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Dynamic Relations between Macroeconomic Variables and Stock Prices

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Authors' contributions

This work was carried out in collaboration between the both authors. Both authors read and approved the final manuscript.

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ABSTRACT

This study has examined the dynamic relationship between certain macroeconomic variables and stock prices in the UK and South Africa. Using the Johansen co-integration technique based on vector error correction model (VECM), the study finds one co-integrating vector for the UK data suggesting that macroeconomic variables have long run effect on stock prices, with the stock prices being positively related to industrial production but negatively related to both long term and inflation rates. The inflation rate was found to respond the most to shocks for the UK. The UK inflation rate can serve as a signal for the condition and state of the economy. No long run relationship was however found for the South Africa. The Granger causality test shows changes in industrial production in South Africa are better explained by both its past values and past stock market performance.

Keywords: Stock market returns; co-integration analysis; arbitrage pricing model; VECM.

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ABBREVIATIONS

Spm - Stock index (FTSE 100)
Cpi - Inflation rate
Tb - Long term rate
Ip - Index of Industrial production
Lspm - Log of stock index
Lcpi - Log of inflation rate
Ltb - Log of long term rate
Lip - Log of industrial production
Rspm - Stock market returns
Gcpi - Inflation rate changes
Gtb - Long term rate changes
Gip - Index of industrial production changes
D_lspm - Stock index changes
D_ltb - Long term rate changes
D_lcpi - Inflation rate changes
D_lip - Index of industrial production changes

1. INTRODUCTION

The stock market is that part of financial market that attracts the most attention and usually under close surveillance. Stock markets have witnessed so much volatility over time. Having superior information about an asset can either increase returns or reduce risk. However, buying a stock involves venturing into the unknown concerning the future stream of cash flows that may accrue from such an investment. Many studies have been done on investigating the sort of relationship that exists between stock market return and sets of macroeconomic variables, for different countries and for varying time horizons. Studies have shown that certain relevant information is contained in fundamental macroeconomic variables over time. Changes in such variables are therefore of interest to participants in the financial market. Based on the efficient market hypothesis, stock prices are said to fully reflect all available information.

A number of factors may affect either directly or indirectly the growth potential or expected future expansion of a company. This provides and makes room for a basis for this study. The focus of this study will be on the relationship that exists between stock prices and important components in the economy as a whole which are capable of impacting stock returns either in the short term or long term.

Many models of stock valuation predict that the discounted value of expected cash flow affects stock prices. The linkage between stock returns, interest rates and economic variables has been explained using different models among which are, the consumption asset pricing model [1]; general equilibrium model [2]; Arbitrage Pricing model [3]; and the Present Value model [4].

The methodological approach to all these related studies remains the co-integration analysis. However, the co- integration technique adopted may have implications for the result. For instance, the Engle-Granger tests were found to lack power [5], and besides it can only model a univariate relationship. The Johansen framework is able to incorporate the dynamic co-movement and interactions of variables. Some studies that adopted this technique include [4,6] among others. The scope of this study covers the markets in the United Kingdom and South Africa over the period 2000 (3 -) to 2009 (12). The choice of United Kingdom as the country of interest is influenced by the ready availability of the relevant data for a robust study including the international significance of the London stock exchange. South Africa is an emerging economy and the market is rated best in Africa.

Stock markets are often times susceptible to speculative attacks with big swings in share prices making newspaper headlines. These stock prices fluctuations affect investor's level of wealth and eventually consumption spending. The stock market is described to be 'the place where people can get rich or poor quickly' [7]. A relatively efficient market can be said to be the one where securities are driven to fully indicate all information that is 'knowable' either about a company, an industry or the general economy at large [8].

The research problem arises from the difficulty that is associated with stock pricing. The problem however seem to be that errors often times occur in valuation. This suggests that asset pricing may not always be perfect [9]. Stock valuation problems have largely been adjudged a major cause of market inefficiencies or bubbles. The focus of this research is however not market efficiency or otherwise but the information contained in the result of the robust long run analysis may be found useful for stock valuation.

As a result, where a change in a particular set of macroeconomic variables could be said to signal a movement in the underlying systematic risk factor impacting returns, it may suggest important information for proper stock pricing and

this may help alleviate the mispricing problem. The argument is that macroeconomic factors which impact expected future flow of cash stream for a firm should also affect the price of the firm's stock. In effect, this can also be extended to the market as a whole as this study is an aggregate analysis of the supposed relationship. The existence of a co-integration relation between stock market prices and macroeconomic variables suggests that these variables are considerably and consistently priced in the resulting stock market returns. Hence this offers a substantial support signaling that the set of macro variables are important explanatory factors of expected stock returns and that there exist a certain level of relationship amid them [10].

To investigate the relationship between stock returns and the macroeconomic variables, the main question is – are economic indicators significant explanatory factors of stock market returns? The main purpose of this study is to examine both the short and long run relationship between macroeconomic variables and stock market prices for the UK and South Africa. The findings of this study show that a long run relationship exists between stock market returns and the selected macroeconomic variables for the UK. However, macroeconomic variables appear not to impact returns for South Africa in the long run.

The second part presents a review of recent and related literature to serve as a guide to having a sound understanding of the phenomenon. The third section presents the methodological approach that the study will adopt and the fourth section gives the detailed analyses of empirical tests and results. The fifth and final part summarises and concludes the study.

2. LITERATURE REVIEW

By co-owning a company through shareholdings, investors pay in advance for the expected growth of such a firm. The expectation of the market in terms of the future relative growth rate, expressed in the earnings and dividends' are discounted into current share market price. This means if investors think that a stock's dividend are most likely to grow at a faster than average rate consistently for a long period of time, the current stock price may be bid up relative to its current dividend per share. This translates to buying a stock at a higher than average expected growth or level of performance. This can result in the realization of a below average rate of return. This is because the dividends that accrue will then be small relative to the share price paid.

The starting point and basis for studies on macroeconomic variables and stock returns can be attributed to some theories in financial economics. Notable theories are - the arbitrage pricing theory, generalized dividend value model and the present value model among others. The theoretical justification for this piece of work is necessary in order to build and establish a solid basis in economic theory for the study. The generalised dividend valuation model is rested on the premise that share prices depend on the anticipated stream of dividend payments and the discounting rate as well. The dividend stream and discount rate may be influenced by some macroeconomic variable which in turn affects aggregate stock prices and eventually returns. Understanding the relationship between them and the information contained in macroeconomic variables is therefore justified based on theory. Dividends are the only source of cash payments and value to a common stock investor. As a result, the changes that occur in the stock price are attributable to changes in the market's expectations with respect to the amount of dividends receivable in the future. Hence, the current market price for the stock can be expressed as a function of the market's expectation of the dividend to be received at the end of the year and the market price that will be in effect at that time. In theory, a linkage can be established between the arbitrage pricing model [3] and stock market returns. Although most empirical studies testing the arbitrage pricing model (APM) are with respect to individual security returns and characterised by modelling the short run relationship, it can still be extended to aggregate studies. The APM explains the situation where many factors may affect returns on an asset. The APM assumes that the co-variances that exist between security returns can be attributed to the fact that the securities respond, to one degree or another, to the pull of one or more factors. A linear relationship is assumed to exist between a stock's rate of return and the indices that are adjudged capable of affecting the rate of return. This theory is credited to [3].

In fact, return can also be determined on the basis of unexpected changes in some specific factors [11]. Distinction was made between the following factors, the growth rate of industrial production; rate of inflation; long term and short

term Treasury bond yield among others. There is evidence that these factors affect the prices that investors are willing to pay for securities. When changes in a fundamental factor is found to be affecting stock returns, then changes can be predicted in the returns based on a forecast of a factor change [8]. The factor loadings represent sensitivities and also similar to beta (measure of market risk) in the Capital Asset Pricing Model.

Their conclusion shows the four macroeconomic variables stated earlier were found to be significant explanatory factors. The basis for these underlying factors is well founded and appears to make sense intuitively. Prices of common stock indicate the present value of the discounted cash flows. The index of industrial production has implications for profitability while the rest of the variables are clearly related to the discount rate. The Arbitrage Pricing Model shall be tested in this study.

In the empirical literature, [12] distinguished 3 possible reasons for the strong linkage between stock returns and economic activities. First, macroeconomic information may reflect in stock prices before it comes to be – hence portraying stock prices as a leading indicator of an economy's health. Second, rates may affect stock prices and even real investment though with a time lag. Third, stock prices changes are viewed as changes in wealth which is capable of influencing the demand for consumption and investment goods in the real economy. The current price of a share stands for the worth investors place on the existing stock of shares. Meanwhile, when prices rise or fall, the stock valuation changes, even though the supply and quantity of shares remains unchanged unless there is a new issue.

Price stability is important because for an investment to be desirable and rewarding, investors expect that prices should be relatively stable over time. A relatively stable price can best be explained by a moderate rate of inflation. A cross section of studies that have been done regarding inflation mostly concluded an indirect association between inflation and stock market returns [13]. Other related work conducted studies covering both short and long period and arrived at varying conclusions. [14] discovered a negative relationship between stock returns and inflation rate in the short run but a somewhat positive association in the long run. But in contrast, a negative relationship ensued between realized inflation and realized stock market returns both in the long and short run in another related study [15]. A different line of reasoning based on another study was that volatility of inflation increases the volatility of stock returns causing a higher return which also translates to stock price fall [16].

Kwon and Shin [10] studied the Korean stock market asking whether certain economic variable like (production level, trade balance, exchange rate and money supply) can explain Korean stock market returns. Their analysis shows that stock prices are co-integrated with economic variables; that is, there is a long run nexus between variables but they stated that stock price index is not a leading indicator for economic variables. This is however not consistent with the finding that stock market rationally signals changes in real activities [17].

Contrary to what obtains in the developed economies like the US and Japan, the Korean market was found to be more sensitive to international trading activities rather than inflation or interest rate. The distinction between impacts of the measures of domestic and international macroeconomic variables on stock returns was carried out [6] and evidence supports the long run relationship between stock prices and domestic and international economic activity and concludes that stock prices are determined by macroeconomic activity.

An investigation on the impact of inflation rate on the Egyptian stock performance in terms of size and liquidity by [18] shows a significant short and long run relationship between these variables showing that inflation has impacted on stock market performance in Egypt.

Summarily, the inter-relationship between interest rate and stock returns on one hand and industrial production on the other hand has been widely explored in literature. Industrial production growth/innovation can be linked to changing expectations of future cash flow [1]. Changes in interest rates or interest rate modifications can also be a determining factor in industrial production. This is because changes in investment and stock prices occur via the changes in discounted cash flow value. A study by [6] found that long term rates negatively influence stock prices – and this is consistent with the role of interest rate as a discount factor and that short term rates are positively related to stock prices.

2.1 An Overview of the South African Stock Exchange and Economy

The South African stock exchange market is undoubtedly the biggest in Africa and also recognised among major markets in the world. Over 400 companies are listed on the exchange with a market capitalisation well over $500 billion as of year 2006. Trading in the market is fully automated. The stock exchanges register shares in two separate markets – the main board and the alternative exchange (AltX). Sterner rules apply to listing on the main board, while firms unable to meet the criteria for the main board enlist on the AltX. The transparency of the market, timely dissemination of sensitive information important for efficiency and investor faith is ensured by the stock exchange news service.

The South African exchanges trade in shares for many industries. It is however worthy of note that the greatest contribution to market capitalization is from the mining sub-sector. The JSE became a publicly held company in 2005.

The history of South African stock exchange cannot be separated from Gold which is the country's chief natural resource. The unearthing of gold in 1886 resulted in a big bang in mining and finance related companies. South Africa turns out over 10% of total world's gold and close to 80% of her platinum. The rand, South African currency often moves with these commodities prices. This soon led to the formation of an exchange. This is not unconnected to the earlier assertion that mining industries play a big part in the economy as a whole.

The conduct of monetary policy in South Africa is within the inflation targeting structure with the primary goal for policy been the achievement and maintenance of price stability. Inflation is targeted within the array of 3 to 6 per cent. Achievement of monetary stability for the South African Reserve Bank is signalled by an efficient and effective financial markets and institutions. The South Africa's department of minerals and energy data shows that over half of their income from abroad is attributable to commodities.

2.2 An Overview of the UK Stock Exchange and Economy

The London Stock Exchange (LSE) is an international exchange that has been in existence for over 300 years and dates back to 1801. More than three thousand companies are listed on the exchange out of which about three hundred and fifty are from around fifty different countries. The LSE also comprises of two different markets – main market and the alternative investment market (AIM). The main market is for the well-grounded companies with severe rules while the AIM caters for the new companies with growth capability. Electronic and real time trading is done on the exchange. There are more than 400 companies on the stock exchange that are investment banks and stock broking firms. The index chosen for the market is the FTSE 100. The FTSE 100 is an index of the 100 most capitalised UK companies enlisted on the exchange. It dates back to 1984 and is the most commonly used index.

The UK economy went into recession in the second quarter of 2008 and crept out of recession in the fourth quarter of 2009 (ONS). The recession period is the longest in current history and in fact the UK was the last major economy that came out of recession. Some anecdotal evidence say the recession might have taken a longer time due to the neo-liberal policies of Thatcher's administration that saw a departure from focus on manufacturing to the financial sector.

Historically, the UK has had varying monetary policies over time. For instance, in the early 80's it was monetary targeting, but from the late 80's it became exchange rate targeting and it has been inflation targeting from 1992 till date. To influence the final target inflation rate, the instruments used are the money supply and interest rate (base rate). Changes to money supply and interest rate affect prices which feed through to level of inflation. During the global economic downturn of the late 2000s, the Bank of England responded by a continuous cutting of the base rate to a record low of 0.5%. At a point they even resulted to the unconventional measure of quantitative easing believed to impact the money supply. All these interventions were geared towards the realization of the inflation target and expenditure boost for the economy.

3. RESEARCH METHODOLOGY

This section addresses the suitable methods and approach relevant to use for this study. A cross section of allied studies shows co-integration techniques approach as appropriate for this study. Co-integrating analysis has been used in

validating long term relationship between variables [19].

The aim of this study is to model a long run relationship between some selected macroeconomic variables and stock market returns. We adopt the [20] approach which is based on a vector error correction model (VECM). The method makes it possible to test for at least a long run relationship between variables. Co integration within the vector error correction framework is more appropriate for multivariate analysis and less ambiguous. To set out the analysis, it is required that the order of integration of variables be determined by employing a sequence of test like the augmented Dickey Fuller and Phillips Peron tests. This section sets out how the methods and techniques will emerge.

To start with, the model will be stated and variables will be defined. For a time series analysis and in particular co-integration analysis, the variables are required to be integrated of the first order i.e. non-stationary. To ensure this, the formal unit root tests shall be carried out. After establishing that the variables of interest are integrated of the first order – I (1), we can then proceed to model a co-integrating relationship to ascertain the existence of a long run relationship. Co-integration exists when variables that are I (1) becomes stationary (does not contain unit root) when regressed on each other.

Studies that have used Johansen co-integration test in the vector error correction model (VECM) include [21, 22, 23, 24]. The Johansen Maximum Likelihood and Granger causality tests were used from a VECM to determine the relationship between Newzealand stock index and macroeconomic variables by [24]. The presence of co-integration suggests that there exists a long term relationship between variables. And by definition, it implies that causality may possibly exist at least in one direction [19]. The appropriate lag length shall be determined by the minimum information criteria of choice. The AIC is preferred for lag determination while the SBIC is favoured for choosing the co-integrating rank. The empirical evidence from the experimental work of [25] informs this decision. The Lagrange Multiplier tests will help to ascertain that the chosen lag length residuals are not serially correlated.

The explanatory variables of interest include index of industrial production, Treasury bill rate and inflation rate. Industrial production index is viewed as a measure or proxy for aggregate output. The interest rate is important because changes in interest rate are capable of altering the discount rate in a valuation model. Distinction has been made between the short term and long term rates in studies. Invariably, interest rates have implications for the present and future value of stock returns. The 10-yr bond yield is chosen to proxy the long term interest rate since it can signal the long term perspective of an economy regarding the discount rate. Real stock prices are affected negatively by unexpected inflation via the channel of unanticipated fluctuations in the price level. Unexpected inflation can also affect the discount rate because of the erosion of the present value of future streams of income. Rising inflation is said to inversely affect corporate income initially and eventually share prices.

3.1 Specification of the Model

The focus is on the co-integration process arising from the linear combination of non-stationary variables. Some series share co-movements with other series and this may be due to the existence of a common underlying economic factor. The phenomenon is referred to as co-integration. A VAR modelling allows for the consideration of several endogenous variables together. Each variable is explained by its past value and lagged values of all other endogenous variables in the system. Economic theory often times suggests that some variables should be related by a long term equilibrium relationship. Even though, the variable may sometimes wander away from equilibrium, eventually equilibrium is expected to be restored. The application of the concept of equilibrium to variables containing unit roots results in co-integrated variables.

To use the Johansen method, we turn to the VAR of the form-

$$Z_t = \beta_1 Z_{t-1} + \beta_1 Z_{t-2} + \ldots + \beta_1 Z_{t-k} + u_t \quad (1)$$

Where Z_t is a vector of variables. In a vector error correction model format, it can be stated as

$$\Delta Zt = \prod Z_{t-k} + \Gamma_1 \Delta Z_{t-1} + \Gamma_2 \Delta Z_{t-2} + \ldots + \Gamma_{k-1} \Delta Z_{t-k} + u_t \quad (2)$$

$\prod$ can be broken down and then the equation re-written as

$$\Delta Zt = \alpha \beta' Z_{t-k} + \Gamma_1 \Delta Z_{t-1} + \Gamma_2 \Delta Z_{t-2} + \ldots + \Gamma_{k-1} \Delta Z_{t-k} + u_t \quad (3)$$

Z_t = is the m dimensional vector of variables (in this case, stock market index, industrial production index, long term rate and inflation rate), k = no of lags, β if any = vector of constants, t refers to the number of observations while u_t = is the error vector which is multivariate, normal and independent across observations and t = 1, 2, . . . , T.

The equation above is analogous to the Augmented Dickey Fuller test of stationarity, but expressed in vector form as a VAR. The presence of the lagged terms like allows for the capturing of dynamic co-movements. The rank of ∏ is particularly of interest since it gives information on the number of co-integrating vectors. The matrix Γ_i consists of the short term adjustment parameters while the matrix ∏ comprises the long term equilibrium association between the Z variables. ∏ is decomposable to the product of two m by r matrix such that ∏ = αβ where β matrix contains r co-integrated vectors and α represents the speed of adjustment parameters. Two likelihood ratio tests have been developed for testing the number of co-integrating vectors (r), that is contained with the trace test and maximum Eigen value test. The trace test statistic tests the null of r =0 (no co-integration) as against the general alternative that r > 0 (one or more co- integrating vector exist). While the maximum Eigen value tests the null that the number of co- integrating vectors is r as against the specific alternative of (r+1) co-integrating vectors. *Apriori*, there are 3 possible outcomes. The first is that rank (∏) = p and so vector Z_t is stationary; secondly, rank (∏) = 0 meaning the absence of long run relationship among the variables of Z_t. Lastly, the rank (∏) < p and therefore r determines the number of co-integrated relationships.

4. DATA ANALYSIS AND DISCUSSION OF RESULTS

4.1 Unit Root Test Results

To start out, the unit root tests are carried out. Prior to this, the log of stock market index is regressed on the other three variables just to pre-examine the relationship even though this is regarded as a spurious regression. The outputs suggest study can progress. In brief, the table below gives the result of the unit root test performed on all variables both at levels and on first differences. All series are found to be I (1) - contain a unit root, with the use of the Augmented Dickey fuller and Phillips Peron tests.

For all variables at levels, the null hypothesis that the series has a unit root cannot be rejected. But in first differences, we reject the null that all series contain a unit root. Both the ADF and PP tests present similar results that all macroeconomic variables and stock market indexes (FTSE 100 and JSE all share) contain a unit root when tested in levels and have no unit roots when first differenced. This is consistent with literature as most macroeconomic variables and stock indexes are found to be non-stationary. Hence all series at levels are regarded as I (1) in the tests that follow.

Table 1. Unit root tests results

Variables	United Kingdom		South Africa	
Levels and first Δ	**ADF**	**Pperron**	**ADF**	**PPerron**
Log SPM	-0.323(1)	-5.896	-0.786(1)	-0.921
Log CPI	-4.009(1)**	-10.318	-1.905(1)	-10.038
logIP	-0.683(2)	-0.914	-0.701(t,1)	-2.963
logTB	-2.96 (1)	-9.377	-1.729(t,1)	-6.861
ΔLSPM=RSPM	-7.364(t,1)***	-110.922***	-7.067(t,1)***	-122.621***
ΔCPI	-8.153(t,1)***	-108.718***	-6.979(t,1)	-143.226***
ΔIP	-7.419(t,1)***	-149.677***	-5.181(t,1)	-110.229***
ΔTB	-7.479(1)***	-89.255***	-6.986(t,1)***	-136.264***

*Note: ** means significant at 1 and 10%,*
**** significant at all levels and (t, 1) refers to (trend, lag)*

4.2 Johansen Multivariate Co-integration Test Results

Here, we establish the existence or otherwise of co-integration between logged stock market index and macroeconomic variables. For the UK case, the trace statistics suggests one co-integrating vectors while the maximum Eigen value statistics also propose one co-integrating vector at 5% and 1% significance levels also. The trace and Eigen value statistic agree on one co-integrating vector.

4.3 Diagnostic Tests

The lag lengths chosen by the AIC and FPE for the UK dataset is five. The Lagrange multiplier test carried out for ensuring the absence of correlation at lag length shows no autocorrelation. For all normality tests including Jarque-Bera, skewness and kurtosis tests, it can be shown that all three tests investigating the multivariate normality of residual cannot reject the null hypothesis of normality.

For South Africa, the lag length unanimously chosen by all information criteria is one. However, at this lag length, we cannot reject the null of no autocorrelation. Hence, intuitively, two lags are used for tests. The normality tests are satisfactory depicting joint normality of residuals. The stability condition is however doubtful.

4.4 Analysis of Co-integrating Equations and Short Run Adjustment Parameters from the VECM

To interpret the co-integrating equations, more importance is given to the sign and significance rather than the magnitude of the coefficients. For the UK market, the CPI was seen to have significant influence and negatively related to the stock price index. The long term rate is also significant and negatively related to stock price index while the index of industrial production is significant and positively associated with the stock price index.

The co-integrating equation normalized on the log of stock market prices for the UK shows that, long term and inflation rate has a negative relationship with stock price index and also statistically significant. Also, the index of industrial production has a significant positive relationship with stock price index. The diagnostic tests are satisfactory as the Lagrange multiplier test shows that we cannot reject the null that there is no autocorrelation at the chosen lag length.

Table 1B gives the result for the adjustment parameters (alpha), about 0.3% of disequilibrium is corrected by changes in stock prices/index. About 0.5% of disequilibrium is corrected by changes in long term rates. About 9% of disequilibrium is corrected by changes in inflation rates. About 0.1% of disequilibrium is corrected by changes in the industrial production index. Only index of industrial production and inflation rate are statistically significant at 5%. The results suggest that when there is a shock or change in the system, the inflation rate responds the most, followed by the stock market, then index of industrial production and long term rates. This suggests that the inflation rate may be the most affected in the event of a sudden shock. We recall that inflation targeting is a central objective of the UK monetary policy goal. For instance, during the very recent economic downturn, the Bank of England used the monetary policy tools of interest rate and money supply (via quantitative easing) in a bid to influence the inflation rate back to the desired range.

Table 1A. Co-integrating equations for the UK

Lspm	Ltb	Lip	Lcpi	Trend	Constant
1	-11.618	45.7006	-5.984	0.0786	-210.2791
	(-3.09)*	(4.21)*	(-6.06)*	(5.12)*	

Table 1B. Adjustment parameters for the UK

	Coefficient	Z-values	P-values
D_lspm	0.00377	0.92	0.357
D_ltb	0.005275	1.58	0.115
D_lcpi	0.09312*	5.96	0.000
D_lip	0.00182*	2.18	0.029

Table 2A. Co-integrating equations for South Africa

Lspm	Ltb	Lip	Lcpi	Constant	Trend
1	-1.8711	2.5656	-0.7688	-15.4703	-0.0195
	(-3.74)*	(1.31)	(-4.40)*		

Table 2B. Short-run adjustment parameters for South Africa

	Coefficient	Z-values	P-values
D_lspm	-0.0363*	-2.14	0.032
D_ltb	0.0214	0.62	0.533
D_lcpi	0.3376*	3.45	0.001
D_lip	0.00207	0.92	0.360

Table 3A. UK – Granger causality results

Variables	RSPM	GIP	GTB	GCPI
RSPM	-	No	Yes**	No
GIP	No	-	No	Yes*
GTB	No	No	-	No
GCPI	Yes*	No	No	-

*The asterisks indicate the following levels of significance *1%, **5%, ***10%*

Table 3B. South Africa – Granger causality results

Variables	RSPM	GIP	GTB	GCPI
RSPM	-	no	No	no
GIP	Yes*	-	No	no
GTB	No	no	-	no
GCPI	No	no	Yes***	-

(indicate the following levels of significance *1%, **5%, ***10%)*

However, for South Africa, co-integration test performed in levels show that the co- integrating rank is zero and hence no long run relation is implied between variables. But the test run on first differences show that a full rank exists since all series used are stationary. However, in this case a long run relationship is not implied even though a strong co-integration is inferred. With the trend term in the model, a positive but insignificant relationship is between index of industrial production and stock price index. While both inflation and prime rates are significantly negatively related to the stock price index. The diagnostic tests are satisfactory, as the Lagrange multiplier test shows that we cannot reject the null of no autocorrelation at the chosen lag order.

For South Africa, the short run adjustment parameters shows that with the inclusion of trend in the model, about 3.6% of imbalance is rectified by changes in the stock price index. Meanwhile just 0.2% of imbalance is amended by changes in the index of industrial production. Around 2.1% of the imbalance is adjusted by changes in the prime rate. While about 33% of the imbalance is corrected by changes the inflation rate. With the lack of co-integration in the case of South Africa, a vector autoregressive model (VAR) in first differences can be done [26]. This is followed by the Wald test (Granger causality) to check the short run joint significance of the lagged values of the independent variable.

4.5 Causality Test Results

A variable Y is said to Granger-cause another variable X if both the past values of Y and X appear useful for predicting X or if X can be better predicted by histories of both Y and X than just by the past values of X alone. Granger causality test finds out if a lagged observation of another variable contains incremental forecasting power when included in a univariate autoregressive representation of a variable.

The Wald test that tests the joint significance of the lagged values of the independent variables follows a chi square distribution.

We can conclude based on the result that a unidirectional causal relationship exists between industrial production and inflation rate, between stock market returns and long term rate and between inflation rate and stock market returns.

Hence, for the UK, stock market returns is better described by both its past values and also changes in the long term rate. In addition, the changes in inflation rate are better accounted for by its past values and that of the stock market returns.

The Wald test that tests the joint significance of the lagged values of the independent variables follows a chi square distribution.

From the Table 3B, the conclusion is that a unidirectional causality link exists between changes in industrial production index and stock market returns and also between the inflation rate and long term rates for South Africa.

This can be interpreted as thus: changes in industrial production in South Africa are better explained by both its past values and also the past stock market performance explained by stock market returns. This finding is not strange as it has been established from the chapter on contextual information about South African market and economy that the exchange was actually birthed shortly after the discovery of gold in Johannesburg.

5. SUMMARY AND CONCLUSION

This study examines the relationship between the chosen stock market index and a set of macroeconomic variables from March 2000 to December 2009 for the UK and South Africa. The macroeconomic series dataset used include monthly observations of the UK FTSE100 index, the South Africa's JSE All share index, index of industrial production (IP), inflation rate (CPI) and long term interest rate. The proxy for UK long term rate is the 10-yr bond yield and the real overnight prime rate for South Africa.

With the use of the Johansen multivariate co-integration test, the study investigated whether the UK market index and South African market index (JSE all share) are co-integrated with a group of macroeconomic variables. The vector error correction model gives the equations and short run adjustment parameters, while Granger causality test is employed establishing contributory relationship.

The Johansen test indicates that there is at least one co-integrating vector for the UK based on the maximum Eigen value test result. The Johansen test indicates that there exist a long run relationship between FTSE 100 and the macroeconomic variables tested. This shows that traded securities respond to some degree to the pull of the macroeconomic fundamentals as predicted by the Arbitrage Pricing Theory (APT). Our findings differ from that of [11] whose conclusion was that macroeconomic variables seem not to impact share returns in the UK market. The difference in findings may largely be due to the dissimilar study period and technique of analysis spent. The Engel-Granger cointegration technique used by [11] can neither handle dynamic co-movements nor interaction of variables and it lack power. It is also important to note that vector of long run relationship between variables can vary over time [27].

The error correction term for the UK shows that the inflation rate and industrial production index contribute to the error correction process. The UK stock market also shows a significant negative relationship with both inflation rate and long term rate, while a statistically positive relationship is with the index of industrial production.

The short run adjustment parameters show that inflation rate appear to be the variable that responds the most to shocks in the system as it is highly significant. The results based on the UK data are largely in order with the existing theory and literature. However, for the South African case, no long run relationship exists between the stock market index and macroeconomic variables. The absence of a long run relationship suggests that past values of series are not useful or consistent predictors of stock prices. It could be that the market is relatively efficient. From the findings, the UK inflation rate can serve as a signal for the condition and state of the economy and stock market returns is important in explaining changes to industrial production in South Africa. The conclusions reached on this study are only suggestive and limited to the available data. Further investigation is necessary in this regard in the light of a richer dataset.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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APPENDIX 1

Diagnostics for lag choice, normality, stability and autocorrelation

A: South Africa (SA)

Varsoc lspm, maxlag(12) exog(lip lcpi ltb)

Selection order criteria

Sample: 13 118 Number of obs = 106

Lag	LL	LR	Df	P	FPE	AIC	HQIC	SBIC
0	-3.25101			.067136	.136811	.177548	.237319	
1	156.078	318.66*	1	0.000	.003385*	-2.85053*	-2.79961*	-2.7249*
2	156.115	.07313	1	0.787	.003447	-2.83236	-2.77125	-2.6816
3	156.18	.13008	1	0.718	.003509	-2.81472	-2.74343	-2.63883
4	156.499	.63904	1	0.424	.003555	-2.80188	-2.7204	-2.60086
5	156.915	.83181	1	0.362	.003595	2.79086	-2.6992	-2.56471
6	158.435	3.0393	1	0.081	.00356	-2.80066	-2.69882	-2.54939
7	158.547	.22361	1	0.636	.003621	-2.7839	-2.67188	-2.50751
8	158.615	.13593	1	0.712	.003686	-2.76632	-2.64411	-2.46479
9	159.053	.87706	1	0.349	.003726	-2.75572	-2.62333	-2.42907
10	159.054	.00047	1	0.983	.003798	-2.73686	-2.59428	-2.38508
11	159.058	.00845	1	0.927	.003872	-2.71807	-2.56531	-2.34117
12	159.308	.50026	1	0.479	.003929	-2.70392	-2.54098	-2.30189

Endogenous: lspm Exogenous: lip lcpi ltb _cons

B. United Kingdom

Varsoc lspm, maxlag(10) exog(lip lcpi ltb)

Selection order criteria

Sample: 11 118 Number of obs = 108

Lag	LL	LR	Df	P	FPE	AIC	HQIC	SBIC
0	60.1811			020687	-1.04039	-1.00011	-.941053	
1	187.328	254.29	1	0.000	.002001	-3.37645	-3.3261*	-3.25228*
2	187.976	1.2955	1	0.255	.002014	-3.36993	-3.30951	-3.22092
3	188.039	.1257	1	0.723	.002049	-3.35257	-3.28209	-3.17873
4	188.592	1.1058	1	0.293	.002067	-3.34429	-3.26374	-3.14562
5	193.093	9.0019*	1	0.003	.001937*	-3.40913*	-3.3185	-3.18561
6	193.128	.07037	1	0.791	.001972	-3.39126	-3.29056	-3.14291
7	194.305	2.3549	1	0.125	.001966	-3.39454	-3.28378	-3.12136
8	194.312	.01284	1	0.910	.002003	-3.37614	-3.25531	-3.07813
9	195.292	1.9601	1	0.161	.002004	-3.37578	-3.24487	-3.05293
10	195.31	.03567	1	0.850	.002042	-3.35759	-3.21661	-3.0099

Endogenous: lspm Exogenous: lip lcpi ltb _cons

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