farka M. (2009), "The effect of monetary policy shocks on stock prices accounting for endogeneity and omitted variable biases", *Review of Financial Economics*, 18(1), 47-55.

Geyser J. and Lowies G. (2001), "The impact of inflation on stock prices in two SADC countries", *Meditari Accountancy Research*, 9(1), 109-122.

Guo H. (2004), "Stock prices, firm size, and changes in the federal funds rate target", *The Quarterly Review of Economics and Finance*, 44(4), 487-507.

Han G., Wu. Y. and Young W. (2014), "Asymmetric effects of monetary policy on an emerging stock market", *International Journal of Monetary Economics and Finance*, 7(3), pages.

Hansen B. (1999), "Testing for linearity", *Journal of Economic Surveys*, 13(5), 551-576.

Hatemi-J A. and Roca E. (2008), "Estimating Bank's equity duration: A panel cointegration approach", *Applied Financial Economics*, 18, 1173-1180.

Henry O. (2009), "Regime switching in the relationship between equity returns and short-term interest rates in the UK", *Journal of Banking and Finance*, 33(2), 405-414.

Hess D., Huang H. and Nissen A. (2008), "How do commodities futures respond to macroeconomic news?", *Financial Markets and Portfolio Management*, 22(2), 127-146.

Iyke B. (2015), "On the term structure of South African interest rates: Cointegration and threshold adjustment", ERSA Working Paper No. 557, October.

Jansen D. and Tsai C. (2010), "Monetary policy and stock returns: Financing constraints and asymmetries in bull and bear markets", *Journal of Empirical Finance*, 17, 981-990.

Johansen S. (1991), "Estimation and hypothesis testing of cointegration vectors in Gaussian vector autoregressive models", *Econometrica*, 59(6), 1551-1580.

Kandel S. and Stambaugh R. (1990), "Expectations and volatility of consumption and asset returns", *Review of Financial Studies*, 3, 207-232.

Kasai N. and Naraidoo R. (2012), "Financial assets, linear and nonlinear policy rules: An in-sample assessment of the reaction function of the South African Reserve Bank", *Journal of Economic Studies*, 39(2), 161-177.

Kasman S., Vardar G. and Tunc G. (2011), "The impact of interest rate and exchange rate volatility on bank's stock returns and volatility: Evidence from Turkey", *Economic Modelling*, 28, 1328-1334.

Keim D.and Stambaugh R. (1986), "Predicting returns in the stock and bond markets", *Journal of Financial Economics*, 7, 357-390.

Konrad E. (2009), "The impact of monetary policy surprises on asset return volatility: The case of Germany", *Financial management and Portfolio Management*, 23(2), 111-135.

Kurov A. (2010), "Investor sentiment and the stock market's reaction to monetary policy", *Journal of Banking and Finance*, 34, 139-149.

Laopodis N. (2010), "Dynamic linkages between monetary policy and the stock market", *Review of Quantitative Finance and Accounting*, 35(3), 271-293.

Laopodis N. (2013), "Monetary policy and stock market dynamics across monetary regimes", *Journal of International Money and Finance,* 35(3), 271-293.

Li J. (2015), "The asymmetric effects of investor sentiments and monetary on stock prices", *Applied Economics*, 47(24), 2514-2522.

Li Y., Iscan T. and Xu K. (2010), "The impact of monetary policy shocks on stock prices: Evidence from Canada and the United States", *Journal of International Money and Finance*, 29(5), 876-896.

Lobo B. (2002), "Interest rate surprises and stock prices", *Financial Review*, 37(1), 73-91.

Maki D. (2005), "Asymmetric adjustment of the equilibrium relationship between the nominal interest rate and inflation", *Economics Bulletin*, 3(9), 1-8.

Matemilola B., Bany-Ariffin A. and Muhtar F. (2015), "The impact of monetary policy on bank lending activity in South Africa", *Borsa Istanbul Review*, 15(1), 52-59.

Moya-Martinez P., Ferrer-Lapen R. and Escribano-Sotos F. (2015), "Interest rate changes and stock returns in Spain: A wavelet analysis", *Business Research Quarterly*, 18, 95-110.

Naraidoo R. and Gupta R. (2007), "Modeling monetary policy in South Africa: Focus on inflation targeting era using a simple learning rule", *International Business and Economics Research Journal*, 9(12), 89-98.

Nyasha S. and Odhiambo N. (2015), "The impact of banks and stock market development on economic growth n South Africa", *Contemporary Economics*, 9(1), 93-108.

Patelis A. (1997), "Stock returns predictability and the role of monetary policy", *The Journal of Finance*, 52(5), 1951-1972.

Perez-Quiros G.and Timmermann A. (2000), "Firm size and cyclical variations in stock returns", *The Journal of Finance*, 55(3), 1229-1262.

Phiri A. (2016), "Examining asymmetric effects in the South African Phillips curve: Evidence from a logistic smooth transition regression models", *International Journal of Sustainable Economy*, 8(1), 18-42.

Pirovano M. (2012), "Monetary policy and stock prices in small open economies: Empirical evidence for new EU member states", *Economic Systems*, 36(3), 372-390.

Ravn S. (2014), "Asymmetric monetary policy towards the stock market: A DSGE approach", *Journal of Macroeconomics*, 39(a), 24-41.

Sheng-Yeh W., Guan-Ru C. and Wu M. (2014), "A nonlinear relationship between stock prices and interest rates: Evidences for G-8 countries", *Global Business and Economics Research Journal*, 3(11), 1-17.

Thorbecke W. (1997), "On stock market returns and monetary policy", *The Journal of Finance*, 52(2), 635-654.

Vahamaa S. and Aijo J. (2011), "The fed's policy decisions and implied volatility", *Journal of Futures Markets*, 31(10), 995-1010.

Van der Merwe E. (2004), "Inflation targeting in South Africa", *Occasional Paper No. 19*, July. South African Reserve Bank (SARB): Pretoria.

Yartley C. (2008), "The determinants of stock market development in emerging economies: Is South Africa different?", IMF Working Paper No. 2008-32, February.

Zare R., Azali M. and Habibullah M. (2013), "Monetary policy and stock market volatility in the ASEAN5: Asymmetries over bull and bear markets", *Procedia Economics and Finance*, 7, 18-27.