
Monetary policy, structural breaks and JSE returns

ABSTRACT

This study investigated the effects of monetary policy on JSE portfolios using a GARCH(1,1) framework. Results for the period 1990 - 2009 were compared with those based on four sub-periods. The analysis shows that discount rate changes are important in describing mean returns and return volatilities. The significance of these effects varies during different states of the economy; according to the definition of the market portfolio; and depending on whether or not the asymmetric effects of monetary policy changes are modelled. The effects of positive and negative policy changes are somewhat asymmetric on the JSE.

1. INTRODUCTION

Since the widely cited work of Chen, Roll and Ross (1986), many researchers have documented evidence that a range of macroeconomic variables can influence stock prices and returns. Reports by van Rensburg (1999, 2000) provide similar evidence using data from the JSE. Using reduced-form and recursive vector error correction (VEC) modelling, Mangani (2005) also established that monetary policy has explanatory power for JSE returns. This evidence is in line with the propositions of some asset price channels of the monetary policy transmission mechanism (see Tobin, 1969; Modigliani, 1971).

Although the VEC procedure can be useful in identifying potentially priced variables on the stock market, its individual parameter estimates are not of particular interest. In addition, most of the prior JSE studies did not account for the volatility of returns documented in Mangani (2008). In order to derive parameter estimates that measure the nature of the association between the stock market and macroeconomic variables while taking into account the evident non-linearities in returns, it is necessary to recast the analysis to a theory-based modelling framework whose parameter estimates yield meaningful interpretations. In this regard, Mangani (2009) found that monetary policy contains some predictive power for individual JSE stock returns and their volatilities within a generalised autoregressive conditional heteroscedasticity (GARCH) modelling framework. Apart from looking at the behaviour of individual stocks, the prior study did not account for structural breaks in the South African economy. Exploring the comparable overall behaviour of the stock market in response to changes in the stance of monetary policy over changing states of the South African economy appears worthwhile.

Using two proxies for the market portfolio, this paper augments the GARCH(1,1) model to examine the effects of monetary policy on the JSE. Specifically, the

paper investigates: (a) the contemporaneous effects of monetary policy on the JSE; (b) the possible asymmetric effects of news about monetary policy stance on JSE return dynamics; and (c) whether the effects in (a) and (b) change according to the state of the South African economy.

The next section recalls the theoretical framework for exploring the effects of monetary policy on the stock market, and reviews a selection of the literature. The methodologies used in the investigation are discussed in Section 3, while the results of the analysis are presented and discussed in Section 4. Section 5 presents a summary and a conclusion.

2. THEORETICAL FRAMEWORK AND THE LITERATURE

The present value formula of asset prices postulates that stock prices are inversely related to interest rates. Therefore, since stock prices may be predictable (see Lo & MacKinlay, 1999; Mangani, 2007), it is expected that contractionary monetary policy (such as a Bank rate increase) should induce a decline in stock prices and returns. This hypothesis is the basis of some asset price channels of the monetary policy transmission mechanism, notably Tobin's q-theory and Modigliani's wealth effect model (Tobin, 1969; Modigliani, 1971).

Tarhan (1993) argues that monetary policy shocks should affect both the mean returns and the volatility of such returns. Moreover, Gulley and Sultan (2003:199) assert that "if positive and negative changes (in monetary policy) are perceived to be conveying either a pessimistic or an optimistic outlook on the economy, then the market's reaction to the information flows should be asymmetric".

The published evidence on these issues is scanty for the South African market, and that from the international literature is equivocal. For instance, Jensen and Johnson (1993) and Gulley and Sultan (2003) documented an inverse relationship between stock prices and the discount rate, while expansionary monetary policy was noted to lower stock prices in Peace and Roley (1983) and in Hafer (1986). Kearney and Daly (1998) noted that the volatility of the stock market was determined by the volatilities of inflation

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and interest rates. Hafer (1986) further confirmed the presence of asymmetric effects of policy on stock prices, while Morgan (1993) found that policy had asymmetric effects on output growth hence, possibly, on asset prices as well. Moreover, Binswanger (2000) and Muradoglu and Metin (2001) argued that the effects of money and interest rates on stock returns tended to be time-sensitive, disappearing as the market became more mature. This paper contributes to this literature by examining closely the effects of South African monetary policy on JSE stock returns during the country's recent business cycles.

3. RESEARCH METHODOLOGY

3.1 Variables and data

Guided by the country's monetary policy framework (see Natrass, Wakeford & Muradzikwa, 2002; Aron & Muellbauer, 2007), this study considered the discount rate as an appropriate measure of the stance of monetary policy in South Africa, and a surrogate for a priced factor on the JSE. As already indicated, monetary policy can impact on both conditional mean returns as well as return volatilities.

Two stock portfolios were used to capture the behaviour of the market, namely the FTSE/JSE All Share index (ALSI), and a price-weighted portfolio consisting of fifty-nine randomly selected stocks, denoted PORT hereafter. PORT was constructed to account for any undue influences arising from resources stocks that dominate the value-weighted computation of the ALSI. The fifty-nine stocks used to construct PORT are shown in Appendix 1. The ALSI had a total of 165 constituents as at 5 May 2009 (Profile Media, 2009), and the sample captured 45,3 per cent of the ALSI free-float market capitalisation on that date. Table 1 shows that the distribution of the sample stocks across the industrial classification of the JSE was quite representative. Given this distribution, PORT was constructed as a price-weighted portfolio in order to make it technically distinct from the ALSI, and to provide an effectively different definition of the JSE market portfolio. Major world stock market indices that are price-weighted include the Dow Jones Industrial index and the Amex Major Market index.

Table 1: Sample distribution across JSE industrial classification

Industry	Number of Stocks		% of Stocks	
	ASLI	Sample	ALSI	Sample
Financials	48	13	29,1	22,0
Goods	12	3	7,3	5,1
Health	5	2	3,0	3,4
Industrials	33	15	20,0	25,4
Materials	33	15	20,0	25,4
Oil and gas	1	1	0,6	1,7
Services	25	8	15,2	13,6
Technology	4	1	2,4	1,7
Telecommunications	4	1	2,4	1,7
Total	165	59	100,0	100,0

The data used in the study were weekly closing prices of the individual stocks and the ALSI, as well as weekly observations of the discount rate. Closing prices of the individual stocks were used to generate the observations for PORT by taking simple price averages in each week, while adjusting for stock splits and dividends. The study period was from 7 January 1990 to 30 August 2009, hence capturing the implementation of the so-called classical cash reserve system as well as the repurchase agreement (repo) system of monetary policy in South Africa. Both systems explicitly employed the discount rate (i.e., the Bank rate for the former system and the repo rate for the later) as a policy instrument (see Natrass *et al.*, 2002). The repo system replaced the cash reserve system in March 1998, and was still operational at the time of this writing. All the data were from the Inet-Bridge online database. Since the FTSE/JSE All Share index was introduced in June 2002 to replace the old All Share index after the adoption of the FTSE global classification system, the data on the ALSI were spliced back to 1990 at source. Continuously compounded returns were computed as first differences of logarithmic prices. In this paper, therefore, the term 'returns' should be understood to mean continuously compounded returns.

It is sensible to suspect that the effects of the discount rate on the JSE were not uniform throughout the study period. In order to capture the possibility that these effects might vary according to the state of the macro economy, regression results based on the entire sample period were compared with those based on four sub-periods chosen to capture JSE dynamics in the context of South African business cycles and structural breaks. Figure 1 depicts the time paths of the ALSI and South African real gross domestic product (GDP) during the entire sample period. The GDP data, at constant 2005 prices, were from the online download facility of the South African Reserve Bank (SARB). Although the graphs show general upward trends that are in synchrony, the slopes of the trend curves vary with time. Du Plessis and Smit (2007) described this varying trend pattern in terms of South African macroeconomic developments. Using their parlance, growth in both the index and real output was slow during the so-called 'decade of decline' which ended in 1994. The country's lacklustre economic performance during this period resulted into dismal real economic growth rates that averaged 0,8 per cent per annum. This poor performance, whose beginning is usually traced back to 1981, was largely occasioned by well-documented political developments that culminated into the declaration of a State of Emergency in July 1985 and the entrenchment of majority rule in May 1994. For an extensive account of these developments, see van Rensburg (1999).

Both the ALSI and GDP curves picked up substantially in the period 1995 - 2004, although there was noticeable volatility on the stock market. During this

period, described by Du Plessis and Smit (2007) as a 'recovery period', real economic growth averaged 3,1 per cent per annum, a less than modest increase relative to the prior decade. This is because political stability arising from the end of Apartheid in 1994 and the adoption of sound economic policies created an atmosphere conducive to investment and growth (Rodrik, 2006). Further, until the onset of the global financial crisis in 2008, South Africa was experiencing a period of high real economic growth: annual real GDP growth between 2005 and 2007 averaged 5,1 per cent. This was largely due to increased domestic demand arising from high credit-financed consumer spending, public sector infrastructure investment and private sector fixed investment (Maia, 2007). This 'co-extensive recovery' experience could explain the persistent bullish market attributes depicted in the ALSI trend until 2007. However, the subsequent global recession distinctly disturbed this trend, such that real GDP only increased by an annualised quarterly average of 3,7 per cent in 2008, and declined by an annualised quarterly average of 1,8 per cent in the first three quarters of 2009 (based on data from <http://www.tradingeconomics.com> as at 5 February 2010). Figure 1 shows that the ALSI and output trends were adversely affected by the crisis.

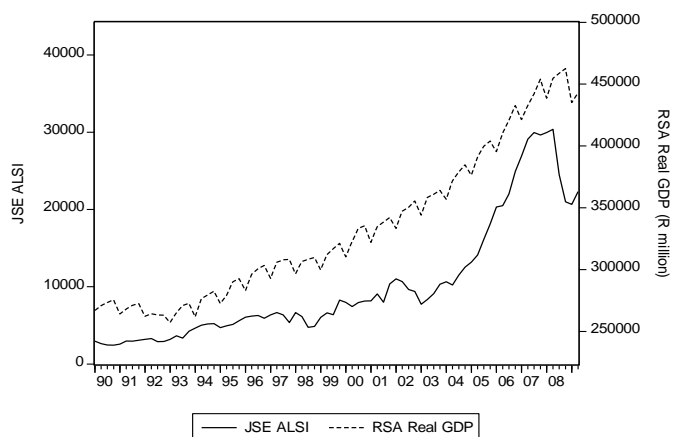


Figure 1: Trends in the JSE ALSI and real GDP: 1990 – 2009

This study analysed the macroeconomic effects during the entire study period, and during the following four sub-periods: January 1990 to December 1994; January 1995 to December 2004; January 2005 to December 2007, and January 2008 to August 2009.

3.2 Modelling framework

Mangani (2007, 2008) showed that JSE returns are non-normally and non-linearly distributed, and that the GARCH(1,1) model is a more suitable description of JSE returns than some of the complex alternatives in the ARCH class of models. Thus, extending the GARCH(1,1) process into dummy GARCH, exponential GARCH, or GARCH-in-mean formulations

to describe JSE dynamics is notably unrewarding. The modelling framework for this study was informed by these findings.

The models used in this investigation were single equation versions of the those proposed by Gulley and Sultan (2003), who used a multivariate GARCH(1,1) process to investigate the dynamic reactions of bond and stock market returns to changes in the Chicago Board of Trade (CBOT) 30-day federal funds futures rate. Thus, let R denote uncorrelated or linearly filtered returns computed for both the ALSI and PORT, where a first-order autoregression is used as a linear filter in the case of correlated returns. An examination of correlograms showed that ALSI returns were uncorrelated, while PORT returns could be modelled as an AR(1) process. Hence, the linear filter only applied to PORT returns. Furthermore, let $DRATE$ be the discount rate and t denote time. Using the standard augmented Dickey-Fuller and Phillip-Peron unit root testing procedures, this study established that R was clearly stationary in levels while $DRATE$ was an integrated process of the first order. As such, the first difference of $DRATE$ is denoted $DDRATE$ in the sequel. To capture the effects of the discount rate on the JSE without regard for the potential asymmetries in those effects, the GARCH(1,1) model was extended as follows (say, Model A):

$$R_t = \alpha_0 + \alpha_1 DDRATE + \mu_t, \quad \dots (1)$$

$$\mu_t | \Omega_{t-1} \sim N(0, h_t), \quad \dots (2)$$

$$h_t = \varphi_0 + \lambda_1 \mu_{t-1} + \theta_1 h_{t-1} + \varphi_1 DDRATE_t \quad \dots (3)$$

In Model A, α_i , φ_j , λ_1 and θ_1 are coefficients to be estimated ($i, j = 0, 1$), and all other terms assume the usual interpretations of the GARCH(1,1) model, where μ_{t-1} is the ARCH term and h_{t-1} is the GARCH term. Equation (1) is the conditional mean (expected) return expression, while Equation (3) gives an expression for the volatility of returns. Equation (2) gives the distribution of the error term, conditional upon the available information. In addition to confirming the presence of ARCH and GARCH effects by assessing the significance of λ_1 and θ_1 , this investigation tested for the significance of the α_1 and φ_1 coefficients. In particular, α_1 captures the effects of the discount rate on mean returns, while φ_1 measures similar effects on the volatilities of returns.

To examine the proposition of asymmetric monetary policy effects on JSE returns depending on how the market interprets news associated with changes in the stance of such policy, the discount rate changes were decomposed into two multiplicative categorical

variables, DPOS and DNEG. These were defined as follows:

$$DPOS_t = DDRATE_t \text{ if } DDRATE_t \geq 0; = 0 \text{ otherwise}$$

$$DNEG_t = DDRATE_t \text{ if } DDRATE_t < 0; = 0 \text{ otherwise}$$

Substituting the new variables for DDRATE in equations (1) and (3) yields the following model of asymmetric monetary policy effects on stock returns and their volatilities (say, Model B):

$$R_t = \alpha_0 + \eta_1 DPOS_t + \eta_2 DNEG_t + \mu_t, \quad \dots (4)$$

$$\mu_t | \Omega_{t-1} \sim N(0, h_t), \quad \dots (5)$$

$$h_t = \varphi_0 + \lambda_1 \mu_{t-1} + \theta_1 h_{t-1} + \phi_1 DPOS_t + \phi_2 DNEG_t \quad \dots (6)$$

In Model B, the effects of positive changes in the discount rate are measured by η_1 in the conditional mean return equation, and by ϕ_1 in the volatility equation. Similarly, the effects of negative changes in the discount rate are measured by η_2 in the mean equation, and by ϕ_2 in the volatility equation. Interest was particularly in testing the significance of these slope coefficients. Apart from an examination of the signs, magnitudes and significance of the relevant individual coefficients, Wald tests for possible equality between the coefficients of DPOS and DNEG were conducted where this was suspected. Note that the signs for the estimated values of η_2 , and ϕ_2 have to be reserved for usual interpretation, since they measure the effects of negative changes in the discount rate.

3.3 Estimation and diagnostic checking

The two models were estimated using the maximum likelihood (ML) technique since, even when the error terms are not normally distributed as assumed in expressions (2) and (5), the ML estimators remain consistent under quasi-maximum likelihood (QML) assumptions. To improve the convergence rate of the iterative optimization process, a Marquardt algorithm within the EViews 7.0 package was employed. Throughout, robust standard errors, z-statistics and probability values were generated following Bollerslev and Wooldridge (1992).

As a diagnostic check, the BDS test due to Brock *et al.* (1987) was applied on the standardised residuals from the augmented GARCH(1,1) models described above, to investigate whether the models could account for non-linearities in JSE returns. A bootstrapping procedure involving 1000 repetitions was used to compute probability values for the test statistics, in EViews 7.0. Values for the embedding dimension (m)

and the measure of closeness (l) were set at $m = 2, 3, 4$ and $l = 0, 5\sigma, 1, 0\sigma, 1, 5\sigma$, where σ was the standard deviation of these residuals. The results of this diagnostic check, which can be supplied upon request, buttressed the observation reported in Mangani (2008) that the GARCH(1,1) model accounts for the non-linearities in JSE returns.

4. RESULTS AND DISCUSSIONS

4.1 Macroeconomic effects on the JSE

The estimation results for Model A are reported in Table 2. For the ALSI, the ARCH and GARCH terms had significantly positive effects in the entire period and during two sub-periods (1995 – 2004 and 2005 – 2007). The coefficient of the GARCH term was only insignificant during 1990 - 1994, as was that of the ARCH term during the same period. But the ARCH term coefficient was also insignificant during 2008 – 2009. An almost similar pattern emerged with respect to PORT, save that the ARCH effect was only significant during the entire period and the sub-period 1995 – 2004. This evidence suggests that the JSE is more volatile during periods of economic recovery and robust growth than when the economy experiences a decline. Aside from this last observation, the JSE was generally volatile, and the GARCH(1,1) process was appropriate.

4.1.1 Monetary policy effects on the ALSI

With regard to the effects of monetary policy on mean ALSI returns, the results agreed with those documented by Gulley and Sultan (2003) for the US market: there was a consistent inverse relationship between expected returns and discount rate changes, which was statistically significant in four of the five cases under consideration. It was only during the period of economic decline that this relationship was not significant. The evidence does not support the assertion by Binswanger (2000) and Muradoglu and Metin (2001) that such effects tend to disappear as the market becomes more mature.

The results in Table 2 also show that the impact of the discount rate on ALSI return volatility was quite time-sensitive: it was significantly positive during the first and last sub-periods; significantly negative during 2005 – 2007; and insignificant when the entire study period was considered, as well as during 1995 – 2004. These results support the claim that monetary policy can yield varied effects on the stock market depending on the state of the economy: discount rate increases can be volatility-increasing during periods of economic distress and moderate growth, and volatility-dampening in times of robust growth. Understandably, these time-varying effects tended to cancel out when the entire study period was considered.

Table 2: Estimation results for Model A

	Estimates for ALSI by Period					Estimates for PORT by Period				
	1990-09	1990-94	1995-04	2005-07	2008-09	1990-09	1990-94	1995-04	2005-07	2008-09
$\hat{\alpha}_0$	0,003 (3,903)*	0,003 (1,86)*	0,002 (2,24)*	0,008 (13,72)*	-0,001 (-0,28)	0,002 (1,91)*	0,001 (0,73)	0,001 (0,56)	0,006 (3,33)*	0,002 (0,44)
$\hat{\alpha}_1$	-0,011 (-2,46)*	-0,001 (-0,41)	-0,011 (-1,97)*	-0,026 (-1,93)*	-0,031 (-7,76)*	-0,009 (-1,96)*	-0,004 (-0,86)	-0,009 (1,50)	-0,015 (-0,89)	-0,015 (-0,52)
$\hat{\phi}_0$	0,000 (2,46)*	0,001 (2,95)*	0,000 (1,41)	0,001 (239,2)*	0,000 (615,0)*	0,000 (1,24)	0,001 (3,08)*	0,000 (0,50)	0,000 (3,36)*	0,000 (203,0)*
$\hat{\lambda}_1$	0,113 (4,01)*	0,124 (1,24)	0,113 (2,76)*	0,091 (2,05)*	0,118 (1,29)	0,052 (3,10)*	0,052 (0,98)	0,056 (2,07)*	-0,032 (-0,46)	0,087 (1,15)
$\hat{\theta}_1$	0,852 (25,46)*	-0,162 (-0,49)	0,873 (23,36)*	-0,908 (-17,7)*	0,703 (6,96)*	0,933 (35,72)*	-0,049 (-0,17)	0,937 (22,87)*	1,037 (15,72)*	0,864 (11,78)*
$\hat{\phi}_1$	-0,000 (-0,48)	0,001 (10,80)*	-0,000 (-0,79)	-0,001 (-2,47)*	0,001 (1,66)*	0,000 (0,46)	0,001 (7,85)*	0,000 (0,04)	-0,000 (-0,79)	0,001 (1,65)*

Note: Model A is described by Equations (1) to (3). Figures in parentheses are p-values based on Bollerslev-Wooldridge robust z-statistics. * denotes significance at 10% or lower.

4.1.2 Monetary policy effects on PORT

In terms of the impact of monetary policy on mean returns as measured by PORT, the results were markedly different from those documented for the ALSI. The theoretical inverse relationship between returns and interest rates was only significant for the entire sample, but could not be confirmed in any of the sub-periods. This suggests that the impact of monetary policy on stock returns is sensitive to the definition of the market portfolio.

The observed effects of the discount rate change on PORT return volatility were comparable with those obtained when the ALSI was used, in the sense that a rate increase was volatility-increasing during times of economic distress (1990 – 1994; 2008 – 2009). However, contrary to the result found when ALSI was used, this positive relationship was non-existent during periods of good economic performance. As with the analysis based on the ALSI, these time-sensitive effects tended to cancel out over a longer period, such as the entire study period. Thus, in addition to being sensitive to the state of the economy, the effects of the discount rate on stock market volatility also depended on the definition of the market portfolio. The result that a discount rate increase would increase JSE volatility during recessions is not consistent with the theoretical expectation that the volatility of asset returns should decline under contractionary monetary policy, as in Tarhan (1993).

4.2 Asymmetric monetary policy effects on the JSE

The estimation results for Model B are presented in Table 3. For both the ALSI and PORT, parameter estimates for the ARCH and GARCH terms were significantly positive when the full sample period was considered, and during 1995 – 2004. GARCH effects alone were also significant for both portfolios during the period 2008 – 2009. As with the results for Model A above, and regardless of how the market portfolio was

defined, there was no evidence of volatility during 1990 – 1994. Additionally, both market portfolios showed no volatility during 2005 – 2007, a period during which Model A provided evidence of volatility. This suggests that Model A displayed more volatility than Model B. Overall, the general conclusion that the JSE was volatile remained valid even when the separate effects of positive and negative monetary policy changes were investigated.

4.2.1 Asymmetric monetary policy effects on ALSI

In terms of the effects of the discount rate decomposition on expected ALSI returns, DPOS coefficients maintained the hypothesised negative sign and yielded significant impacts during most of the estimation periods (except 2008 – 2009). This is analogous with the results for Model A and those documented by Gulley and Sultan (2003). However, although one significantly positive DNEG coefficient was realised (as suggested by the theory), the remaining four DNEG coefficients were negative, but only one of them was significantly so. This observation supports the hypothesis of asymmetric DDRATE effects on ALSI returns: the effects were asymmetric during all the estimation periods except 2005 - 2007. A Wald test for the null hypothesis that $\eta_1 = -\eta_2$ during the co-extensive recovery period yielded a probability value of 0,36, hence the effects were of equal magnitude in absolute value terms. Otherwise, the effects were clearly asymmetric during the first three estimation periods in Table 3, since the DNEG effects were not significant when those of DPOS were actually significant. Moreover, during 2008 – 2009, this order of significance was reversed, suggesting further asymmetric effects. The finding that JSE returns were largely more responsive to positive discount rate changes than to negative changes agrees with the proposition that the market can interpret such changes differently (Gulley and Sultan, 2003).

Table 3: Estimation results for Model B

	Estimates for ALSI by Period					Estimates for PORT by Period				
	1990-09	1990-94	1995-04	2005-07	2008-09	1990-09	1990-94	1995-04	2005-07	2008-09
$\hat{\alpha}_0$	0,003 (3,90)*	0,002 (1,36)	0,002 (2,28)*	0,007 (3,54)*	-0,001 (-0,36)	0,002 (1,91)*	0,001 (0,60)	0,001 (0,66)	0,001 (2,81)*	-0,003 (-0,86)
$\hat{\eta}_1$	-0,014 (-2,59)*	-0,015 (-8,37)*	-0,013 (-2,21)*	-0,043 (-1,94)*	-0,012 (-0,48)	-0,009 (-1,43)	-0,003 (-0,00)	-0,008 (-1,23)	-0,035 (-1,75)*	0,025 (0,59)
$\hat{\eta}_2$	-0,008 (-1,42)	-0,005 (-1,61)	-0,007 (-0,88)	0,051 (12,50)*	-0,020 (-3,89)*	-0,009 (-1,60)	-0,008 (-0,96)	-0,010 (-1,13)	0,043 (9,34)*	-0,033 (-7,96)*
$\hat{\phi}_0$	0,000 (2,36)*	0,000 (2,14)*	0,000 (1,76)*	0,000 (1,39)	0,000 (2,23)*	0,000 (1,29)	0,000 (1,06)	0,000 (0,73)	0,000 (1,39)	0,000 (179,2)*
$\hat{\lambda}_1$	0,106 (3,98)*	-0,038 (-1,23)	0,092 (3,06)*	-0,047 (-1,47)	0,081 (0,91)	0,052 (3,17)*	-0,015 (-0,31)	0,054 (2,65)*	-0,041 (-1,08)	0,098 (1,19)
$\hat{\theta}_1$	0,843 (20,28)*	0,453 (1,63)	0,857 (18,50)*	0,472 (1,10)	0,847 (7,98)*	0,926 (29,56)*	0,466 (0,88)	0,920 (19,93)*	0,478 (1,17)	0,688 (7,00)*
$\hat{\phi}_1$	0,000 (0,41)	-0,007 (-0,03)	-0,000 (-0,10)	-0,000 (-0,07)	-0,002 (-2,42)*	0,000 (0,87)	-0,001 (-0,11)	0,000 (0,68)	-0,000 (-0,63)	-0,002 (-2,32)*
$\hat{\phi}_2$	-0,000 (-1,06)	0,001 (8,82)*	-0,000 (-1,43)	0,001 (0,00)	0,001 (4,20)*	-0,000 (-0,42)	0,001 (3,31)*	-0,000 (-0,74)	0,002 (0,02)	0,001 (2,14)*

Note: Model B is described by Equations (4) to (6). Figures in parentheses are p-values based on Bollerslev-Wooldridge robust z-statistics. * denotes significance at 10% or lower.

The effects of monetary policy on ALSI return volatility were weaker in Model B than they were in Model A. The decomposed discount rate changes were only significant in explaining ALSI return volatility during two estimation periods (i.e., the troubled periods of sluggish economic growth and a global financial crisis), confirming the observation that the effects were susceptible to economic conditions. In both of these periods, the effects were asymmetric but intuitively consistent with each other: a positive discount rate change was volatility-dampening (at least during the period of the financial crisis), while a negative change tended to step up volatility. In other words, expansionary monetary policy would increase the riskiness of the JSE as measured by the ALSI, while contractionary policy would have the converse effect. This observation is in line with the conventional expectation regarding the effect of monetary policy changes on the stock market. The fact that these effects were scarcely significant implies that, in general, the separate influences of positive and negative policy changes did not strongly impact on the volatility of ALSI returns.

4.2.2 Asymmetric monetary policy effects on PORT

The impacts of the decomposed DDRATE variables on mean PORT returns had some semblance with those presented for the ALSI. In particular, DPOS also yielded the hypothesised negative effect in four of the five cases, but only one of these effects was significant (compared with four for ALSI). However, the effects of DNEG on PORT were completely identical with those for the ALSI.

The evidence suggests that monetary policy did not have strong effects on the volatility of JSE returns, even when PORT was used. The effects of the decomposed DDRATE variables on PORT return volatility exactly replicated those reported for the ALSI: statistically significant and theoretically consistent

asymmetric effects were only observed during the 1990 – 1994 and 2008 – 2009 estimation periods. Thus, the weak effects of the discount rate decomposition on mean returns were not a construct of the definition of the market portfolio in this context.

5. SUMMARY AND CONCLUSION

Building on the observation that the discount rate (hence monetary policy) has predictive power for the stock market, and can explain the returns and return volatilities of individual stocks (Mangani, 2005; 2009), these interrelationships were investigated for two stock portfolios within a theoretic modelling framework by extending the GARCH(1,1) process proposed for the Johannesburg Stock Exchange (JSE) in Mangani (2008). Weekly data from January 1990 to August 2009 were used in the study. Since the effects of the discount rate may be sensitive to South African macroeconomic business cycles and structural breaks, results based on the entire study period were compared with those based on four sub-periods, namely: 1990 – 1994, 1995 – 2004, 2005 – 2007 and 2008 – 2009. In the literature, the first three sub-periods are respectively described as part of the 'decade of decline'; the 'recovery period', and the 'co-extensive recovery period' of South African business cycles (Du Plessis & Smit, 2007). The last sub-period was added to reflect a global financial crisis.

The investigation was conducted using the JSE All Share index (ALSI) and a price-weighted portfolio of fifty-nine randomly selected stocks (denoted PORT). Diagnostic tests showed that, after the inclusion of the discount rate or its decomposition, the ARCH and GARCH terms in the models used remained significant during the entire period as well as during some of the sub-periods. The market is, however, evidently not volatile when the country's economic performance is lacklustre. The augmented GARCH(1,1) models could

also account for stochastic non-linearities in JSE returns.

Apart from investigating the effects of monetary policy changes on conditional mean returns and return volatilities *per se*, the study also investigated the possibility that news about such changes had asymmetric effects on the JSE. This was accomplished by decomposing the discount rate into multiplicative categorical variables reflective of positive and negative changes. Several specific observations and conclusions were made from the analysis, as follows:

Firstly, when possible asymmetric effects of changes in the discount rate were ignored, the evidence showed that the hypothesised inverse relationship between interest rates and stock prices prevailed on the JSE. But this relationship was by far more significant when the performance of the market was measured using the ALSI rather than PORT. Hence, the effects of monetary policy are sensitive to the definition of the market portfolio. There was no support for the assertion that these effects tend to disappear as the market becomes more mature, as argued by Binswanger (2000) and Muradoglu and Metin (2001).

The second observation made was that the effects of monetary policy on stock returns were only partially consistent with the theory when possible asymmetric effects of discount rate changes were taken into account. Contractionary monetary policy tended to lower stock returns as expected. This effect was, once again, mostly significant for the ALSI but hardly so for PORT. However, expansionary policy also tended to lower returns in some periods, such as during the financial crisis. In general, these effects were noted to be asymmetric in most periods. The significant effects of negative discount rate changes occurred much less frequently than those of positive changes, suggesting that JSE returns are more responsive to contractionary monetary policy than to expansionary policy. This is in agreement with the assertion that the reaction of the market to monetary policy is asymmetric, as suggested by Gulley and Sultan (2003). The evidence further suggests that the definition of the market portfolio is crucial in gauging these effects.

Third, the effects of discount rate changes on stock return volatilities appeared to be dependent on the state of the economy: a discount rate increase could be volatility-increasing during periods of sluggish or moderate economic growth and volatility-dampening when the rate of economic growth was high. This finding was more pronounced for the model without asymmetric effects - and when the ALSI was used - than otherwise. The time-sensitive effects on stock market volatilities tended to cancel out over a long period, and completely disappeared when the entire study period was considered. The finding that contractionary monetary policy tends to increase the

volatility of the market is in conflict with the theoretical proposition by Tarhan (1993).

In a nutshell, the evidence suggests that a JSE stock portfolio that is constructed to mimic the value-weighted ALSI is more likely to be influenced by changes in the stance of monetary policy than a price-weighted portfolio whose construction is significantly different to that of the ALSI.

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Appendix 1: Stocks used to construct PORT

#	JSE Code	Company Name	Weight (%)	#	JSE Code	Company Name	Weight (%)
1	ADR	Adcorp Holdings Ltd (I)	0,03	31	INP	Investec plc (F)	0,60
2	AFE	AECI Ltd (M)	0,19	32	IVT	Invicta Holdings Ltd (I)	0,02
3	AFX	African Oxygen Ltd (M)	0,10	33	JDG	J D Group Ltd (S)	0,20
4	AGL	Anglo American plc (M)	7,76	34	MDC	Medi-Clinic Corporation Ltd (H)	0,23
5	ALT	Allied Technologies Ltd (Tc)	0,10	35	MET	Metropolitan Holdings Ltd (F)	0,20
6	AMS	Anglo Platinum Ltd (M)	1,64	36	MPC	Mr Price Group Ltd (S)	0,22
7	ANG	Anglogold Ashanti Ltd (M)	4,38	37	MTA	Matair Investment Ltd (G)	0,02
8	APN	Aspen Pharmacare Holdings Ltd (H)	0,59	38	MUR	Murray and Roberts Holdings Ltd (I)	0,49
9	ATN	Allied Electronics Corp Ltd (I)	0,03	39	NED	Nedbank Group Ltd (F)	0,72
10	BAT	Brait SA (F)	0,04	40	NHM	Northam Platinum Ltd (M)	0,13
11	BSR	Basil Real Holdings Ltd (I)	0,03	41	NPK	Nampak Ltd (I)	0,30
12	BVT	The Bidvest Group Ltd (I)	1,06	42	OCE	Oceana Group Ltd (G)	0,04
		Caxton & CTP Publishers & Printers Ltd (S)	0,09				0,08
13	CAT			43	OMN	Omnia Holdings Ltd (M)	
14	CPL	Capital Property Fund Ltd (F)	0,13	44	PAM	Palabora Mining Company Ltd (M)	0,03
15	CSB	Cashbuild Ltd (S)	0,06	45	PAP	Pangbourne Properties Ltd (F)	0,22
		Distribution & Warehousing Network Ltd (I)	0,04				0,27
16	DAW			46	PIK	Pik n Pay Stores Ltd (S)	
17	DDT	Dimension Data Holdings Ltd (Te)	0,34	47	PPC	Pretoria Portland Cement Co Ltd (I)	0,67
18	DRD	DRD Gold Ltd (M)	0,11	48	RBW	Rainbow Chicken Ltd (G)	0,08
19	FOS	Foschini Ltd (S)	0,38	49	RLO	Reunert Ltd (I)	0,26
20	FPT	Fountainhead Property Trust (F)	0,20	50	SAP	Sappi Ltd (M)	0,35
21	FSR	Firstrand Ltd (F)	1,84	51	SBK	Standard Bank Group Ltd (F)	4,39
22	GFI	Gold Fields Ltd (M)	2,46	52	SFN	Sasfin Holdings Ltd (I)	0,01
23	GND	Grindrod Ltd (I)	0,16	53	SHP	Shoprite Holdings Ltd (S)	0,99
24	GRF	Group Five Ltd (I)	0,09	54	SIM	Simmer and Jack Mines Ltd (M)	0,08
25	HAR	Harmony Gold Mining Co Ltd (M)	1,54	55	SNT	Santam Ltd (F)	0,13
26	HDC	Hudaco Industries Ltd (I)	0,05	56	SOL	Sasol Ltd (O)	6,34
27	HVL	Highveld Steel & Vanadium Corp Ltd (M)	0,13	57	SUI	Sun International Ltd (S)	0,27
28	HYP	Hyprop Investments Ltd (F)	0,18	58	SYC	Sycum Property Fund (F)	0,10
29	IMP	Impala Platinum Holdings Ltd (M)	3,61	59	TRE	Trencor Ltd (I)	0,09
30	INL	Investec Ltd (F)	0,37			Total	45,26

Note: Letters in parentheses indicate the company industry (broad sector), as follows: F = financials; G = goods; H = health; I = industrials; M = materials; O = oil and gas; S = services; Tc = telecommunications and Te = technology. "Weight" is the weight of the stock in the All Share index. (Source: Generated from Profile Media, 2009).