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Did the global financial crisis alter equilibrium adjustment dynamics between the US federal fund fund rates and stock price volatility in the SSA region?

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Abstract

In this paper we use the recently introduced MTAR model to examine whether equilibrium adjustment dynamics between the US federal fund rates and stock market volatility in 5 SSA countries have changed from periods before the globally financial crisis (1999-2007) to periods after the crisis (2009-2015). We find that this relationship existed for all 5 SSA exchange before the crisis and yet for only 3 SSA exchanges after the crisis. In particular, there exists a negative co-relationship between the federal fund rates and stock market volatility before the crisis and this relationship generally turns positive in periods subsequent to the crisis. Moreover, causality is found to run from stock market volatility to the US federal fund rates in both sample periods.

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1 Introduction

The recent global financial crisis of 2007 to 2008 caused by a crash of the financial system of the US, has been dubbed as the worst global financial crisis since the Great Depression. Since then, US monetary authorities have engaged in a 'quantitative easing' monetary policy which entails that the Federal Reserve of the United States buys financial assets and bonds from the banking sector as means of lowering the yields of these assets and hence lowering the federal funds interest rates to it's targeted 'zero lower bound' level. The resulting large injection of money from the Federal Reserve to the banking system has caused the fall of the effective federal fund rate from 5.3 percent in 2007 to a constant rate of 0.09 percent between 2012 and 2014. Currently, it is believed that the US is in it's final phase of it's three-stage quantitative easing policy programme and it is also expected that the Fed's will begin hiking up their interest rates as a means of phasing in partial contractionary monetary policy. It is thus important that policymakers worldwide understand the relationship between US policy conduct and international stock market development, especially in growing or emerging markets.

Following the global financial crisis, researchers have paid much attention to movements of the US federal fund rates and the impact it has on stock market volatility. Many studies show that the US federal fund rates are negatively related with stock market volatility especially if changes in the Federal fund rates come immediately after a 'surprise' announcement (Lobo (2002), Bernanke and Kuttner (2005) and Chulia-Soler et al. (2010)). Other studies show that stock markets respond differently to changes in Federal Reserve policy depending on whether the stock market is experiencing a bull or bear phase in the market (Jansen and Tsai (2010) and Ravn (2014)). There is also another cluster of studies showing that the stock market adjusts different depending on whether the macroeconomy is in an expansionary or contractionary phase of the business cycle (Anderson et al. (2007) and Vahamaa and Aijo (2011)). Notably, most of this empirical literature has been conducted for industrialized economies and very few studies have been done for emerging and developing countries, and in particular sub-Saharan African (SSA) countries.

In our study, we contribute to the literature by examining equilibrium adjustment movement between the US Federal fund rates and stock market volatility in 5 SSA countries, namely; South Africa, Nigeria, Egypt, Morocco and Mauritius. To this end, we use the momentum threshold autoregressive (MTAR) model of Enders and Siklos (2001) which allows for the modelling of asymmetric cointegration and error correction effects. Conveniently, the MTAR model allows the researcher to distinguish between the equilibrium adjustment dynamics depending on whether shocks induced by monetary policy produce positive or negative deviations from the steady state equilibrium. As a consequence, we are able to ascertain the policy implications of future increases of the US Federal fund rate on stock market volatility in SSA countries.

The paper is organized as follows. Section 2 presents the empirical framework while section 3 discuss data and empirical analysis. Section 4 concludes and offers policy implications.

2 Empirical framework

In order to investigate equilibrium adjustment effects between the US federal fund rates and stock market volatility in SSA countries we will rely on a two-stage cointegration procedure as put forth by Engle and Granger (1987). In the first stage of this process, we apply the Zivot and Andrews (1992) unit root tests with a structural break to the time series in order to determine the integration properties of the variables. If the time series are found to be difference stationary (i.e. integrated of order I(1)), then we can assume that there is at least one long-run cointegration vector between the variables, which can ultimately be captured through an error correction model. As previously mentioned, our study deviates from the norm of a linear cointegration analysis and focuses on modelling threshold cointegration effects between US federal fund rates (i.e. $feds_t$) and stock market volatility (i.e. smv_t). In light of this, the second stage of the cointegration procedure involves estimating the following long-run cointegration regression by OLS:

$$smv_t = \psi_1 + \psi_2 feds_t + \mu_t \quad (1)$$

where μ_t is the long-run equilibrium error term. Enders and Siklos (2001) propose that the error correction term, μ_t, be modelled as the following threshold process:

$$\mu_t = \rho_1 I_t \mu_{t-1} + \rho_2 (1 - I_t)\mu_{t-1} + \varepsilon_t \quad (2)$$

with I_t being a Heaviside indicator function which can assume the following functional forms:

$$I_t = \begin{cases} 1 \; if \; \mu_{t-1} \geq \tau \\ 0 \; if \; \mu_{t-1} < \tau \end{cases} \qquad I_t = \begin{cases} 1 \; if \; \Delta\mu_{t-1} \geq \tau \\ 0 \; if \; \Delta\mu_{t-1} < \tau \end{cases} \qquad (3)$$

From equation (3), the former indicator function is representative of a threshold autoregressive (TAR) specification and the later indicator function represents a momentum threshold autoregressive (MTAR) specification. The threshold value, τ, which dictates regime switching behaviour is unknown and it estimated using the minimization criteria described in Hansen (19999). Furthermore, Enders and Siklos (2001) propose a two-stage testing procedure for threshold cointegration effects. Firstly, the authors suggest testing the null hypothesis of no cointegration effects (i.e. H_{10}: $\rho_1 = \rho_2 = 0$) against the alternative of cointegration effects (i.e. H_{11}: $\rho_1 \neq \rho_2 \neq 0$). Secondly, the authors suggest testing the null of linear cointegration effects (i.e. H_{20}: $\rho_1 = \rho_2$) against the alternative of threshold cointegration effects (i.e. H_{21}: $\rho_1 \neq \rho_2$). The standard F-test is used to test these hypotheses and the critical values for these tests are tabulated in Enders and Siklos (2001). Once threshold cointegration is confirmed, then short-and-long run dynamics can be captured via the following pair of threshold error correction (TEC) models:

$$\Delta smv_t = \alpha + \gamma_{11} Z_t^- + \gamma_{12} Z_t^+ + \sum_{i=1}^{k} \phi_{1i} \, \Delta smv_{t-i} + \sum_{i=1}^{k} \beta_{1i} \, \Delta feds_{t-i} + e_t \qquad (4)$$

$$\Delta feds_t = \alpha + \gamma_{21} Z_t^- + \gamma_{22} Z_t^+ + \sum_{i=1}^{k} \phi_{2i} \, \Delta smv_{t-i} + \sum_{i=1}^{k} \beta_{2i} \, \Delta feds_{t-i} + e_t \qquad (5)$$

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 (4) and (5), the null hypothesis of no threshold error correction effects can be tested as H_{30}: $\gamma_{1i} Z_t^- = \gamma_{1i} Z_t^+$ against the alternative of threshold cointegration effects i.e. H_{31}: $\gamma_{1i} Z_t^- \neq \gamma_{1i} Z_t^+$. Furthermore, causality tests can be performed as follows. The null hypothesis of stock market volatility not leading the Federal fund rate is tested as H_{40}: $\phi_i = 0$ whereas the null hypothesis of Federal fund rates not causing stock market volatility is tested as H_{50}: $\beta_i = 0$.

3 Data and empirical results

3.1 Data description

In conducting our empirical study, we use the effective federal funds rate and the volatility of stock price index for South Africa, Nigeria, Egypt, Morocco and Mauritius. This data has been collected from Federal Reserve Economic Data (FRED) online database between the periods of 1999 to 2015. Since the data on stock market volatility is available in annual figures, we use a cubic spline interpolation method to transform this data into monthly data and match it against monthly data of the US Fed fund rates. The empirical data is further broken into two sub-sets of data corresponding to the pre-crisis period (i.e. 1999:m1-2007:m6) and the post-crisis period (i.e. 2008:m9-2015:m11) and we thereafter perform our empirical analysis on these two sub-sets of data.

3.2 Empirical results

As a preliminary step, we perform Zivot and Andrews (1992) unit root tests to the observed time series variables for the entire period and report the result in Table 1 below.

Table 1: Zivot and Andrews (1992) unit root tests

Variables	t-statistic	breakpoint (date)
$feds_t$	-2.54 (-5.46)***	2004:q3
smv_t (SA)	-3.38 (-6.61)***	2008:q3
smv_t (Nigeria)	-3.42 (-4.69)*	2009:q3
smv_t (Egypt)	-4.42 (-5.81)***	2008:q3
smv_t (Morocco)	-3.87 (-4.86)*	2008:q4
smv_t (Mauritius)	-3.84 (-4.93)	2007:q1

Notes: Significance codes: '***', '**', '*' denote 1 percent, 5 percent and 10 percent significance levels, respectively. Test statistics results on first differences reported in parentheses ().

From our results in Table 1, one can observe that all the time series, in their levels, cannot reject the null hypothesis of a unit root at all significance levels and only manage to do so in their first differences, thus rendering the time series as I(1) variables. Moreover, it can observed that the established breakpoints generally correspond with periods within the global financial crisis of 2007 to 2009. This result allows us to proceed to test for i) cointegration, ii) threshold cointegration and iii) threshold error correction effects between the time series. These tests are performed on TAR and MTAR model regression variants formed by different pairs of time series between US feds and stock market volatility for the SSA countries. The results of these threshold cointegration tests are given in Table 2.

Table 2: Tests for threshold cointegration and error correction effects

Country	Model	Pre-crisis (1999:m1-2007:m6)			Post-crisis (2009:m9-2015:m11)		
		H_{01}	H_{02}	H_{03}	H_{01}	H_{02}	H_{03}
South Africa	tar	7.68	14.76	0.73	3.70	3.73	4.81
		(0.00)***	(0.00)***	(0.40)	(0.04)*	(0.06)*	(0.04)**
	mtar	9.64	17.02	17.00	5.40	6.67	13.71
		(0.00)***	(0.00)***	(0.00)***	(0.01)*	(0.02)*	(0.00)***
Nigeria	tar	1.79	1.09	3.44	0.19	0.37	7.98
		(0.19)	(0.31)	(0.07)*	(0.83)	(0.55)	(0.01)**
	mtar	3.95	5.06	4.45	0.89	1.77	0.35
		(0.03)*	(0.03)*	(0.05)**	(0.43)	(0.20)	(0.56)
Egypt	tar	8.87	15.12	3.35	7.86	8.30	5.51
		(0.00)***	(0.00)***	(0.08)*	(0.00)***	(0.01)**	(0.03)**
	mtar	4.74	7.27	4.99	2.96	0.54	0.89
		(0.02)*	(0.01)*	(0.04)**	(0.07)*	(0.47)	(0.36)
Morocco	tar	7.84	3.54	3.11	1.00	1.57	0.54
		(0.00)**	(0.07)*	(0.09)*	(0.38)	(0.22)	(0.47)
	mtar	21.13	22.56	19.75	4.41	8.32	4.68
		(0.00)***	(0.00)***	(0.00)***	(0.03)*	(0.01)*	(0.04)**
Mauritius	tar	5.53	8.27	4.60	1.31	1.41	0.45
		(0.01)**	(0.01)**	(0.04)**	(0.29)	(0.25)	(0.51)
	mtar	2.54	4.01	22.50	0.93	0.69	0.44
		(0.09)*	(0.06)*	(0.00)***	(0.41)	(0.42)	(0.52)

Notes: Significance codes: '***', '**', '*' denote 1 percent, 5 percent and 10 percent significance levels, respectively.

For the pre-crisis period (1999:m1-2007:m6), we find significant threshold cointegration and error correction effects for all SSA countries. In particular, we find that the MTAR model is most suitable for modelling equilibrium adjustment effects for South Africa and Nigeria whereas both TAR and MTAR models can be used for the cases of Egypt, Morocco and Mauritius. For the post-crisis period (2008:m9-2015:m11), the results are less encouraging as significant equilibrium adjustment effects are only found for South Africa (both TAR and MTAR models), Egypt (TAR model) and Morocco (MTAR model). We therefore proceed to estimate the different TAR and MTAR models for the relevant data and we also perform causality tests within the estimated models. The estimation results for the TAR and MTAR models associated with the pre-crisis period are reported in Tables 3 and 4, respectively, whereas the results of the TAR and MTAR models for the post-crisis period is reported in Tables 5 and 6, respectively.

Table 3: Estimation of TAR models for the pre-crisis period (1999:m1-2007:m6)

	Egypt		Morocco		Mauritius	
	dependent variable					
	Δsmv_t	$\Delta feds_t$	Δsmv_t	$\Delta feds_t$	Δsmv_t	$\Delta feds_t$
τ	2.883		2.03			
ψ_1	26.54		11.90		8.46	
	(0.00)***		(0.00)***		(0.00)***	
ψ_2	-0.09		-0.17		-0.43	
	(0.84)		(0.53)		(0.01)**	
$\rho_1 \mu_{t-1}$	-0.56		-0.35		-0.38	
	(0.01)**		(0.00)***		(0.00)***	
$\rho_2 \mu_{t-1}$	-0.03		-0.09		-0.22	
	(0.88)		(0.43)		(0.19)	
$\gamma_{i1} Z_t^+$	-0.60	0.16	-0.38	0.03	-0.27	-0.20
	(0.00)***	(0.09)*	(0.00)***	(0.78)	(0.07)*	(0.35)
$\gamma_{i2} Z_t^-$	-0.12	0.01	-0.05	-0.11	-0.13	0.54
	(0.54)	(0.99)	(0.72)	(0.37)	(0.41)	(0.03)**
$\phi_i \Delta smv_t^+$	0.18	0.26	0.98	0.11	0.29	0.54
	(0.82)	(0.52)	(0.03)**	(0.77)	(0.60)	(0.51)
$\phi_i \Delta smv_t^-$	1.18	0.01	1.04	-0.07	0.97	-0.56
	(0.00)***	(0.95)	(0.00)***	(0.70)	(0.00)***	(0.10)*
$\beta_i \Delta fed_t^+$	-0.48	0.29	0.08	0.28	0.06	0.19
	(0.51)	(0.43)	(0.86)	(0.49)	(0.79)	(0.58)
$\beta_i \Delta fed_t^-$	-0.41	-0.23	0.02	-0.21	0.01	-0.26
	(0.56)	(0.52)	(0.97)	(0.57)	(0.99)	(0.44)
H_{40}: $\phi_i = 0$	13.44		28.71		1.36	
	(0.00)***		(0.00)***		(0.28)	
H_{50}: $\beta_i = 0$	0.61		0.02		0.36	
	(0.55)		(0.98)		(0.70)	
dw	2.29		2.23			

Notes: Significance codes: ‘***’, ‘**’, ‘’ denote 1 percent, 5percent and 10 percent significance levels, respectively. t-statistics reported in parentheses. dw denotes Durbin Watson test statistic for autocorrelation.

Table 4: Estimation of MTAR models for the pre-crisis period (1999:m1-2007:m6)

	South Africa		Nigeria		Egypt		Morocco		Mauritius	
	dependent variable									
	smv_t	$feds_t$	smv_t	$feds_t$	smv_t	$feds_t$	smv_t	$feds_t$	smv_t	$feds_t$
τ	-1.661		-1.987		1.072		1.067			
ψ_1	18.47		-19.93		26.54		11.90		8.46	
	(0.08)		(0.00)***		(0.00)***		(0.00)***		(0.00)***	
ψ_2	-0.81		-1.58		-0.09		-0.17		-0.43	
	(0.04)*		(0.00)***		(0.84)		(0.53)		(0.01)**	
$\rho_1 \mu_{t-1}$	-0.20		-0.18		-0.46		-0.57		-0.38	
	(0.08)*		(0.06)*		(0.01)**		(0.00)***		(0.00)***	
$\rho_2 \mu_{t-1}$	-0.02		-0.73		-0.05		-0.05		-0.22	
	(0.06)*		(0.08)*		(0.08)*		(0.47)		(0.19)	
$\gamma_{i1} Z_t^+$	-0.09	-0.09	-0.11	-0.04	-0.87	0.11	-0.60	-0.07	-1.02	-0.01
	(0.30)	(0.01)**	(0.08)*	(0.51)	(0.00)***	(0.41)	(0.00)***	(0.60)	(0.00)***	(0.99)
$\gamma_{i2} Z_t^-$	-0.01	0.30	0.01	0.59	-0.22	-0.15	-0.04	-0.01	-0.08	0.16
	(0.97)	(0.00)***	(0.99)	(0.04)*	(0.17)	(0.07)*	(0.63)	(0.89)	(0.28)	(0.34)
$\phi_i \Delta smv_t^+$	-0.81	0.48	-0.30	0.31	0.39	-0.20	0.98	0.10	0.53	0.08
	(0.27)	(0.25)	(0.47)	(0.13)*	(0.63)	(0.63)	(0.00)***	(0.80)	(0.17)	(0.92)
$\phi_i \Delta smv_t^-$	1.03	-0.57	0.27	-0.67	1.23	0.17	1.03	-0.03	1.06	-0.25
	(0.00)***	(0.00)***	(0.50)	(0.02)**	(0.00)***	(0.14)*	(0.00)***	(0.84)	(0.00)***	(0.48)
$\beta_i \Delta fed_t^+$	0.41	0.01	0.65	0.46	-0.01	0.33	0.30	0.39	0.26	0.32
	(0.41)	(0.97)	(0.01)***	(0.19)	(0.99)	(0.36)	(0.38)	(0.34)	(0.13)*	(0.40)
$\beta_i \Delta fed_t^-$	-0.28	-0.10	1.06	-0.49	-0.11	-0.34	0.04	-0.13	-0.05	-0.25
	(0.54)	(0.71)	(0.00)***	(0.17)	(0.87)	(0.32)	(0.89)	(0.73)	(0.77)	(0.50)
H_{40}: $\phi_i = 0$	5.49		3.44		4.99		47.42		42.72	
	(0.01)**		(0.00)***		(0.04)*		(0.00)***		(0.00)***	
H_{50}: $\beta_i = 0$	0.07		1.44		0.02		0.49		1.23	
	(0.66)		(0.68)		(0.98)		(0.62)		(0.31)	
dw	2.22		2.27		2.28		2.14		2.17	

Notes: Significance codes: ‘***’, ‘**’, ‘*’ denote 1 percent, 5percent and 10 percent significance levels, respectively. t-statistics reported in parentheses. dw denotes Durbin Watson test statistic for autocorrelation.

Table 5: Estimation of TAR models for the post-crisis period (2008:m9-2015:m11)

	South Africa		Egypt	
	dependent variable			
	smv_t	$feds_t$	smv_t	$feds_t$
τ	4.934		-3.387	
ψ_1	21.58		30.84	
	(0.00)***		(0.00)***	
ψ_2	0.31		-1.22	
	(0.66)		(0.02)*	
$\rho_1\ \mu_{t-1}$	-0.13		-0.14	
	(0.01)*		(0.09)*	
$\rho_2\ \mu_{t-1}$	0.02		-0.83	
	(0.70)		(0.01)**	
$\gamma_{i1}Z_t^-$	-0.22	0.03	-0.27	0.03
	(0.02)**	(0.53)	(0.03)**	(0.54)
$\gamma_{i2}Z_t^+$	0.02	-0.02	-0.81	-0.05
	(0.88)	(0.78)	(0.00)***	(0.63)
$\phi_i \Delta smv_t^+$	0.98	-0.22	1.11	-0.15
	(0.06)*	(0.41)	(0.00)***	(0.31)
$\phi_i \Delta smv_t^-$	0.38	-0.05	-0.08	0.19
	(0.35)	(0.83)	(0.90)	(0.51)
$\beta_i \Delta fed_t^+$	-6.91	0.48	0.11	2.37
	(0.56)	(0.94)	(0.99)	(0.72)
$\beta_i \Delta fed_t^-$	-1.08	0.06	-0.68	0.17
	(0.05)**	(0.83)	(0.23)	(0.52)
H_{40}: $\phi_i = 0$	11.11		16.99	
	(0.00)***		(0.00)***	
H_{50}: $\beta_i = 0$	2.92		0.83	
	(0.08)*		(0.46)	
dw	2.43		2.25	

Notes: Significance codes: '***', '**', '*' denote 1 percent, 5percent and 10 percent significance levels, respectively. t-statistics reported in parentheses. dw denotes Durbin Watson test statistic for autocorrelation.

Table 6: Estimation of MTAR models for the post-crisis period (2008:m9-2015:m11)

	South Africa		Morocco	
	dependent variable			
	Δsmv_t	$\Delta feds_t$	Δsmv_t	$\Delta feds_t$
τ	1.002			
ψ_1	21.58		13.08	
	(0.00)***		(0.00)***	
ψ_2	0.31		1.05	
	(0.66)		(0.00)***	
$\rho_1\ \mu_{t-1}$	-0.23		0.36	
	(0.00)***		(0.04)*	
$\rho_2\ \mu_{t-1}$	0.01		-0.19	
	(0.91)		(0.05)*	
$\gamma_{i1}Z_t^-$	-0.50	-3.19	0.14	0.33
	(0.00)***	(0.75)	(0.49)	(0.15)*
$\gamma_{i2}Z_t^+$	-1.10	-1.03	-0.26	0.19
	(0.10)*	(0.02)**	(0.00)***	(0.07)*
$\phi_i \Delta smv_t^+$	2.19	-0.66	1.31	-2.11
	(0.00)***	(0.02)**	(0.09)*	(0.02)**
$\phi_i \Delta smv_t^-$	0.28	-0.05	0.04	0.61
	(0.39)	(0.79)	(0.90)	(0.09)*
$\beta_i \Delta fed_t^+$	-3.19	-0.67	1.03	-1.16
	(0.75)	(0.90)	(0.84)	(0.84)
$\beta_i \Delta fed_t^-$	-1.03	0.01	0.09	0.35
	(0.02)**	(0.99)	(0.77)	(0.29)
H_{40}: $\phi_i = 0$	21.13		2.99	
	(0.00)***		(0.08)*	
H_{50}: $\beta_i = 0$	3.35		0.09	
	(0.06)*		(0.92)	
dw	2.25		2.09	

Notes: Significance codes: '***', '**', '*' denote 1 percent, 5percent and 10 percent significance levels, respectively. t-statistics reported in parentheses. dw denotes Durbin Watson test statistic for autocorrelation.

From Tables 3 and 4, it can be observed that there is a negative relationship between the Federal fund rates and stock market volatility for all 5 SSA countries in periods before the crisis. Our results also show that in periods before the crisis, positive deviations from the steady state equilibrium were eradicated quicker than negative deviations since for all estimated models $\rho_1 > \rho_2$. This also means that stock market volatility in the SSA exchanges reacted quicker to decreases in the Fed funds rate than increases. In turning to the results of our error correction models, we find at least one significant negative error correction term for each of the stock exchanges hence implying that equilibrium correcting behaviour among the time series over the long-run. We also observe that for all SSA stock exchanges, causality runs from the stock market volatility to the Federal Fund rate. This is not a surprising result since it is well known that the Feds follow developments in global stock exchanges and hence this may influence the setting of interest rates by the Feds. Furthermore, the finding of no causality from Federal fund rates to stock market volatility is not surprising since the Fed's announcements of interest rate movements are not 'surprise' announcements. A number of studies have shown that stock market's only react to changes in the federal rate if the change in interest rates is unanticipated or a 'surprise' announcement (Lobo (2002), Bernanke and Kuttner (2005) and Chulia-Soler et al. (2010)).

From Tables 5 and 6, we find a positive relationship between the federal fund rates and stock market volatility in South African and Moroccan stock exchange in periods following the global financial crisis. For this same period, we also find a negative relationship between the Feds rate and volatility in the Egyptian Stock Exchange (EGX). Our results also show that South African and Moroccan stock markets react quicker to negative deviations away from equilibrium i.e. $\rho_1 < \rho_2$, whilst positive deviations are eradicated quicker in the EGX i.e. $\rho_1 > \rho_2$. Concerning error correction adjustment, we once again find at least one significantly negative error correction term thus indicating equilibrium correcting behaviour among each pair of time series. Furthermore, causality is found to run from stock market volatility to the Feds rate for Egypt and Morocco whereas bi-directional causality between the time series exists for South Africa. The results show that the Fed's should monitor stock exchange developments in South Africa (Johannesburg Stock Exchange), Egypt (Egyptian Stock exchange) and Morocco (Casablanca Stock Exchange). This result is plausible since stock exchanges in these SSA countries may have global effects on the Fed's decisions through the cross-listing of international companies on these SSA exchanges.

4 Conclusions

This paper demonstrates that there has been a change in equilibrium adjustment dynamics between the federal fund rates and stock market volatility for periods before the global financial crisis (1999-2007) and for periods subsequent to the financial crisis (2008-2015). We generally find that all 5 SSA stock exchanges are co-related with the US federal fund rates before the crisis and yet only 3 stock exchanges (i.e. South Africa, Egypt and Morocco) are found to be cointegrated with the changes in the federal fund rate after the crisis. Furthermore, there is a negative relationship found between Feds rate and stock market volatility in SSA countries before the crisis. After the crisis this relationship turns positive for two stock exchanges (South Africa and Morocco). The Egyptian Stock market is the only exchange in the SSA region which maintained a negative relationship between stock market volatility and the federal fund rate before and after the crisis. A future rise in the federal fund rate would thus have a positive effect on the South African and Moroccan stock exchange volatility and adversely affect volatility in the Egyptian stock exchange. Volatility in the remaining stock exchanges (i.e. Nigeria and Mauritius) have no effects on the federal fund rates and will neither be affected by any future increases in the funds rate.

REFERENCES

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.

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

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.

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

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

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.

Hansen, B. (1999) "Threshold effects in non-dynamic panels: Estimation, testing and inference" *Journal of Econometrics* **93**, 345-68.

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

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

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

Zivot, E. and Andrews, D. (1992) “Further evidence on the Great crash, oil price shock and the unit root hypothesis” *Journal of Business and Economic Statistics* **10**, 251-270.