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Do Macroeconomic Variables Explain Future Stock Market Movements in South Africa?

Andrew MacFarlane, MCom *

and

Darron West, MCom MPhil CA(SA) CFA

Senior Lecturer, Department of Finance and Tax, University of Cape Town

E-mail: darron.west@uct.ac.za

Contact address for the authors:

Department of Finance and Tax

University of Cape Town

Private Bag X3

Rondebosch

7701

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Abstract

This study addresses the empirical question of whether macroeconomic variables drive future stock market returns in South Africa. Where such a relationship can be found, the macroeconomic variables are useful predictive information for future equity index returns. Data was examined over the 45 year period from 1965 to 2010. The macroeconomic variables were selected based on international and local precedent of influential macroeconomic factors. Through the use of Johansen multivariate cointegration, Granger causality and innovation accounting, it was found that the selected South African macroeconomic variables do not significantly influence future FTSE/JSE All Share Index returns.

1. Introduction

Equity prices are generally expected to have a strong relationship with macroeconomic variables. Economic factors affect the discount rates, companies' ability to generate cash flows as well as future dividend payouts. Thus, the macroeconomic variables may become key drivers of underlying company returns. These returns should then influence the intrinsic stock price of the share and therefore an observable relationship should be expected and subsequent causality should be found.

Previous studies, both internationally and locally have examined the relationship and causality between macroeconomic variables and stock market returns in order to ascertain whether current and future stock market returns are a function of macroeconomic variables. If macroeconomic variables do constitute predictive information for future stock market returns, it would be critical to take macroeconomic variables into account when making investing decisions.

Johansen cointegration (Johansen 1991) and Granger causality analysis (Granger 1969) are used in this study. These approaches have become standard empirical tests when investigating long run relationships and the subsequent underlying causality. Innovation accounting is used as an additional evaluation method in order to analyse the interrelationships amongst the macroeconomic variables chosen. This is done through examining the response of the stock exchange to a significant movement in the selected macroeconomic variables.

This paper uses the approach described above to examine whether South African macroeconomic factors have influenced the FTSE/Jse All Share Index (ALSI) returns over the 45 years from 1965 to 2010, and further whether those macroeconomic variables constitute future predictive information for the ALSI's future returns.

This study avoids the potential inaccuracies set out by Su Zho (2001) by using a long time horizons with a high number of observations and a short lag length between observations when testing the data for causality and predictive ability.

This paper is structured in the following way. Section 2 sets out the hypothesised model and the theoretical expected outcomes of the model. Section 3 briefly sets out the data period and the resource used to acquire the data. The empirical methodology is outlined in section 4. Section 5 tests the relationships empirically using cointegration, causal analysis and innovation accounting. Section 6 concludes the study proposes possible avenues for further analysis.

2. Hypothesised model

According to Chen, Roll and Ross (1986), the selection of applicable macroeconomic variables is based on their hypothesized effect on either the cash flows and/or the required rate of return as per valuation models. This study draws on existing theory and empirical evidence when deciding on which macroeconomic variables are appropriate to include in the model.

The proxy for the level of real economy activity is GDP (Cheung and Ng (1998), Wongabanpo and Sharma (2001), Chundri and Smiles (2004), Gan et al (2006), Hsing (2011) and Jefferis and Okeahalam (2000)). South African GDP is only made public on a quarterly basis. An increase in output may increase future expected cash flows and subsequent profitability. Thus, it is initially expected that a positive relationship between stock prices and GDP will exist and that GDP will have a causal effect on the ALSI.

It is hypothesised that there will be a negative relation between inflation and stock prices. Inflation raises a firm's production costs and therefore decreases its future cash flow which lowers revenue as well as profits. Inflation would also likely inform the tightening of monetary policies which would have an adverse effect on profits (as financing costs increase) and stock price (as discount rates increase). This study employs the Consumer Price Index (CPI) as a measure of inflation. This is consistent with Mukherjee and Naka (1995) , Maysami and Koh (2000), Nasseh and Strauss (2000), Wongbangpo and Sharma (2001), Ibrahim and Aziz (2003), Gunsekaraage et al (2004), Gan et al (2006) and Humpe and MacMillain (2009). Gupta and Modise (2011) and Van Rensburg (1995) investigated this effect in South Africa.

Interest rates directly affect the discount rate in the discounted cash flow valuation model and influence future cash flows. An increase in interest rates raises the required rate of return, which in turn inversely affects the value of the asset. Additionally, the opportunity cost of holding low or no yield assets in a portfolio will increase and result in a reallocation from equities to such higher yield, lower risk assets . Hence, there should be an inverse relationship between the interest rate and stock prices. Interest rates are used in similar studies by Bulmash and Trivoli (1991), Mukherjee and Naka (1995), Kwon and Shin (1999), Karamustafa and Kucukkale (2003), Nasseh and Strauss (2000), Maysami and Koh (2000), Gan et al (2006), Brahmasrene and Jiranyakul (2007) and Humpe and MacMillain (2009). In South African studies, Jefferis and Okeahalam (2000), Alam and Uddin (2009), Mangani (2008a), Jefferis and Okeahalam (2000) studied this effect.

The appreciation of the rand dollar exchange rate is hypothesised as being inversely related to the stock price index. Conversely, the local currenciy's depreciation will increase exports causing the competitiveness and subsequent profits of South African listed companies resulting in higher stock market value. Internationally, the role of exchange rates has been examined in studies by Mukherjee and Naka (1995), Kwon and Shin (1999), Karamustafa and Kucukkale (2003), Maysami and Koh (2000), Wongbangpo and Sharma (2001), Ibrahim and Aziz (2003), Gunsekaraage et al (2004), Gan et al (2006) and Brahmasrene and Jiranyakul (2007). In South Africa, Hsing (2011), Gupta and Modise (2011), Bonga-Bonga and Makakbule (2010) and Jefferis and Okeahalam (2000) have examined this factor.

The role of money supply may have either a positive or negative effect on stock prices as shown by Mukherjee and Naka (1995), Cheung and Ng (1998), Kwon and Shin (1999), Maysami and Koh (2000), Wongbangpo and Sharma (2001), Karamustafa and Kucukkale (2003), Ibrahim and Aziz (2003), Gunsekaraage et al (2004), Chaudhuri and Smiles (2004), Gan et al (2006), Wong, Khan and Du (2006), Brahmasrene and Jiranyakul (2007) and Humpe and MacMillain (2009). South African studies using money supply have been by Hsing (2011) and Gupta and Modise (2011). The money supply may increase owing to inflation and therefore may have a negative relationship with stock prices. However, the increase in money supply creates demand for equities (as interest rates fall and returns are sought by investors) which results in increase in stock prices.

3. Data

Data is sourced from INET and it is analysed on a quarterly basis owing to some data only being available at this frequency. The data set runs from July 1965 to July 2010 which consists of 180 observations for each variable. Inflation (CPI) and GDP show strong seasonality and therefore seasonally adjusted data are used. Table 1 and 2 illustrate the data used and the subsequent manipulation required.

Table 1
Definitions of variables

Variables	Definitions of Variables
LOGALSI	Natural logarithm of the index of of quarterly-end closing prices for all shares listed on the Johannesburg Stock Exchange
LOGZARUSD	Natural logarithm of the quarterly-end exchange rate of the South African Rand to U.S Dollar
LOGM1	Natural logarithm of the quarterly-end M1 money supply in South Africa.
LCPISA	Natural logarithm of the quarterly-end Consumer Price Index.
LOGGDPSA	Natural logarithm of the quarter-end Gross Domestic Product of South Africa.
LOGSAGOV10	Natural logarithm of the quarter-end yield on 10-year long term South Africa long term government yield

Table 2
Definitions of time-series transformations

Transformation	Definitions of Time-Series Transformations
$\Delta LOGALSI_t = LOGALSI_t - LOGALSI_{t-1}$	Quarterly return on the Johannesburg Stock Exchange
$\Delta LOGZARUSD_t = LER_t - LER_{t-1}$	Quarterly change in exchange rate.
$\Delta LOGM1_t = LM1_t - LM1_{t-1}$	Quarterly realised money supply rate
$\Delta LOGCPISA_t = LOGCPISA_t - LOGCPISA_{t-1}$	Quarterly realised inflation rate.
$\Delta LOGDGPSA_t = LOGGDPSA_t - LOGGDPSA_{t-1}$	Quarterly realised GDP rate.
$\Delta LOGSAGOV10_t = LOGSAGOV10_t - LOGSAGOV10_{t-1}$	Quarterly return on 10 year government bond yield.

4. Empirical Methodology

Cointegration analysis (Johansen, 1991) is used to determine the long term relationship between macroeconomic variables and the stock market. Verbeek (2008) notes that cointegration is a statistical property of a time series where variables are cointegrated if they each share a common trend or they share a certain type of similarity in terms of their long-term fluctuations; however they may not automatically move together and may be otherwise unrelated.

According to Su Zhou (2001), defining long run relationships and subsequent interpretations from cointegration depend on both of the length of time of the study as well as the number of observations. Su Zhou's (2001) findings indicate that using a small sample of 30 to 50 annual observations, instead of more observations of higher frequency data, may not only result in significant loss of the test's power but also very likely contribute to the problem of size distortion. The power of the cointegration test with a small number of years and observations makes the results very sensitive to the lag length used and the test is more easily affected by the problem of under-parameterization. This paper therefore avoids these potential pitfalls by employing an extended number of years as well as an adequate frequency with a low lag length when testing the data.

To apply standard testing procedures such as cointegration in a dynamic time series model, it is normally required that the respective variables are stationary since most econometric theory is built upon the assumption of stationarity (Verbeek, 2008). Stationarity is defined by Challis and Kitney (1991) as a quality of process in which the statistical parameters such as the mean, standard deviation autocorrelation etc do not change with time and depends on the lag alone at which the function was calculated. This is critical as without the normal distribution, the subsequent time series analysis will give incorrect results. When time series data does not follow the normal distribution due to fluctuations, that data is non-stationary.

The non-stationarity of a series can influence its behaviour and properties substantially. Verbeek (2008) stipulates that regressing a non-stationary variable upon another non-stationary variable may lead to spurious regression.. Thus any correlation between two such variables is misleading as it does not entail causation.

According to Joshi and Shukla (2009), when one is dealing with non-stationarity, the t-ratios will not follow a t-distribution, so one cannot correctly test the regression parameters. Secondly, if the series is consistently increasing over time, the sample mean and variance will grow with the size of the sample, and they will always underestimate the mean and variance in future periods. If the mean and variance of a series are not well-defined then neither are its correlations with other variables. When testing time series models, the implication that non-stationary variables can lead to spurious regressions means that some form of testing of cointegration is almost mandatory (Harris, 1994).

However, the use of non-stationary variables does not necessarily result in invalid estimators as an important exception arises when two or more variables are cointegrated. If the non-stationary variables exist in a particular linear combination that is stationary then a long run relationship between these variables exists (Verbeek, 2008).

The first step of the process of testing for long run relationships between variables involves a test for stationarity and the order of the integration of the variables is estimated. The Augmented Dickey-Fuller (ADF) and Phillips-Perron tests for unit roots are used in order to do this.

Once the order of integration of each variable is determined, the next step is to calculate the optimal lag length for the Vector Auto Regression (VAR) as all results in the VAR model depend on the right model specification.

As explained by Liew (2004), an auto regressive process with a lag length *p* refers to a time series in which its current value is dependent on its first *p* lagged values. The autoregressive lag length *p* is always unknown however, and therefore it has to be estimated through a lag length selection criterion such as the Aikaike's information criterion (AIC) (Akaike 1973) or Schwarz information criterion (SIC) (Schwarz 1978).

The importance of lag length determination criteria is shown by Braun and Mittnik (1993) who illustrate that the approximation of a VAR whose lag length is contrary to what the actual correct lag length should be leads to inaccurate results. Granger causality, impulse response functions and variance decompositions that may be calculated from the estimated VAR are similarly affected.

Additionally, Lütkepohl (1993) points out that selecting a higher order lag length than the actual correct lag length causes an increase in the mean-squared forecast errors of the VAR. Selecting a lower value lag length than the true lag length frequently generates autocorrelated errors. Hafer and Sheehan (1989) also find that the accuracy of forecasts from VAR models can vary considerably when using mis-specified lag lengths.

When using Johansen (1991) cointegration, Banerjee et al. (1998) propose that the number of cointegrating vectors generated by the Johansen approach may be sensitive to the number of lags in the VAR and therefore one needs to determine the optimal lag length.

For this study, owing to the large sample size, the SIC is most appropriate owing to its superior large sample properties (Myung, Tang and Pitt (2009), Azzem (2007), Burnham and Anderson (2002) and Johnson and Scott (1999)).

4.1 Cointegration

Once the appropriate lag length has been defined, the cointegration analysis is applied to determine whether the time series of these variables displays a stationary process in a linear combination.

Engle and Granger (1987) provide a means for testing for cointegration in a single equation structure and the Johansen (1991) method enables testing for cointegration in a system of equations. Although Engle and Granger’s two step error correction model can be used in multivariate context, the vector error correction model (VECM) gives more efficient estimates of cointegrating vectors (Phillips, 1991).

The Johansen procedure is based on the VECM to test for at least one long run relationship between the variables. This step is consistent with Mukherjee and Naka (1995), Maysami and Koh (2000), Wongbangpo and Sharma (2001), Ibrahim and Aziz (2003), Gunsekaraage et al (2004) and Humpe and McMillian (2007).

According to Maysami and Koh (2000), the VECM is a full information maximum likelihood model which therefore permits the testing for cointegration in a whole system of equations in one step and which does not require a specific variable to be normalized. This means that it avoids carrying over the errors from the first step into the second and gives more efficient estimators of cointegrating vectors, as would be the case if Engle and Granger’s methodology is used. It also has the advantage of not requiring *a priori* assumptions of endogenity or exogenity of the variables.

The following Johansen multivariate model is used to calculate the relationships between the variables;

$$\Delta X_t = \Gamma_1 \Delta X_{t-1} + \Gamma_2 \Delta X_{t-2} + \ldots + \Gamma_{k-1} \Delta X_{t-k+1} + \prod X_{t-k} + \mu + \Phi D_t + \epsilon_t \quad (1)$$

where $\Gamma_i = -I + \prod_1 + \prod_2 + ...+ \prod_i$ for i = 1,2,k-1;

(2)

$\prod = -I + \prod_1 + \prod_2 + ...+ \prod_k$ I is an identity matrix

(3)

The matrix Γ_i comprises the short term adjustment parameters, and matrix $\prod$ contains the long term equilibrium relationship information between the *X* variables. The $\prod$ could be decomposed into the the product of two *n* by *r* matrix α and β so that $\prod = \alpha\beta$ where the β matrix contains *r* cointegration vectors and α represents the speed of adjustment parameters (Johansen (1998) and Gan et al. (2006)).

4.2 Granger Causality Test

Once the relationship between the two has been established, the next objective of this study is to observe whether the macroeconomic variables selected are valuable in predicting future stock market movements in South Africa. Granger causality is a test used to determine whether one time series can forecast another. Roebroeck et al. (2005) describe Granger causality as quantifying the usefulness of unique information in one time series in predicting values of the other. Specifically, if incorporating past values of *x* improves the prediction of the current value of *y*, then *x* Granger causes *y*. Therefore, precedence is used to identify the direction of causality from information in the data.

Roebroek et al. (2005) explain that the VAR model can be thought of as a linear prediction model that forecasts the current value based on a linear combination of the most recent past influential variables. Thus, the current value of a component is predicted based on a linear combination of its own past values and past values of other components. This shows the value of the VAR model in quantifying Granger causality between groups of components.

The practicability of the Granger causality test depends on the stationarity of the system. If the series is stationary, the null hypothesis of no Granger causality can be tested by the standard Wald tests as shown by Lutkepohl (1991). Additionally, because Granger causality requires large sample sizes to make conclusions, it should evaluated over a long time period.The Gan et al. (2006) illustration of Granger causality is used to test the lead-lag relationship between the macroeconomic variables and the ALSI thus:

$$\Delta X_t = a_x + \sum_{i=1}^{k} \beta_{x,i}\,\Delta X_{t-i} + \sum_{i=1}^{k} \omega_{x,i}\Delta Y_{t-i} + \varphi_x ECT_{x,t-i} + \epsilon_{x,t} \quad (4)$$

$$\Delta Y_t = a_x + \sum_{i=1}^{k} \beta_{y,i}\,\Delta X_{t-i} + \sum_{i=1}^{k} \omega_{y,i}\Delta X_{t-i} + \varphi_y ECT_{x,t-i} + \epsilon_{y,t} \quad (5)$$

where φ_x and φ_y are the parameters of the ECT term, measuring the error correction mechanism that drives the X_t and Y_t back to their long run equilibrium relationship.

Furthermore, Gan et al. (2006) stipulate that the null hypothesis for (4) is H_0: $\sum \omega_{x,} = 0$ which suggests that the lagged terms ΔY do not belong to the regression. Conversely, the null hypothesis for the equation (5) is H_0 : $\sum \omega_{y,} = 0$ which implies that the lagged terms ΔX do not belong to the regression.

4.3 Innovation Accounting

Innovation accounting such as the impulse response function and variance decomposition is used in analysing the interrelationships among the variables chosen in the system (Gan et al, 2006). Accordingly, this study proceeds to evaluate variance decompositions and impulse-response functions based on the VAR specification to capture the dynamic interactions among the variables (Wongbangpo and Sharma (2001), Ibrahim and Aziz (2003), Nasseh and Strauss (2000), Chundri and Smiles (2004), Gunsekaraage et al (2004) and Gan et al. (2006)).

4.3.1 Impulse response functions

A shock to the i-th variable not only directly affects the i-th variable but it is also transmitted to all of the other endogenous variables through the dynamic lag structure of the VAR. An impulse response function traces the effect of a one time shock function to one of the innovations on current and future values of the endogenous variables. Therefore, the impulse response describes the ALSI's reaction to a shock in the macroeconomic variables and the subsequent periods.

If the innovations e_t are contemporaneously uncorrelated, interpretation of the impulse response is as follows (Shachmurove and Shachmurove., 2008): The i-th innovation $e_{i,t}$ is simply a shock to the i-th endogenous variable $y_{i,t}$. However, innovations are generally correlated, and may be viewed as having a common component which cannot be associated with a specific variable. In order to interpret the impulses, it is common to apply a transformation P to the innovations so that they become uncorrelated with the formula being

$v_t = P\, e_t \sim (o, D)$,

where D is a diagonal covariance matrix.

4.3.2 Variance decompositions

The impulse response function trails the effect of a shock to one variable on the other variables in the VAR. The variance decomposition, however, separates the variation in one the South African macroeconomic variables into the constituent shocks to the VAR.

Variance decomposition shows how much of the forecast error variance for any variable in the VAR is explained by innovations to each explanatory variable over a series of time horizons.

Variance decompositions are constructed from a VAR with orthogonal residuals and hence can directly address the contribution of macroeconomic variables in forecasting the variance of stock prices (Sims, 1980). Cointegration implies that R-squared approaches 1 and therefore the variance decomposition in levels approximates the total variance of stock prices.

Enders (1995) states the proportion of Y variance due to Z shock can be expressed as:

$$\frac{\partial_2^2\,[\,a_{12}(0)^2 + a_{12}(1)^2 + \ldots\ldots + a_{12}(m-1)^2]}{\partial_y\,(m)^2}$$

Per Enders (1995) and Gan et al. (2006) one can see that as m period increases the $\partial_y(m)^2$ also increases. Furthermore, this variance can be separated into two series: y_t and z_t series. Consequently, the error variance for y can be composed of e_{yt} and e_{zt}. If e_{yt} approaches unity it implies that y_t series is independent of z_t series. It can be said that y_t is exogenous relative to z_t. On the other hand, if e_{yt} approaches zero (indicates that e_{zt} approaches unity) the y_t is said to be endogenous with respect to the z_t (Gan et al., 2006).

5. Empirical Results

5.1 Cointegration Analysis

Cointegration requires the variables to be integrated to the same order and therefore the Augmented Dickey-Fuller (ADF) and Phillips-Peron tests are used. The results of the tests are given in Table 3. Both ADF and Phillip-Perron do not reject the null hypothesis of the existence of a unit root in log levels of all variables. Hence the presence of non-stationarity is indicated which may lead to spurious relationships.

However, the tests do reject the same null hypothesis in the log first difference of the series. This indicates that GDP, inflation (CPI), money supply, rand dollar exchange rate and the interest rate (10 year government bond yield) are integrated of order one. Since the various variables exhibit stationarity the analysis may continue.

Table 3
Augmented Dickey-Fuller Test Results

Null Hypothesis: LOGCPISA has a unit root			Null Hypothesis: LOGGDPSA has a unit root		
	t-Statistic	Prob.*		t-Statistic	Prob.*
Augmented Dickey-Fuller test	-1.28439	0.6365	Augmented Dickey-Fuller test	-1.1628	0.6901
First Differenced			First Differenced		
	t-Statistic	Prob.*		t-Statistic	Prob.*
Augmented Dickey-Fuller test	-3.50302	0.009	Augmented Dickey-Fuller test	-4.99569	0
Null Hypothesis: LOGM1 has a unit root			Null Hypothesis: LOGSAGOV10 has a unit root		
	t-Statistic	Prob.*		t-Statistic	Prob.*
Augmented Dickey-Fuller test	0.338204	0.9797	Augmented Dickey-Fuller test	-1.87944	0.3414
First Differenced			First Differenced		
	t-Statistic	Prob.*		t-Statistic	Prob.*
Augmented Dickey-Fuller test	-14.0106	0	Augmented Dickey-Fuller test	-11.5893	0
Null Hypothesis: LOGZARUSD has a unit root					
	t-Statistic	Prob.*			
Augmented Dickey-Fuller test	-0.24608	0.9288			
First Differenced					
	t-Statistic	Prob.*			
Augmented Dickey-Fuller test stat	-12.0026	0			

*MacKinnon (1996) one-sided p-values.

Before testing the VAR for cointegration, the lag length criterion needs to be specified. The optimum lag length suggested by SIC was 1.

In selecting the lag length, a requirement is that the error terms for the equations must be uncorrelated. The Ljung-Box-Pierce Q statistic tests the null hypothesis that the error terms are uncorrelated. The results indicate the lack of autocorrelation in the residuals and therefore the model is adequately specified.

The results of Johansen cointegration test are reported in Table 4. There are 3 cointegrating equations at the 5% level of significance.

Table 4

Sample (adjusted): 1965Q4 2010Q2
Included observations: 179 after adjustments
Trend assumption: Linear deterministic trend
Series: LOGALSI LOGCPISA LOGGDPSA LOGM1 LOGSAGOV10 LOGZARUSD
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.407646	181.2234	95.75366	0
At most 1 *	0.192776	87.48980	69.81889	0.001
At most 2 *	0.135510	49.15625	47.85613	0.0375
At most 3	0.079733	23.09320	29.79707	0.2415
At most 4	0.041139	8.219767	15.49471	0.4422
At most 5	0.003904	0.700160	3.841466	0.4027

Trace test indicates 3 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Johansen and Juselius (1990) note that the first cointegrating vector that corresponds to the largest eigenvalue is the most correlated with the stationary part of the model and therefore will be its most useful. Hence, in this long run study, the analysis is based on the first cointegrating vector.

After normalising the coefficients of the ALSI to one in order to establish the long run relationship of the variables against the ALSI from 1965-2010, the relationship can be expressed as

ALSI = -7.548GDP + 0.322CPI + 2.452M1 – 2.433SAGB10 - 1.140ZARUSD

These estimated long run coefficients of the macroeconomic factors may be interpreted as elasticity measures since the variables are expressed in natural logarithms. From these results, one is able to interpret the long term relationship for the past 45 years and offer possible theoretical explanations for the relationship, but not the causality, between the ALSI and the macroeconomic variables.

5.2 Causal Analysis

When dealing with a cointegrated set of variables, Granger (1988) recommends that the causal relations between the variable should be investigated within the structure of the VECM. The lag value (SIC = 1) was tested against the 179 observations for each variable. Two statistical tests are performed: the pairwise Granger Causality test and the Block Exogeneity Wald test.

The pairwise Granger Causality test is used to identify the exogeneity of each variable introduced in the system. The p values indicate the significance of lagged coefficients of each variable in the equation of each endogenous variable.

The Block Exogeneity Wald Test is used to test the joint significance of each of the other lagged endogenous variables in each equation and also to test for the joint significance of all the other lagged endogenous variables in each equation. The causal test statistics are shown in Table 5 below.

Table 5
VECM Pairwise Granger Causality / Block Exogeneity Wald Tests

Sample: 1965Q2 2010Q2
Included observations: 179

Dependent variable: D(LOGALSI)

Excluded Variable	Probability
D(LOGCPISA)	0.0763
D(LOGGDPSA)	0.1397
D(LOGM1)	0.2491
D(LOGSAGOV10)	0.5782
D(LOGZARUSD)	0.4249
All	0.1149

The results of the tests for the causal relationship between the input variables and the ALSI and the using the pairwise Granger causality test are as follows:

Table 6
Granger Causality - Causality Relationships

CPI **does not** Granger Cause	→	ALSI
GDP **does not** Granger Cause	→	ALSI
M1 **does not** Granger Cause	→	ALSI
SAGOV10 **does not** Granger Cause	→	ALSI
ZARUSD **does not** Granger Cause	→	ALSI

Therefore, one is able to infer that none of the macroeconomic variables independently has a direct influence on the ALSI over the period June 1965 to June 2010. The null hypothesis (that there is no Granger causality) cannot be rejected at a 5% significance level.

To confirm the results above, the block exogeneity test results can be examined to test the joint significance of each of the lagged endogenous variables in each equation. It is represented by the word "All" in Table 5 above which is the p value of the χ^2 Wald statistic for joint significance of all other lagged endogenous variables in the equation.

Similarly, this test fails to reject the null hypothesis as the p-value of the causality is insignificant at the 5% level

It can therefore be concluded that none of the macroeconomic variables has significant Granger causality for the ALSI. This implies that in South Africa the value of the ALSI is not a function of the past and current macroeconomic factors set out in this paper and that these variables do not constitute useful predictive information for the ALSI's future returns.

5.3 Innovation Accounting

5.3.1 Impulse Response Function

An impulse response function traces the effect of a one time shock function to one of the innovations on current and future values of the endogenous variables. Therefore, the impulse response describes the ALSI's reaction as a function of time to the macroeconomic factors at the time of the shock and the subsequent points. The results of the impulse response analysis of the South African macroeconomic variables and the ALSI is shown below:

Table 7
Impulse Resonse analysis

Response of stock prices (to one standard deviation shock in macroeconomic variables)

Periods ahead	LOGCPI	LOGGDP	LOGM1	LOGSAGOV10	LOGZARUSD
2	0.002313	0.004117	-0.005798	-0.005527	0.004252
4	0.005572	0.010032	-0.012373	-0.012211	0.010522
12	0.009288	0.016122	-0.00699	-0.010302	0.013721
20	0.010047	0.016549	0.001435	-0.001084	0.005543

The forecast period is the first column and is the period of time forecasted ahead (viz. bi-annually, annually, 3 years and 5 years respectively). As expected, given the lack of causality, a one standard deviation shock in any of the macroeconomic variables has an inconsequential effect on the ALSI. For example, the response of the ALSI two quarters or 6 months after one standard deviation shock in the macroeconomic variable is 0.2%, 0.4%, -0.5%, -0.5% and 0.4% for CPI, GDP, money supply, interest rate and rand dollar exchange rate respectively.

5.3.2 Variance Decomposition

The impulse response function trails the effect of a shock to one variable on the other variables in the VAR. The variance decomposition, however, separates the variation of the South African macroeconomic variables into the constituent shocks to the VAR.

Ordering of the variables is of importance given the causal influence that they may have on the relevant stock index. However, given that the South African macroeconomic variables and the ALSI have been shown to have a non causal relationship, the ordering becomes less important.

According to Sims (1980), the power of the Granger causality can be ascertained by the variance decomposition. In the South African example, it would be expected that owing to the lack of Granger causality between the macroeconomic variables and the ALSI, there would be a very small portion of a variable (such as the money supply) that would explain the forecast error variance of the ALSI. The decomposition between the ALSI and South African macroeconomic variables is shown below.

Table 8

Variance Decomposition analysis

Forecast error variance of stock prices (explained by innovations in the macroeconomic variables)

Periods ahead	S.E.	LOGALSI	LOGCPI	LOGGDP	LOGM1	LOGSAGOV10	LOGZARUSD
2	0.155739	99.56896	0.022063	0.069866	0.138617	0.125966	0.074528
4	0.199324	97.5621	0.134847	0.434861	0.712914	0.679844	0.475437
12	0.252154	88.13933	0.978001	3.091362	2.183362	2.669988	2.39796
20	0.263911	83.64311	1.276507	5.829448	2.076281	2.778053	3.705661

The variance decomposition analysis should compare favourably with the impulse response analysis. The table format shows separate variance decompositions for each endogenous variable. The “S.E” in the second column is the forecast error of the ALSI at the given forecast horizon. The remaining columns give the percentage of the forecast variance due to each innovation, with each row adding up to 100%.

As expected, given the lack of Granger causality results and poor explanatory impulse response analysis results, the macroeconomic variables appear to have little influence on future stock prices. For instance, over 12 quarters, the influence of the macroeconomic variables on the future stock price is 0.98%, 3.09%, 2.18%, 2.67%, 2.4% for CPI, GDP, money supply, interest rate and rand dollar exchange rate respectively with the multitude of other factors incorporated in the ALSI accounting for 88.14% of the influence on future stock price movements.

6. Conclusion

Using both the Augmented Dickey-Fuller and Phillips Peron tests, it was found that the macroeconomic variables are integrated of order one and therefore the data is stationary. Cointegration was subsequently discovered amongst the variables revealing that there is a long term relationship between the South African stock market and the macroeconomic variables.

According the VECM model estimated in the study, inflation and money supply have a positive relationship with the ALSI over the long run. However, inflation is not significant. A negative relationship was found for the South African 10 year Government Bond Yield (which is used as a measure of the interest rate), the rand dollar exchange rate and GDP.

The influence of the macroeconomic factors influence on stock market returns was examined. The Granger causality results indicated that the ALSI is not a function of the past and current macroeconomic factors analysed in this paper and that these variables do not constitute useful predictive information for the ALSI.

This assessment was then vindicated by use of innovation accounting. Impulse response function traced the effect of a one standard deviation shock of the macroeconomic variables on the South African stock exchange. The results were inconsequential. Similarly, variance decomposition was used to explain the forecast error variance of the ALSI for each individual macroeconomic variable with the results confirming the previous findings of this study that the macroeconomic variables explain an insignificant portion of future returns.

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