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The impact of selected macroeconomic variables on resource equity prices on the Johannesburg Stock Exchange

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A research project submitted to the Gordon Institute of Business Science, University of Pretoria, in partial fulfillment of the requirement for the degree of Master of Business Administration.

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ABSTRACT

There exists significant literature investigating the link between macroeconomic variables and stock market returns. Most previous studies utilise an overall stock market index to measure stock market returns, thereby aggregating a number of different industries into a single index. This research investigated the link between macroeconomic variables and a single sector's share returns, being the Resources sector. The aim was to ascertain whether or not a correlation exists between the Resource Index of the Johannesburg Stock Exchange and four macroeconomic variables, namely: GDP, Inflation, Interest rates and the Rand/US Dollar Exchange Rate. Quarterly data for all 4 macroeconomic variables and the Resource Index was collected for the period 2002 to 2011 and tests of correlation performed between each macroeconomic variable and the Resource Index.

The findings reveal that there is a positive correlation between GDP and resources share returns, a negative correlation between interest rates and resources share returns and a positive relationship between the Rand/US Dollar Exchange rate and resources share returns. The relationship between the inflation and the resource share returns proved inconclusive.

Keywords: GDP, CPI, prime interest rate, Exchange rate, JSE Resources Index.

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DECLARATION

I declare that this research project is my own work. It is submitted in partial fulfilment of the requirements for the degree of Master of Business Administration at the Gordon Institute of Business Science, University of Pretoria. It has not been submitted before for any degree or examination in any other University. I further declare that I have obtained the necessary authorisation and consent to carry out this research.

Patrick Afordofe

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1 INTRODUCTION TO THE RESEARCH PROBLEM

1.1 Introduction

An efficient capital market is one in which prices of securities adjust rapidly to the arrival of new information (Singh, Mehta, & Varsha, 2011). The semi strong form of the Efficient Market Hypothesis (EMH) states that stock prices must contain all relevant information including publicly available information (Fama, 1970). Economic theory suggests that stock prices should reflect expectations about future corporate performance. Corporate profits generally reflect the level of economic activity.

The most basic factors that influence the price of any security (equities, bonds, etc) are demand and supply factors. If demand for a share is high, its price increases and if people start selling a share, its price goes down (Al-Shubiri, 2010). Beyond basic supply and demand factors, macroeconomic factors can also affect equity share prices. Macroeconomic factors that affect share prices include government regulations, economic growth, exchange rates, interest rates, government debt and fiscal deficits, to name a few.

1.2 Research Problem

Significant literature now exists which investigates the relationship between stock market returns and a range of macroeconomic and financial variables, across a number of different stock markets (Humpe & Macmillan, 2009, p. 111). Prior studies

conducted have utilised an overall stock index as a proxy for stock market performance. An overall stock index aggregates the share price performance of a number of different companies, in different industries, into a single index. This paper argues that by studying the relationship between macroeconomic variables and an overall stock index, unique correlations between different sector share prices and macroeconomic variables may be concealed.

This paper reviews the correlation between selected macroeconomic variables and the composite of a single sector's share prices, the resources sector. The resources sector is comprised of the mining and oil and gas industries. The macroeconomic variables that have been used in this investigation are the following:

- Gross Domestic Product (GDP)
- Inflation
- Interest rates
- Rand/US Dollar exchange rate.

The motivation for the research follows in section 1.3.

1.3 Research Motivation

The resources sector is a critical component of the South African economy and likewise the economies of many African countries, given the abundance of natural mineral resources on the continent. Although South Africa's economy has diversified away from resources to other sectors such as manufacturing and financial services, resources still contribute significantly to the economy. In other African countries, the

extent of diversification is less advanced and resources contribute an even greater portion to their GDPs.

Economic statistics show the continued importance of the resources sector to the South African economy. The performance or non-performance of listed resource shares can have a significant impact on the Johannesburg Securities Exchange.

Chen, Roll and Ross (1986) suggest that the selection of macroeconomic variables to be tested requires judgement. Many authors (Fama, 1990; Cheung & Ng, 1998; Nasseh & Strauss, 2000) find that corporate cash flows are related to a measure of aggregate output such as GDP and this has been chosen as one of the independent variables to be tested.

Unexpected inflation may influence real stock prices through unexpected changes in the price level and inflation uncertainty may also affect the discount rate, thus affecting the present value of future corporate cash flows. The interest rate directly changes the discount rate in the valuation model and thus influences current values of corporate cash flows. Exchange rates affect the earnings of resources companies as commodity prices are denominated in dollars. Changes in the US Dollar exchange rate can therefore have a significant impact on the earnings of South African resources companies.

1.4 Research objectives

The aim of this research is to determine whether macroeconomic conditions impact equity prices on the resources sector of the JSE. The related research objectives are as follows:

- To determine the relationship between aggregate economic activity and the average market return (AMR) of the Financial Times and London Stock Exchange (FTSE)/JSE Resources 10 Index (RESI).
- To determine the relationship between inflation and the AMR of the FTSE/JSE RESI Index.
- To determine the relationship between interest rates and the AMR of the FTSE/JSE RESI Index.
- To determine the relationship between the Rand/US Dollar exchange rates and the AMR of the FTSE/JSE RESI Index.

The results of the study will be relevant to business leaders, investors, and academics concerned with the driving forces behind the share price performance of listed resources companies.

2 LITERATURE REVIEW

2.1 Introduction

The first part of the literature review contains a discussion of the South African resources sector and also a discussion of the resources sector of the JSE. The literature review then considers previous studies conducted on the impact of four key macroeconomic variables on stock market returns, being aggregate economic activity, inflation, interest rates and exchange rates.

2.2 The South African Resources Sector

The resources sector, especially mining, has been a significant contributor to the South African economy for over a century. South Africa's long history with minerals began with the discovery of diamonds near the Orange River in the 1860s. However, it was the Witwatersrand gold rush of the late 1880s that really ignited South Africa's long and successful period of mining. (Government Communication and Information Systems, 2011)

Along with the mining industry came the development of key services, manufacturing and side stream industries. Hence the mining industry acted as a catalyst for the inception and development of other key industries.

The mining industry's contribution to the South African economy has declined from the highs of the 20th century, but it still plays a significant role. The relative decline of the mining industry's contribution was against the backdrop of economic

diversification and the faster growth pace of other sectors such as manufacturing, finance and construction; industries to which the mining sector also contributes greatly (Government Communication and Information Systems, 2011).

Despite the relative decline of the mining industry, it remains an attractive industry for investment and development with significant resources of gold, uranium, chrome, manganese, palladium group metals (PGMs), titanium-minerals, vanadium, coal, limestone, vermiculite and zirconium (Government Communication and Information Systems, 2011).

The mining industry's contribution to the South African economy follows (Government Communication and Information Systems, 2011):

- It contributes about 10% to the South African GDP;
- It contributes more than 30% to the country's total exports;
- 18% of corporate tax receipts are from the mining industry;
- Employs about 2% of the economically active population of South Africa;
- Directly contributes more than 95% towards electricity generation;
- Listed mining companies represent over 30% of the market capitalisation of the JSE.

The major oil and gas producer in South Africa is Sasol. This energy and chemicals entity was established in the 1950s to commercialise coal-to-liquids technology in South Africa. It produced its first automotive fuel in 1955 (Sasol History, 2009). The entity has grown over time, reaching revenues of about R120 billion of revenue in the 2010 financial year (Sasol, 2011).

2.3 The JSE Resource Sector

The Resources sector of the JSE comprises the mining and oil and gas industrial sectors. The FTSE/JSE Resource 20 Index was formed in June 2002 and the Index comprised the top 20 resource shares on the JSE by full market value (JSE, 2011).

In March 2011 the Index was changed to the Resources 10 Index and is now made up of the top ten resource shares by full market value. In addition, companies need to pass normal All Share screening criteria, for example liquidity and free float screening (JSE, 2011). The Resource Index utilised for this study shall henceforth be referred to as the RESI Index.

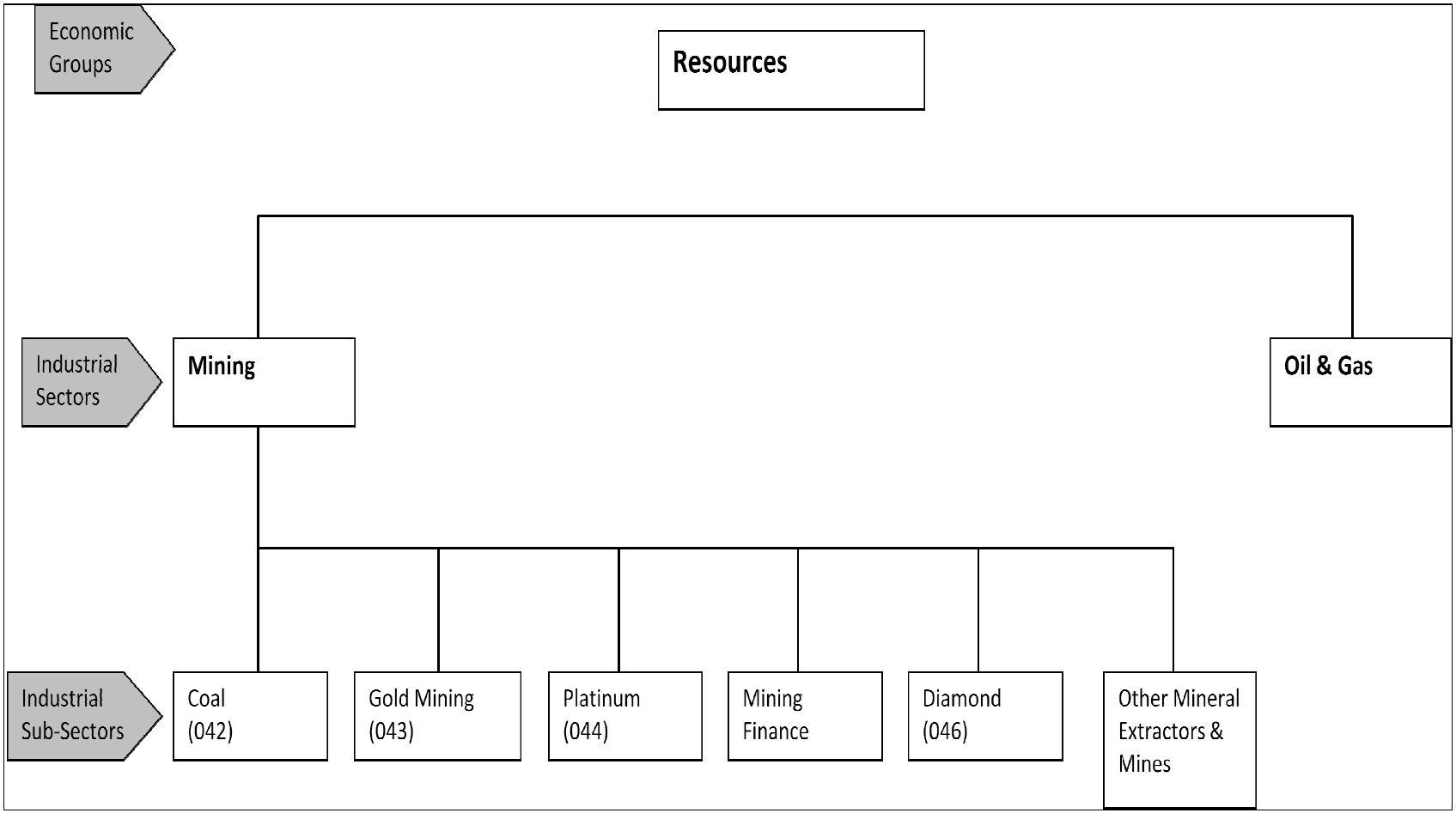
Table 1 lists the companies that the Resources 20 Index was comprised of as at March 2011. Figure 1A and 1B present a diagrammatic structure of the resources sector of the JSE.

Table 1: Composition of Resource 10 Index at October 2011

FTSE/JSE Resource 10 Index				
Quarterly Review - October 2011				
Rank	**Security**	**Ticker**	**Current Index**	**Market Capitalisation (ZAR)**
1	BHP BILLITON PLC	BIL	RESI	521,072,408,023
2	ANGLO AMERICAN PLC	AGL	RESI	391,982,075,208
3	SASOL LTD	SOL	RESI	215,552,303,366
4	ANGLO AMERICAN PLAT LTD	AMS	RESI	153,829,707,784
5	ANGLOGOLD ASHANTI LTD	ANG	RESI	121,213,790,874
6	IMPALA PLATINUM HLGS LD	IMP	RESI	113,410,444,506
7	GOLD FIELDS LTD	GFI	RESI	84,212,102,988
8	EXXARO RESOURCES LTD	EXX	RESI	67,440,716,353
9	AFRICAN RAINBOW MINERALS	ARI	RESI	40,082,443,612
10	LONMIN P L C	LON	RESI	30,330,219,600

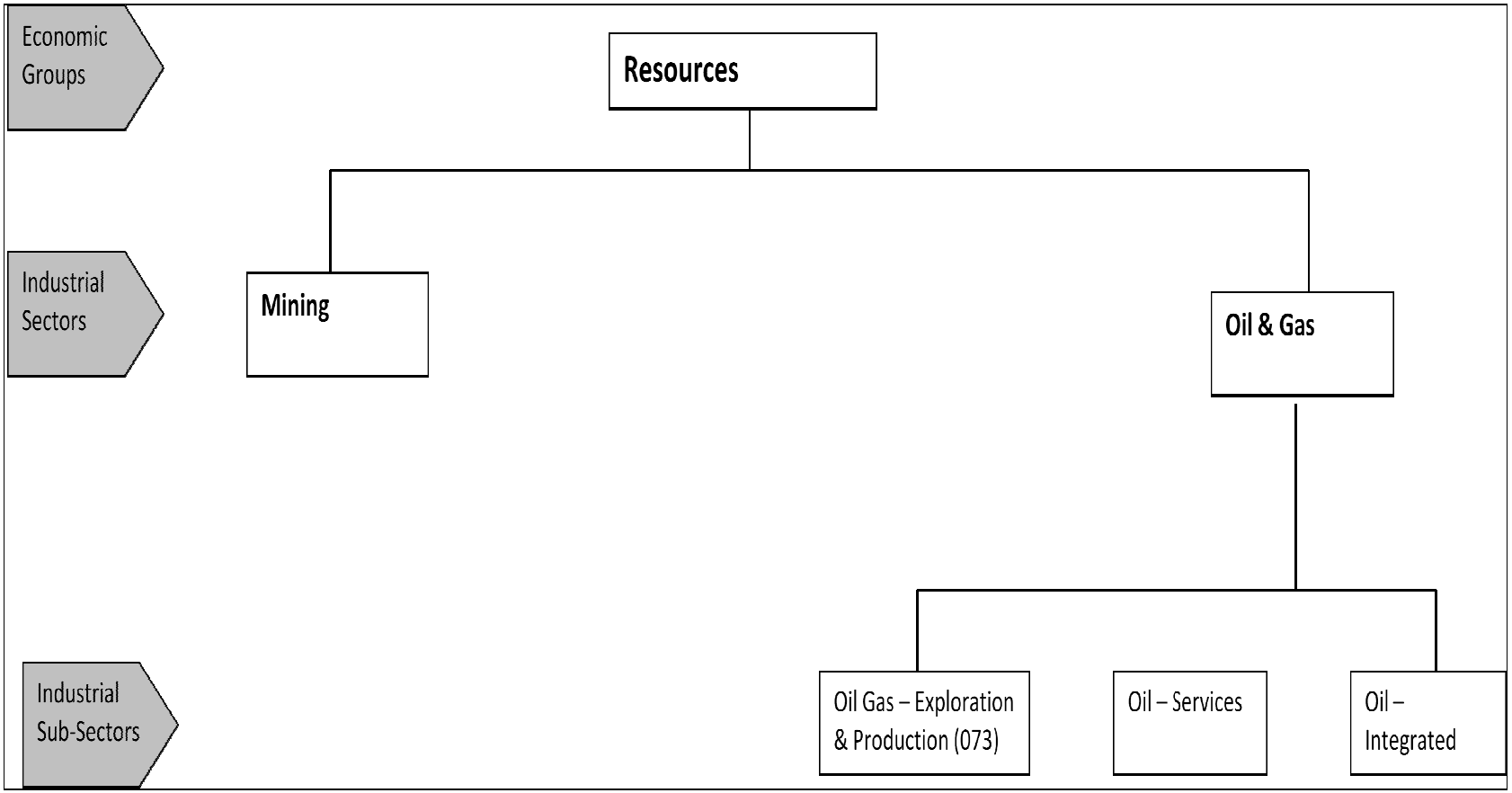
Source: (JSE, 2011)

Figure 1: JSE Resources Sector: Mining



Source: (JSE, 2009)

Figure 2: JSE Resources Sector: Oil and Gas



Source: (JSE, 2009)

2.4 The great nationalisation debate

Although not the main focus of this paper it would be remiss not to include a discussion of the debate on the possible nationalisation of mines that engulfed South Africa at the time of writing. The debate had split the country into two camps, some arguing for, and others arguing against the nationalisation of mines.

For a long period of time, South Africa has been ranked as one of the most unequal societies in the world. The country experienced very high levels of income inequality under Apartheid, which was due to the differences between high white incomes and low black incomes (Nix, 2007). Under Apartheid there was a system of job reservation for whites and those jobs that the Black population (being African Blacks, Coloureds and Asians) could obtain were very low paid jobs (Sherer, 2000). The Black population was also excluded from participation in the mainstream economy due to restrictions on physical movement and the ownership of land and assets.

All the above factors combined to create a society in which there was very high income inequality, with the minority White population earning an overwhelming majority of the country's total income. Post-Apartheid, with the scrapping of many discriminatory laws and integration of the Black population into the mainstream economy, expectations were high that income inequality would decrease. Contrary to expectations however, income inequality as measured by the Gini coefficient continued to rise in South Africa (Nix, 2007).

Income inequality remains high in South Africa, with the average household income among the top 10% of earners being 94 times higher than what the poorest 10% earn. Also, while all income groups have seen a real increase in income between 2000 and 2005/6, 10% of the country's population receives over 50% of its income from social grants (Monteiro, 2008). Income inequality in South Africa, as measured by the Gini coefficient, was estimated to be between 60 and 70 percent at the time of writing (Statistics South Africa, 2008). 100% is an indication of absolute inequality, while zero percent indicates no inequality.

It is against this backdrop that the calls for the nationalisation of mines had become increasingly vociferous. The African National Congress Youth League (ANCYL), the youth arm of the ruling party, invoked the Freedom Charter to support its calls for nationalisation. The Freedom Charter is a statement of the South African Congress Alliance, an alliance of several political parties that met on 26 June 1955 in Kliptown to demand equal rights for all South Africans. The Freedom Charter states the following:

> "The people shall share in the country's wealth! The national wealth of our country, the heritage of South Africans, shall be restored to the people; the mineral wealth beneath the soil, the banks and monopoly industry shall be transferred to the ownership of the people as a whole; all other industry and trade shall be controlled to assist the wellbeing of the people; all people shall have equal rights to trade where they choose, to manufacture and to enter all trades, crafts and professions. The land shall be shared among those who work it!" (African National Congress Youth League, 2010).

The proponents of nationalisation list the potential benefits to South African society as being, among other things, increases in government revenue, creation of jobs, creation of better working conditions, safeguarding of South Africa's sovereignty, breaking the dependence on monopoly capital and the transformation of unequal spatial development (African National Congress Youth League, 2010).

Those against nationalisation have offered some reasons for their lack of support. First, the South African government may be unable to afford the compensation required to purchase the mines in South Africa (Odendaal, 2011). At the time of writing the market capitalisation of the listed mining companies on the JSE was *circa* R2 billion. If the expropriation route is taken, investors may be anxious to further invest in the mining sector due to the fear of losing their assets. It may also lead to a withdrawal or reduction of investment in other sectors (Kamhunga, 2011). Moreover, others question the ability of the government to operate mines considering the financial troubles that many state owned enterprises (SOE) find themselves in. Lastly, many doubt the ability of the nationalisation process to actually deliver benefits to all citizens of the country and whether any revenues derived would actually be used for worthwhile projects.

For all the pros and cons of nationalisation being debated, the government had not issued a clear policy statement on the issue of nationalisation at the time of writing. It was also unclear as to the effect that the talk of potential nationalisation or what the actual process of nationalisation may have on the share prices of listed mining companies, should it be implemented. The impact

of nationalisation on mining company share prices was however not the objective of this paper and as such was not investigated any further.

2.5 The link between macroeconomic variables and stock returns

Significant literature now exists that investigates the relationship between the stock market and a range of macroeconomic and financial variables, across a number of different stock markets and over different time horizons. There are a number of models based on economic theory that provide a framework for the study of this relationship.

One way of linking macroeconomic variables and stock market returns is through Arbitrage Pricing Theory (APT) where multiple risk factors can explain asset returns (Ross, 1976). APT is a general theory of asset pricing that holds that the expected return of a financial asset can be modelled as a linear function of various macro-economic factors or theoretical market indices, where sensitivity to changes in each factor is represented by a factor-specific beta coefficient (Ross, 1976). Most of the empirical studies based on APT theory, linking the state of the macro economy to stock market returns are characterized by modelling a short-run relationship between macroeconomic variables and the stock price (Humpe & Macmillan, 2009).

An alternative model for linking macroeconomic variables and stock market returns is the discounted cash flow or the Present Value Model (PVM). This model relates stock prices to future expected cash flows and the future discount rate of these cash flows (Humpe & Macmillan, 2009). By implication, any

macroeconomic variables that influence future expected cash flows or the discount rate at which these cash flows are discounted should have an influence on the stock price. Humpe and Macmillan (2009) proceed to state that the PVM model has an advantage over the APT in that it can be used to focus on the long-run relationship between the stock market and macroeconomic variables.

Fama (1970) states that an ideal market is one in which prices provide accurate signals for resource allocation. He goes further to postulate that an efficient market is one in which prices always fully reflect available information. This is the central tenet of the EMH. Fama (1970) also classifies three types of efficient markets, the weak form, semi strong and strong form. The weak form market reflects all past, publicly available information, while the semi strong form not only reflects available information, but prices change instantly to reflect new public information. The strong form market fully reflects all information, adjusts instantly to new information and even reflects hidden or “insider” information.

Based on the models discussed several studies have been conducted to investigate the link between macroeconomic variables and stock market returns. Some macroeconomic variables that have been investigated include economic activity, inflation, interest rates, exchange rates, productivity, unemployment, money supply, government bond rates and oil prices, to name a few.

2.6 Aggregate Economic Activity and share prices

The most widely used measure of economic activity is GDP. GDP is the total market value of all final goods and services produced in an economy in a one year period (Colander, 2010). Another measure of economic activity that is used is Gross National Product (GNP). GNP is basically GDP less the economic activity of foreign individuals and businesses in a country, but including the economic activity of a country's citizens and businesses that reside in another country (Colander, 2010).

Numerous studies have been undertaken to investigate the relationship between a country's aggregate economic activity and its stock market returns. Fama (1990), using regression analysis, tested the link between growth in real activity and equity returns on the New York Stock Exchange (NYSE). He found that real activity explained at least 43% of the variation in annual returns on the NYSE. Beckers, Grinold, Rudd, & Stefek (1992), Ferson and Harvey (1993), and Cheung, He and Ng (1997) have all reached a similar conclusion using other international market data. All of these studies were however focused on short term relationships between the stock markets and economic activity.

McQueen and Roley (1993) investigated the relationship between macroeconomic news and stock prices. After allowing for different stages of the business cycle, a strong relationship between stock prices and news was evident. In addition, they investigated the effect of real activity news on proxies for expected cash flows and equity discount rates. They found that when the economy was strong, the stock market responded negatively to news about

higher real economic activity. The negative relation was caused by the larger increase in discount rates relative to expected cash flows through an expectation of increased interest rates.

Park (1997) selected five macroeconomic variables being annualised growth rates of employment, GDP, private investment, industrial production and retail sales. He then regressed the five macroeconomic variables on stock returns indirectly by measuring the effects of the five macroeconomic variables on future cash flows and inflation. The conclusion drawn from his study was that the stock market's reaction to an economic variable reflects the variable's effects on future corporate cash flows and inflation. Stock returns were found to be related most negatively with employment growth and most positively with GDP growth.

Utilising a Johansen cointegration technique, Cheung and Ng (1998) studied the long run comovements between five national stock market indexes and measures of aggregate real activity. Their study found that in the long run there was an even stronger relationship between real activity and stock returns. Nasseh and Strauss (2000) also agree that there is a definite long-term relationship between stock price levels and industrial production.

Hassapis and Kalyvitis (2002) investigated the link between real stock price changes and economic growth. A Vector Autoregression (VAR) Methodology was utilised in testing for this link. The paper extended the existing literature at the time on the relationship between output growth and real stock returns by showing that the links between the two variables did not move solely from stock returns to output growth as hypothesized in many previous studies. The authors

analysed annual and quarterly data in reaching their conclusions. The results revealed a statistically significant positive correlation between real stock returns and output growth for the five biggest economies, namely Canada, Germany, UK, Japan and the US. The result for France indicated a positive, but statistically insignificant correlation, while that of Italy was a statistically insignificant negative correlation.

Mauro (2003) studied the correlation between output growth and stock returns in advanced and emerging economies, finding that the proportion of countries in which the correlation is significant is the same for emerging market economies as it is for advanced economies.

Chaudhuri and Smiles (2004) using multivariate cointegration methodology, document the evidence of long-run relationships between real stock price and measures of aggregate real economic activity including real GDP, real private consumption, real money and the real price of oil in the Australian market. A first-differenced series of all the variables being tested was produced and these transformed series were used in the regression analysis. Evidence was also found that other sources of stock return variation such as term spread and future GDP growth rates did not provide additional explanatory power for the variability in stock price returns.

DeStefano (2004) examined whether movements in economic factors dictated by the dividend discount model could explain broad movements in stock returns over the business cycle. As anticipated, stock returns decreased throughout economic expansions and became negative during the first half of recessions. Returns were largest during the second half of recessions, suggesting an

important role for expected earnings. The results were consistent with the notion that expected stock returns vary indirectly with economic conditions.

Tsouma (2009) tested the relationship between stock returns and economic activity in mature and emerging markets. A significant finding of Tsouma's study was that there was strong evidence of the ability of stock returns to predict future economic activity, while the converse only held a weak relationship. Further, it was found that, for most emerging markets, economic activity includes significant information concerning future stock returns, whereas for mature markets stock returns had stronger predicting power for future economic activity. This study suggests that, in emerging markets, economic activity is a strong predictor of future stock returns.

From the literature, it is clear that there is significant evidence of a correlation between aggregate economic activity and stock returns. The majority of results displayed a positive correlation although a few displayed a negative correlation. The correlations were found to be stronger over a long-term horizon than over the short-term.

2.7 Inflation and share prices

Inflation is a continual rise in the price level, the price level being an index of all prices in the economy (Colander, 2010). Inflation guides the macroeconomic policies of governments and often prevents governments from taking actions such as lowering interest rates, reducing unemployment and increasing government spending, which have the effect of expanding the economy.

Reduced economic activity can impact stock returns by decreasing business profitability and cash flows. The most commonly used measure of inflation is the rate of change in the Consumer Price Index (CPI) which measures the price of a fixed basket of consumer goods, weighted according to each components share of an average consumer's expenditures (Colander, 2010).

Firth (1979) in his study on the relationship between stock market returns and inflation in the UK found that expected rates of return on common stocks consist of a real return plus the expected rate of inflation and that the real rate of return is independent of the rate of inflation. This hypothesis is known as the 'Fisher effect'. He concluded that the stock market did provide some hedge against inflation. His results provided a sharp contrast to the results of work done in the USA (Bodie, 1976; Fama & Schwert, 1977; Jaffe & Mandelker, 1976) that found a significant negative relationship between stock market returns and rates of inflation. At the time no meaningful explanation could be given for the difference in results. Feldstein (1980) shed some light on this conundrum in his study on inflation and the stock market. He found that US tax laws, particularly historic cost depreciation and the taxation of nominal capital gains was the primary reason for the negative relationship between inflation and stock prices in the US.

Gultekin (1983) extended the study of inflation and stock market returns to 26 other countries. His results did not support the Fisher hypothesis which asserted the independence of real rates of return on common stocks and expected inflation. Further, a consistent positive relation between inflation and stock returns could not be found. This is similar to the results of the US studies

at the time. Geske and Rolls's (1983) study also confirmed the negative relationship between stock prices and inflation.

Boudokh and Richardson (1993) argued for testing the relationship between inflation and stock returns over a long-run horizon as most investors hold stocks over long holding periods and given the anomalous results of studies conducted over short term horizons, it was important to determine the relationship over longer horizons. It was found that over a longer horizon there was strong evidence of a positive relation between nominal stock returns and inflation.

Ely and Robinson (1997) supported the conclusion of a positive relationship between inflation and stock returns over the long-term. Their approach was to utilise a reduced-form approach and advances in the theory of cointegration to explore the international evidence on the relationship between stock prices and goods prices. This approach enabled them to test whether stocks maintained their value relative to goods prices and whether the response patterns depended on the source of the inflation shock. Their results indicated that stocks did maintain their value relative to movements in overall price indexes and the conclusion did not depend on whether the source of the inflation shock was from the real or monetary sector.

It soon became apparent that the time period was crucial in the study of linkages between inflation and stock returns and that the short-term focus of the earlier studies was the main reason for the anomalous results. Further studies (Murphy & Sahu, 2001; Choudhry, 2001; Rapach, 2002; Al-Khazali & Pyun, 2004) strengthen the finding of a positive long-run relationship between inflation and stock prices. Maysami, Lee and Hamzah (2004) in their study on the

relationship between certain macroeconomic variables and stock market returns documented evidence of Singapore's stock market index forming a cointegrating relationship with changes in price levels.

Alagidede & Panagiotidis (2010) studied six African economies, namely Egypt, Kenya, Morroco, Nigeria, South Africa and Tunisia and found that there was definite evidence of a positive long run relationship between stock prices and inflation. In a South African specific study, Arjoon, Botes, Chesang, & Gupta (2010) confirmed a positive long run relationship between inflation and real stock prices.

From the literature the existence of a positive long run relationship between inflation and stock prices is evident. Initial short-term focuses lead to anomalous results. The positive long run relationship is consistent for studies performed for different countries and regions of the world.

2.8 Interest Rates and share prices

Abdullah & Hayward (1989) employed Granger causality tests and Sims innovation accounting to explain fluctuations in monthly stock returns within a vector autoregressive framework. The results showed that both short and long-term interest rates were Granger causal to stock returns. Mukherjee and Naka (1995) employed a vector error correction model (VECM) to study the relation of the Tokyo Stock exchange (TSE) with various macroeconomic variables. The study produced mixed results for the relation between the TSE and interest rates. The relation between the TSE and long-term government bond rates was

found to be negative while the opposite was true for the relation between the TSE and call money rates. The explanation offered for this conflicting result was the possibility that in Japan the long-term bond rate served as a better surrogate for the nominal risk free component of the discount rate in the present value model. Further studies (Maghayereh, 2003; Ratanapakorn & Sharma, 2007; Humpe & Macmillan, 2009) confirmed the existence of a significant negative relationship between short and long-term interest rates and stock prices.

Alam (2009) investigated the empirical relationship between stock market indexes and interest rates for fifteen developed and developing countries including South Africa. Alam tested the randomness of the markets using tools of stationarity of share prices and the relationship between interest rates and share prices by means of regression analysis. Overall, the theoretical argument of a negative relationship between stock price and interest rate could not be rejected. In most of the countries sampled it was found that interest rates had a negative relationship with share prices, except in Japan where interest rate was found to have a positive relationship with share prices.

Al-Shubiri (2010) investigated the relationship between the stock prices of 14 Jordanian commercial banks and several macroeconomic variables including the Jordanian lending interest rate. A significant negative relationship was found to exist between the stock prices and the lending interest rate. Hsing (2011) also studied the relationship between Hungary's stock market index and relevant macroeconomic variables. A negative relationship was found to exist between the stock market index and the real interest rate.

From the existing literature, there is clear evidence of a negative relationship between interest rates and stock market returns. This negative relationship is consistent over different time periods and in different countries.

2.9 Exchange rates and share prices

Bahmani-Oskooee and Sohrabian (1992) employed the Granger concept of causality as well as cointegration techniques to test the relationship between stock prices and exchange rates in the US. The empirical results showed a bi-directional causality between stock prices as measured by the Standard and Poor's 500 index and the effective exchange rate of the dollar, at least in the short run. No long-run relationship between the two variables was found to exist. Ajayi & Mougoue (1996) studied the linkage between stock prices and exchange rates in eight advanced economies using an error correction model (ECM) to simultaneously estimate the short and long run dynamics of the variables. The results revealed significant short-run and long-run relations between the two variables. Currency depreciation was found to have a negative short and long-run effect on the stock market.

Abdalla & Murinde (1997) focused their study on the emerging financial markets of India, Korea, Pakistan and the Philippines. The linkages between stock prices and exchange rates were considered important due to the attempts to develop stock markets in emerging economies simultaneously with a policy shift towards independently floating exchange rates. The study's finding was that of a unidirectional causality from exchange rate to stock prices.

Several further studies (Kanas, 2000; Nieh & Lee, 2001; Wu, 2001) confirmed the existence of a linkage from exchange rates to stock prices. Kim (2003) found a specific negative relationship. Smyth and Nandha (2003) however, found no long run equilibrium relationship between the two variables in a study conducted on the South Asian countries of Bangladesh, India, Pakistan and Sri Lanka. There was found to be uni-directional short term causality running from exchange rates to stock prices in India and Sri Lanka, while no relationship was found for Bangladesh and Pakistan. The finding of a nonexistent long-run relationship is consistent with that of Bahmani-Oskooee and Sohrabian (1992).

A study conducted by Gay (2008) for the four emerging economies of Brazil, Russia, India and China (BRIC) found there to be a positive relationship between exchange rate and the stock market index prices of Brazil, India and China, but not for Russia.

The research on the links between exchange rate and stock prices has shown conflicting results. Bahmani-Oskooee and Sohrabian (1992) and Smyth and Nandha (2003) found no evidence of a long-run relationship. Ajayi and Mougoue (1996) in contrast found evidence of a significant long-run relationship. All the other studies found evidence of a short-run unidirectional relationship from exchange rate to stock prices. A predominantly negative relationship was found to exist between exchange rate and stock prices.

2.10 Summary of Literature Review

The prior literature studying the relationship between macroeconomic variables and share returns is plentiful. Literature has shown that there is a definite positive relationship between aggregate economic activity and share returns, regardless of the measure of economic activity. Increased economic activity leads to increased revenues and profitability and hence increased share prices as investors' expectations of future dividends rises.

There is also evidence of a positive long-run relationship between inflation and share prices. The short term results prove inconclusive. This indicates that, in the long run, shares provide a hedge against inflation. Most of the studies conducted on the relationship between interest rates and share returns indicate a significant negative relationship between the two variables. The studies on the relationship between exchange rates and share returns have returned conflicting results, with some studies finding evidence of a significant long run relationship and others finding no evidence of a relationship.

The one factor that stands out from the literature review is that all the studies have tracked the relationship of macroeconomic variables with an overall stock market index. The overall stock market index includes companies from different industries which might react differently to the various macroeconomic variables being studied. Using an overall index aggregates possible unique interactions between the variables and specific industries. This paper proposes studying the impact of macroeconomic variables on one industry sector (the resources

sector), in an attempt to understand the interaction of this industry with various macroeconomic variables.

3 RESEARCH HYPOTHESES

3.1 Hypothesis 1

The first research objective was to determine the relationship between aggregate economic activity and the average market returns (AMR) of the RESI Index.

The null hypothesis associated was: There is no correlation between aggregate economic activity and the AMR of the RESI Index.

The alternative hypothesis associated with this objective was: There is a correlation between aggregate economic activity and the AMR of the RESI Index.

Thus:

$H1_0$: r = 0

$H1_A$: r <>0

3.2 Hypothesis 2

The second research objective was to determine the relationship between inflation and the AMR of the RESI Index.

The null hypothesis associated was: There is no correlation between inflation and the AMR of the RESI Index.

The alternative hypothesis associated with this objective was: There is a correlation between inflation and the AMR of the RESI Index.

Thus:

$H1_0$: r = 0

$H1_A$: r <>0

3.3 Hypothesis 3

The third research objective was to determine the relationship between interest rates and the AMR of the RESI Index.

The null hypothesis associated was: There is no correlation between interest rates and the AMR of the RESI Index.

The alternative hypothesis associated with this objective was: There is a correlation between interest rates and the AMR of the RESI Index.

Thus:

$H1_0$: r = 0

$H1_A$: r <>0

3.4 Hypothesis 4

The fourth research objective was to determine the relationship between the Rand/US Dollar exchange rate and the AMR of the RESI Index.

The null hypothesis associated was: There is no correlation between the Rand/US Dollar exchange rate and the AMR of the RESI Index.

The alternative hypothesis associated with this objective was: There is a correlation between the Rand/US Dollar exchange rate and the AMR of the RESI Index.

Thus:

$H1_0$: r = 0

$H1_A$: r <>0

4 RESEARCH METHODOLOGY

4.1 Overview

The aim of the study was to determine whether resource share prices have a correlation with the macroeconomic variables GDP, inflation, interest rates and the Rand/US Dollar exchange rate. Numerous studies have been conducted to test the correlation of stock market prices with macroeconomic variables. These prior studies have studied the correlation of the market as a whole with macroeconomic variables. This study aimed to test whether there is any evidence on the JSE that macroeconomic variables have any impact whatsoever on Resource share prices specifically, be it positive or negative.

The JSE has developed a host of indices that can be used as benchmarks to measure the performance of major industry segments of the African market. The FTSE/JSE All Share Index (ALSI) falls under the Headline Indices category of the FTSE/JSE Africa Index series, which replaced the JSE Actuaries Indices in June 2002. In turn, the RESI Index is constructed against the base universe of the ALSI.

One dependent variable, the FTSE/JSE RESI Index, was tested against four independent variables: GDP, inflation, interest rates and the Rand/US Dollar exchange rate. The RESI Index comprises the top ten resource shares of the JSE by market capitalisation.

Average Market Return (AMR) refers to the change in a company's share price between two periods, measured as a function of share price.

$$AMR = \frac{\text{Opening Share Price in period i } (P_i)}{\text{Opening Share Price in period i-1 } (P_{i-1})} - 1$$

Dividends paid by individual companies have not been explicitly taken into account in the calculation of the AMR. The RESI Index movements are based on the movements of the share prices of the individual listed companies constituting the Index. Any dividend expectations would be priced into the individual share prices of the companies within the RESI Index. As such, the impact of dividends is already accounted for in the Index. The research aimed to investigate the impact of macroeconomic variables on the share prices of resource companies. Hence, it is appropriate to exclude dividends in the calculation of the AMR.

An index represents a summation of these AMR values, reflecting the collective returns of the category of companies that are constituents of the index in question. The movement of the RESI Index was therefore used a proxy for the movement in Resources shares' prices in order to measure the AMR.

As per prior research, GDP has been used as a proxy for aggregate economic activity. GDP is normally reported on a quarterly basis and the GDP growth is calculated by comparing the current quarter's GDP to the same quarter of the previous year. This is a year-over-year comparison. GDP of one quarter can also be compared to the GDP of the previous quarter, which is a quarter-on-quarter comparison. GDP is also reported in real terms in order to make year-

to-year comparisons meaningful. Real GDP is the nominal GDP adjusted for inflation. Inflation was measured using changes in the Consumer Price Index (CPI). CPI is reported on a monthly basis in South Africa.

There are two key measures of the interest rate in South Africa, being the repo rate and the prime lending rate. The repo rate is the rate at which the South African Reserve Bank (SARB) lends money to commercial banks and the prime interest rate is the basis for the rate structure at which the commercial banks lend money to the public and businesses. The prime interest rate usually includes a premium of 3.5 percentage points on top of the repo rate to allow the commercial banks to earn a margin. Although the repo rate and the prime lending rate in South Africa generally move in unison, the prime lending rate was utilised as the interest rate for this study as it is the rate that determines the cost of borrowing for businesses. Depending on risk assessment, commercial banks charge a rate structure around the prime rate, with low-risk borrowers receiving a discount on prime and high-risk borrowers paying a premium on prime.

For the exchange rate, the Rand/US Dollar exchange rate was utilised. This is due to the fact that most resource prices are denominated in US Dollars and hence the revenues earned by resources companies would mostly be affected by changes in the Rand/US Dollar exchange rate.

4.2 Research Design

The research methodology took a quantitative, descriptive approach, examining the relationship between the macroeconomic variables and the AMR of the RESI Index.

No attempt was made to establish causality between the macroeconomic variables and resources share price performance as the relationships are complex and governed by a multiplicity of factors that extend well beyond the scope of this research. For the purposes of this study, it would be sufficient to establish that there was indeed a correlation between the said variables.

The research took place in the following stages:

1. The quarterly closing values of the RESI Index for the period June 2002 to June 2011 were obtained.
2. The quarterly figures for the four macroeconomic variables: GDP, inflation, prime interest rate and Rand/US Dollar exchange rate were obtained for the period June 2002 to June 2011.
3. Statistical analysis was performed to determine the nature and extent of the correlation between the individual macroeconomic variables and the RESI Index.

4.3 Unit of Analysis

The unit of analysis describes the level at which the research is performed and which objects are researched (Blumberg, Cooper, & Schindler, 2008). The unit of analysis for this study was the RESI Index.

4.4 Population

A population is the total collection of elements about which we wish to make inferences (Blumberg, *et al.,* 2008). The population for this study includes all the companies that were part of the JSE Resources economic group, at the time of writing (October 2011), which was comprised of the mining and oil and gas industrial sectors.

4.5 Sampling method

The sampling frame of the study was all the companies listed on the RESI Index of the JSE. The sample size was the number of companies used in the formation of the RESI Index from the period 2002 to 2011. Individual companies listed in the RESI Index during the period 2002 to 2011 acted as the sampling elements.

Since the study called for the selection of only resource companies, a probability sampling method was not utilised. Blumberg *et al.* (2008) describe a purposive sample as a non probability sample that conforms to certain criteria. Since the sample in this study had to conform to the criterion of being a

resource share, purposive sampling was utilised as the appropriate sampling technique for this study.

4.6 Data Collection

The first step of the data collection process for this study entailed obtaining the quarterly closing values of the RESI Index for the period from June 2002 (inception of the RESI Index) to June 2011. The closing values were obtained from Bloomberg database, a subscription service supplying real-time and historical financial information on South African listed companies.

The quarterly figures for the macroeconomic variables: GDP, CPI, prime interest rate and US Dollar exchange rate were obtained from the South African Reserve Bank statistics database.

4.7 Data Analysis

According to Zikmund (2003, p. 473), “the process of data analysis entails summarising large quantities of raw data so the results can be interpreted. The aim of data analysis is to reveal any consistent patterns in the data so the results may be studied and interpreted in a brief and meaningful manner”.

The data for this study consists of five variables observed at equally spaced points in time and hence constitute time series data. The data analysis procedure described below applies to all the hypotheses that were being tested.

To begin, the collected data for the five variables was tabulated in Microsoft Excel 2007. The tabulated data was then imported into the STATISTICA 10 software, statistical analysis software designed by StatSoft Inc.

For each of the four macroeconomic variables, a graph was produced plotting the macroeconomic variable with the RESI Index for the period June 2002 to June 2011. This enabled a visual inspection of how the macroeconomic variables plotted against the RESI Index and whether the RESI Index and the macroeconomic variables tracked each other. This visual representation was however not adequate to determine the exact nature and extent of the correlation between the macroeconomic variables and the RESI Index. To determine the exact nature and extent of the correlation of the macroeconomic variables with RESI Index a statistical test for correlation would have to be performed.

Albright, Winston and Zappe (2009) state that time series data occur when we track one or more variables through time. According to that definition, the data collected for the RESI Index and the four macroeconomic variables constitute time series data as these five variables are tracked through time from June 2002 to June 2011.

Albright *et al.* (2009) also state that time series data contain four components being the trend component, the seasonal component, the cyclic component and the random (noise) component. For time series data there is a residual for each historical observation. This residual is the difference between the actual observed historical value and the fitted value on the line of best fit on a

scatterplot. The time series of residuals should be random noise and not indicative of a trend, cycle or seasonality.

There are two statistical tests that can be performed to check for randomness in a time series, being the runs test and a test for autocorrelations. In the runs test a base value is chosen and a run is defined as a conservative series of observations that remain on one side of the base value. An autocorrelation is a type of correlation used to measure whether values of a time series are related to their own past values. The time series of residuals is lagged against the original time series to determine if there is an autocorrelation inherent within the time series of residuals. A high autocorrelation may mean that observed values are very closely related to previous values which could imply a trend, seasonality or cyclicality in the time series.

In this study, autocorrelations were used to test for randomness in the time series of all five variables. In the autocorrelations test, the null hypothesis is that the time series is a random series and the alternative hypothesis is that the time series is not a random series. If there are statistically significant autocorrelations at the 5% confidence interval, then the null hypothesis can be rejected and the conclusion drawn that the series is not random. However, Albright *et al.* (2009) state that it is common practice to consider no more lags than 25% of the number of observations, in this case being nine lags as there are 36 observations. Moreover, the first few lags are generally the most important. If there is any relationship between successive observations, it is likely to be between nearby observations. Hence autocorrelations at large lags may be ignored as random unless there is some obvious reason for their occurrence.

The random walk model states that while a series itself may not be random, its differences - that is, the changes from one period to the next - are random (Albright *et al.* 2009). This type of behaviour is typical of stock price data for example. To eliminate the autocorrelation within a time series, the differenced time series is produced which is a time series of the differences between observations. This procedure was performed for all four macroeconomic variables and the RESI Index. The test for autocorrelations and the subsequent differencing of the five time series is in accordance with procedures followed in existing literature (Chaudhuri & Smiles, 2004; Alam, 2009)

The differenced time series was then tested for randomness to ensure that all the autocorrelations had been removed from the time series. Once the tests of randomness proved satisfactory, the time series were then used to test for correlations between the macroeconomic variables and the RESI Index.

To test the nature and extent of the relationship between the four macroeconomic variables and the RESI Index, a cross-correlation test was performed between each variable and the RESI Index. The cross-correlation test would reveal the strength and direction (positive or negative) of the relationship between each macroeconomic variable and the RESI Index. A cross-correlation test was preferred to regression testing as cross-correlations allowed the relationship at different time lags to be observed.

4.8 Research Limitations

The research had the following limitations:

- The research did not take into the account the presence of other operational, market or economic factors that may have an effect on the AMR of the RESI Index.
- The FTSE/JSE RESI Index was only established in 2002, which meant that the study could not take a long term view of the correlation between the macroeconomic variables and the RESI Index. The short term nature of the study may not allow the true relationships between the macroeconomic variables and the RESI Index to be manifested if some of the relationships are long-term in nature.
- The study used the returns on the RESI Index as a proxy for resource returns and did not actually study the returns of the individual listed companies. It is possible that different results may be achieved by looking at the individual companies.
- The study focused on listed companies and as such inferences have not been made about private South African resources companies, although some of the conclusions may very well apply to private companies also.

5 RESULTS

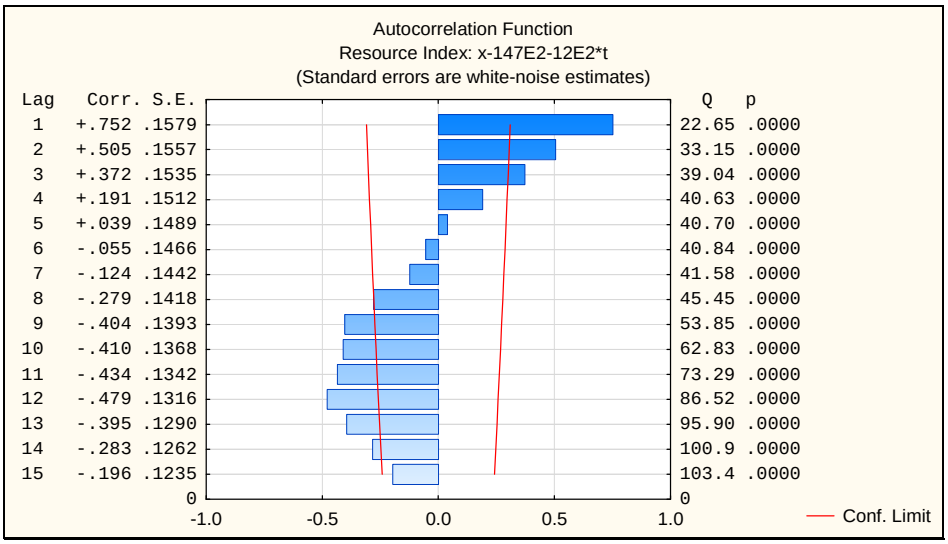
5.1 Overview

This section presents the findings from the analysis described in Chapter 4 and evaluates whether the research hypotheses presented in Chapter 3 are supported or refuted by the data. The results are arranged in accordance with each hypothesis and appraise the outcomes of the analysis, followed by a conclusion stating whether or not the null hypothesis can be rejected.

5.2 Resource Index

In accordance with the research design presented in section 4.7, the RESI Index time series was tested for randomness using an autocorrelation test. The results of that test appear in Figure 3.

Figure 3: RESI Index time series autocorrelation

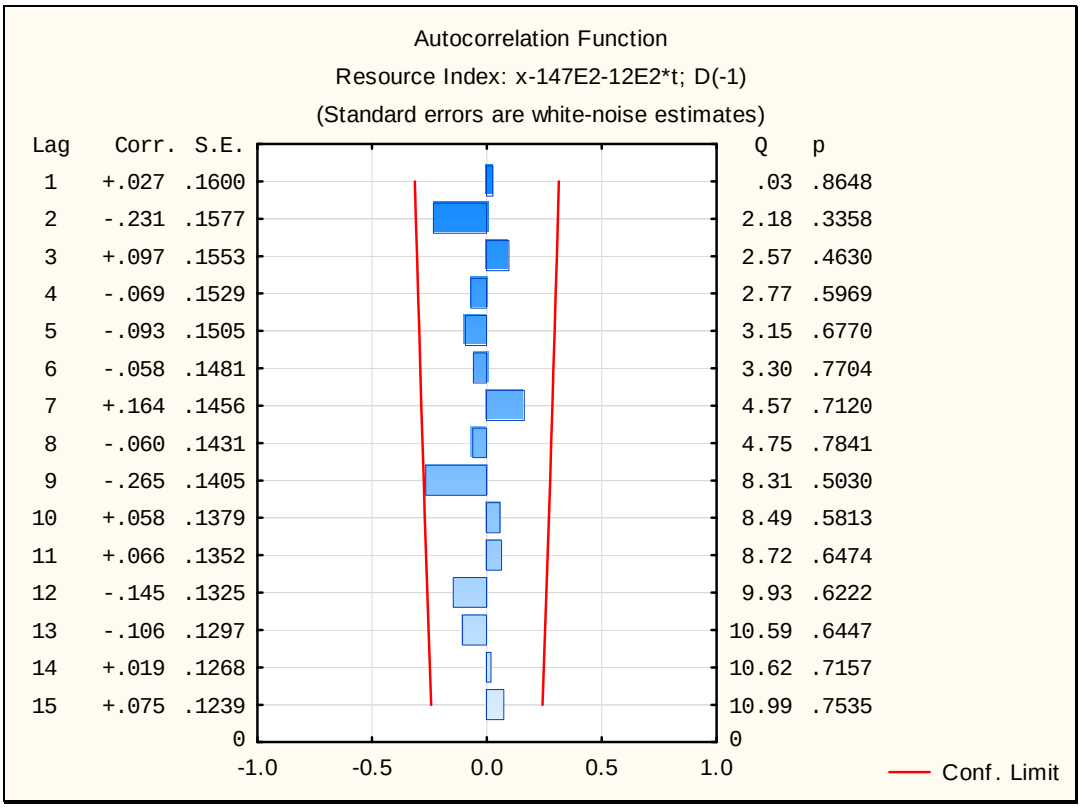


Source: Author's research

The results of the autocorrelation test indicated statistically significant positive autocorrelation at low lags of one to three periods and statistically significant negative autocorrelations at larger lags of period 9 to 13 periods.

A differenced time series was then produced and again tested for autocorrelations. The results appear in Figure 4.

Figure 4: Transformed Resource Index time series autocorrelation



Source: Author's research

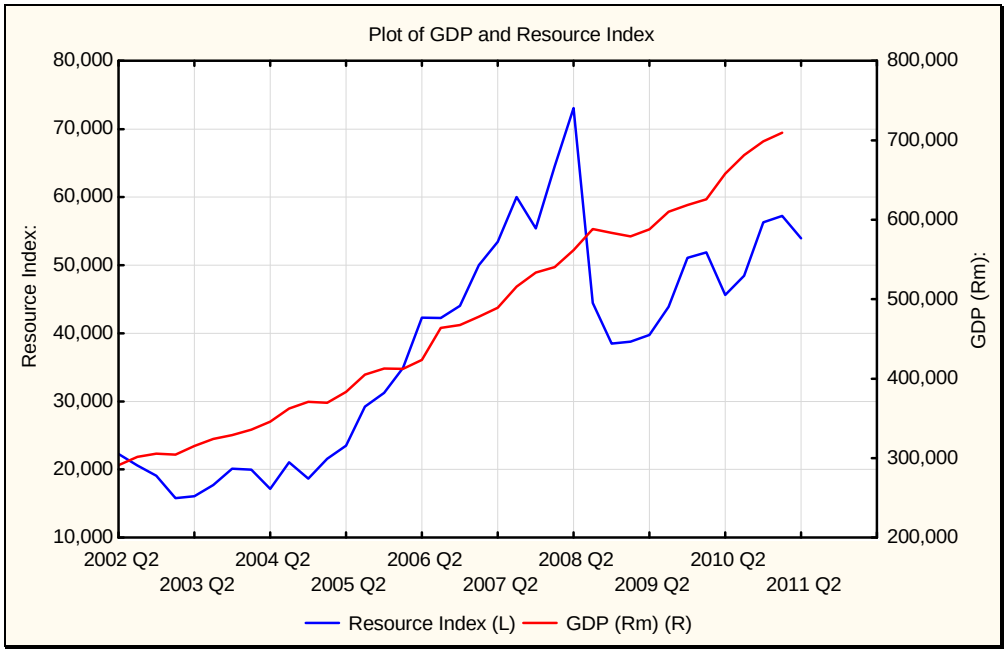
The results showed that all the autocorrelations had been removed from the differenced RESI Index time series. The transformed time series was the time series with which the macroeconomic variables were cross-correlated under the different hypotheses tested.

5.3 Hypothesis 1

The null hypothesis stated that there is no correlation between aggregate economic activity and the AMR of the RESI Index. The alternative hypothesis stated that there is a correlation between aggregate economic activity and the AMR of the RESI Index.

The quarterly closing values for GDP and the RESI Index were obtained for the period June 2002 to June 2011. The GDP and RESI Index were then plotted on a time-series chart as displayed in Figure 5.

Figure 5: Plot of GDP and Resource Index



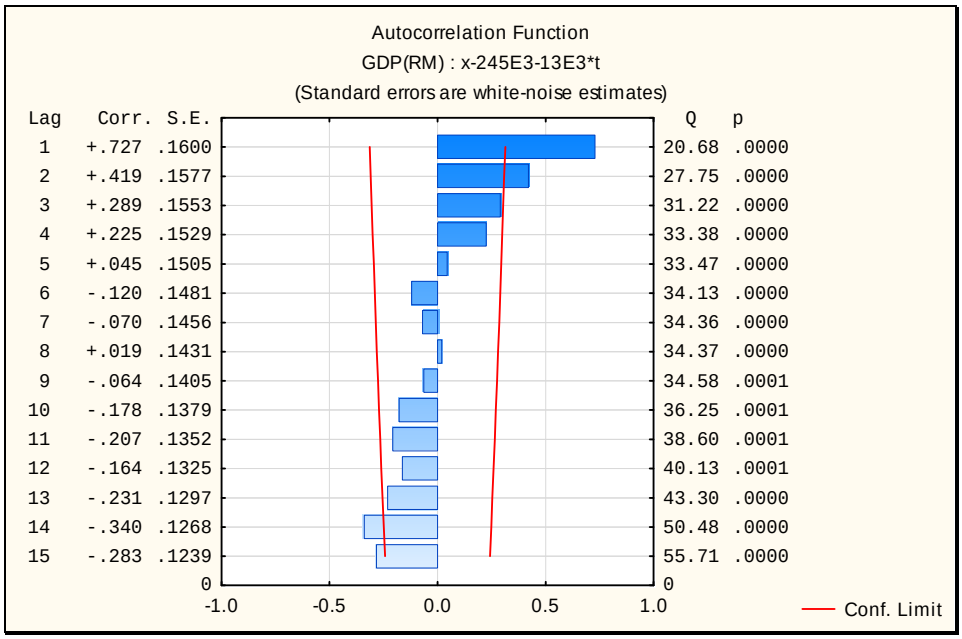
Source: Author's research

It can be observed from the chart that GDP and the RESI Index did track each other to a significant extent. It is also evident that both variables displayed an

upward trend except for the period from 2008 quarter two to 2009 quarter two when GDP took a slight dip and the RESI Index dropped significantly, amidst the global financial crisis of that time.

To test for randomness within the GDP time series, the autocorrelation of the time series was plotted. The results are displayed in the correlogram in Figure 6 below.

Figure 6: GDP time series autocorrelation

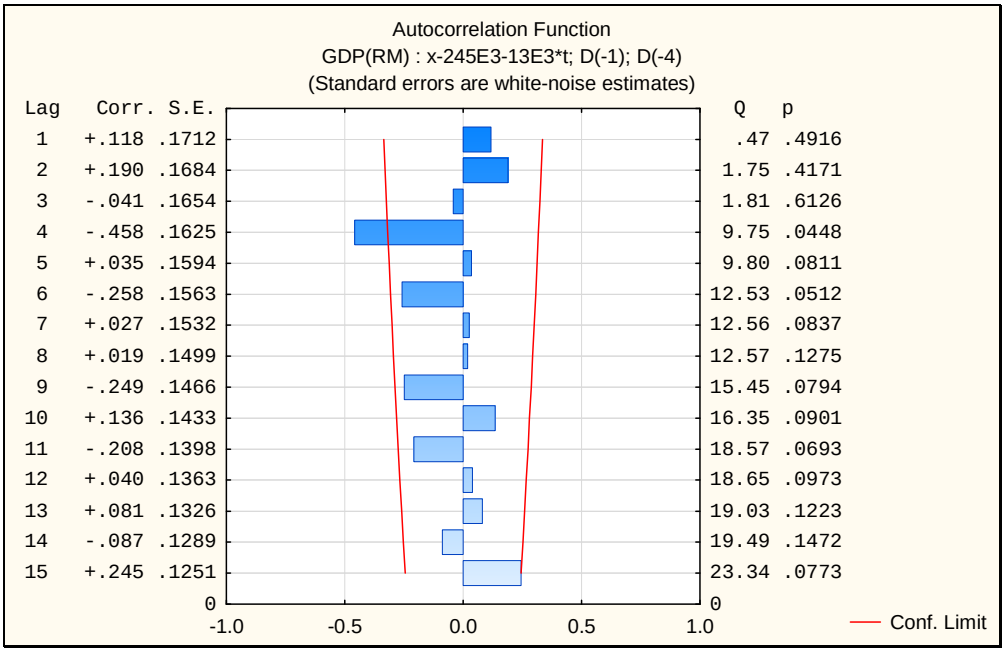


Source: Author's research

The correlogram indicated that the lag one and lag two autocorrelations were statistically significant at the 5% confidence interval. This was indicated by the blue bars breaching the red line which was the confidence limit. There was also a slight negative autocorrelation at lag 14. To remove the autocorrelation from the GDP time series a differenced time series was produced using the

STATISTICA 10 software. The differencing procedure produced the autocorrelations in Figure 7.

Figure 7: Transformed GDP time series autocorrelation



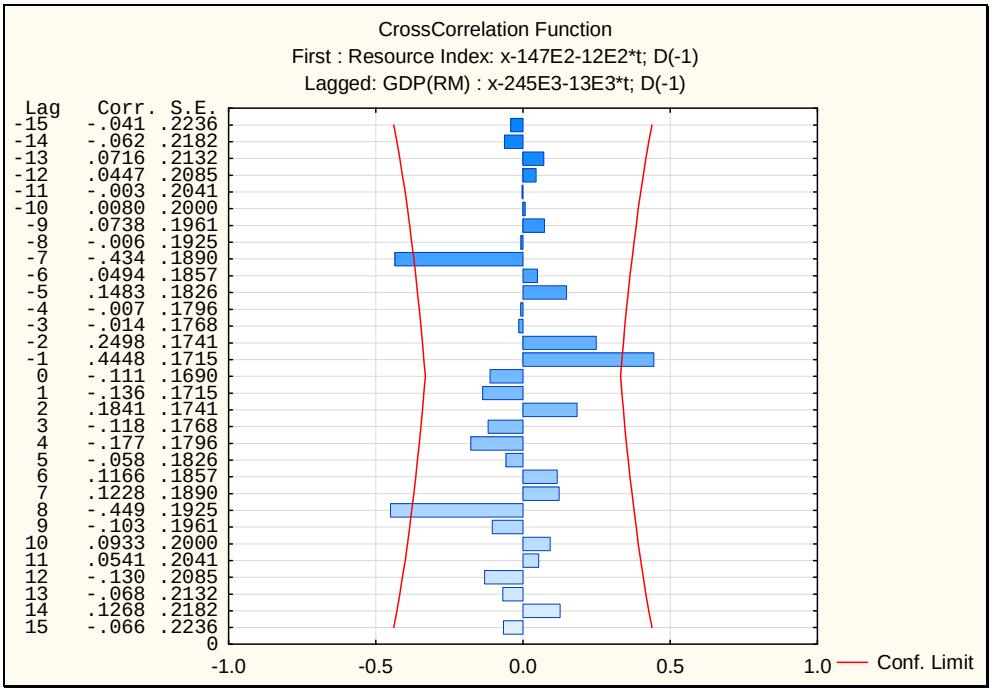
Source: Author's research

The differencing procedure removed most of the autocorrelation inherent within the initial GDP time series. There was only a single period, lag 4, for which there was significant autocorrelation remaining. This could however be ignored as a random autocorrelation as it was a negative autocorrelation. There is no reason for GDP figures one year apart to be negatively auto-correlated. If anything, GDP figures a year apart would be positively auto-correlated, which could be an indication of seasonality.

After removing the trend from the GDP time series, the series was cross-correlated with the transformed RESI Index time series (as per Section 5.2) to

determine the relationship between the two variables. The results of the cross correlation are displayed in Figure 8.

Figure 8: GDP and Resource Index cross-correlation



Source: Author's research

The cross-correlation plot displays the cross correlation of GDP with the RESI Index for the period June 2002 to June 2011. The plot indicated the cross correlation between the two variables at different lags. The negative lag indicates the correlation when the RESI Index lagged GDP by one period through to 16 periods, a single period being a quarter. The positive lag indicates the correlation when GDP lagged the RESI Index by 1 period through to 16 periods.

The results of the cross-correlation test revealed a significant positive relationship between GDP and the RESI Index at a lag of one period. That is, at

the 5% significance level, there was a statistically significant positive relationship between GDP movements and movements in the RESI Index a quarter later. Based on this, the null hypothesis was rejected and the alternative hypothesis that there was a correlation between GDP and the RESI Index was accepted.

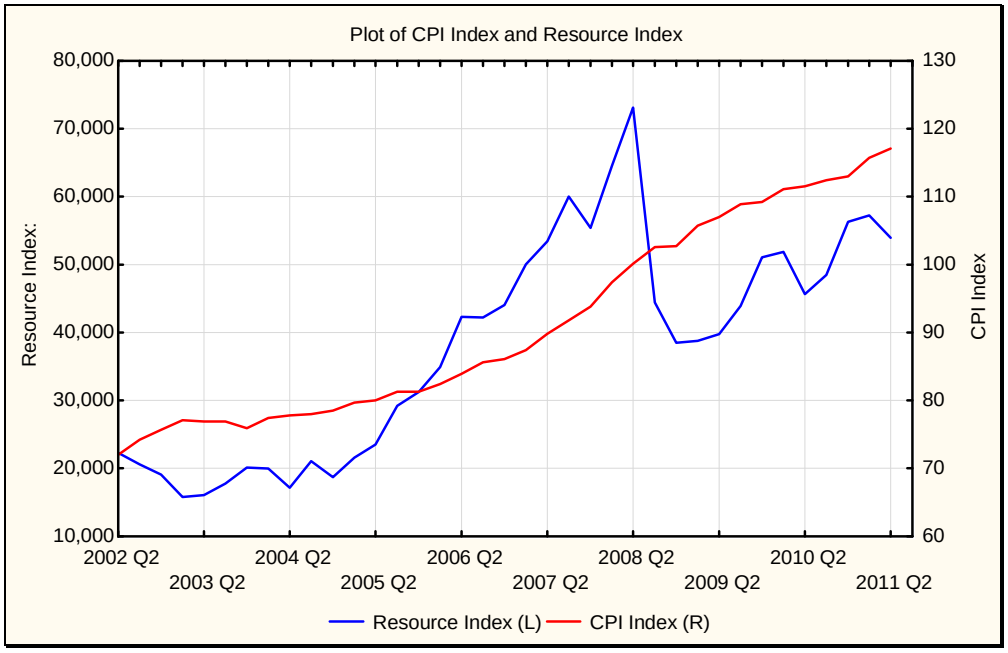
There was also a significant negative relationship between GDP and the RESI Index when the RESI Index lagged GDP by seven quarters. Lastly, when GDP lagged the RESI Index by 8 quarters, there was a significant negative relationship observed between the two variables.

5.4 Hypothesis 2

The null hypothesis stated that there is no correlation between inflation and the AMR of the RESI Index. The alternative hypothesis stated that there is a correlation between inflation and the AMR of the RESI Index.

Figure 9 gives a graphical depiction of the plots of the CPI Index and the RESI Index. The CPI Index has been used as a proxy for inflation.

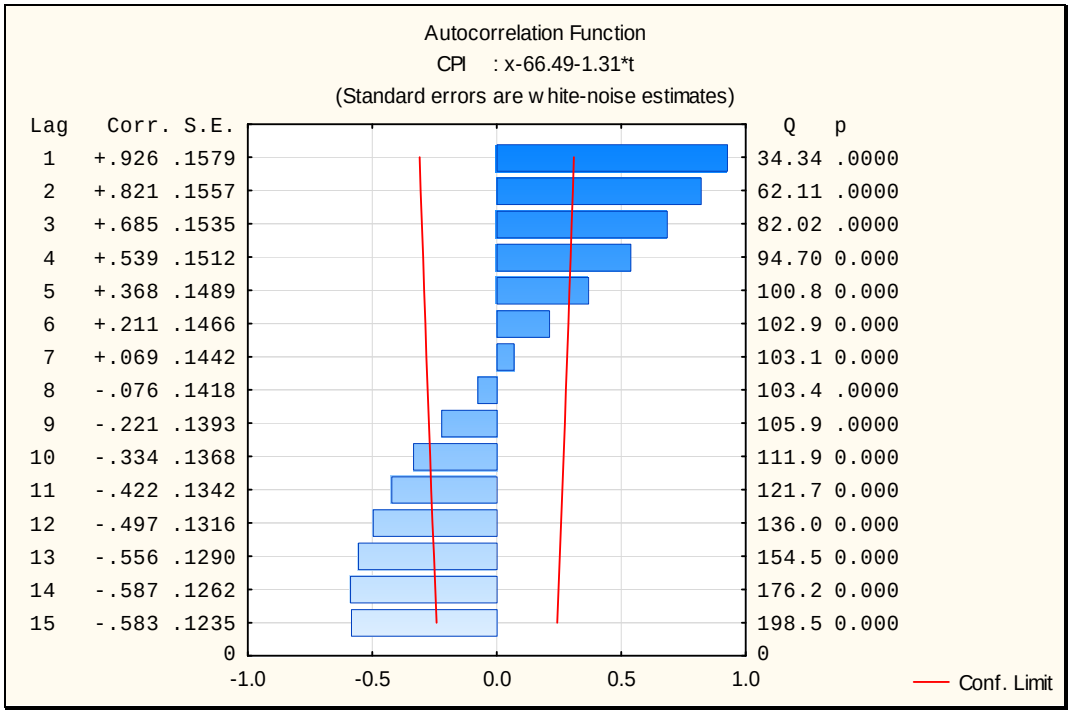
Figure 9: Plot of CPI and Resource Index



Source: Author's research

The graph shows that both the CPI Index and the RESI Index display an upward trend and that the two indexes do track each other to a significant extent. To test for randomness within the CPI Index, the autocorrelation of the Index was plotted. The results of the autocorrelation test are displayed in Figure 10.

Figure 10: CPI time series autocorrelation

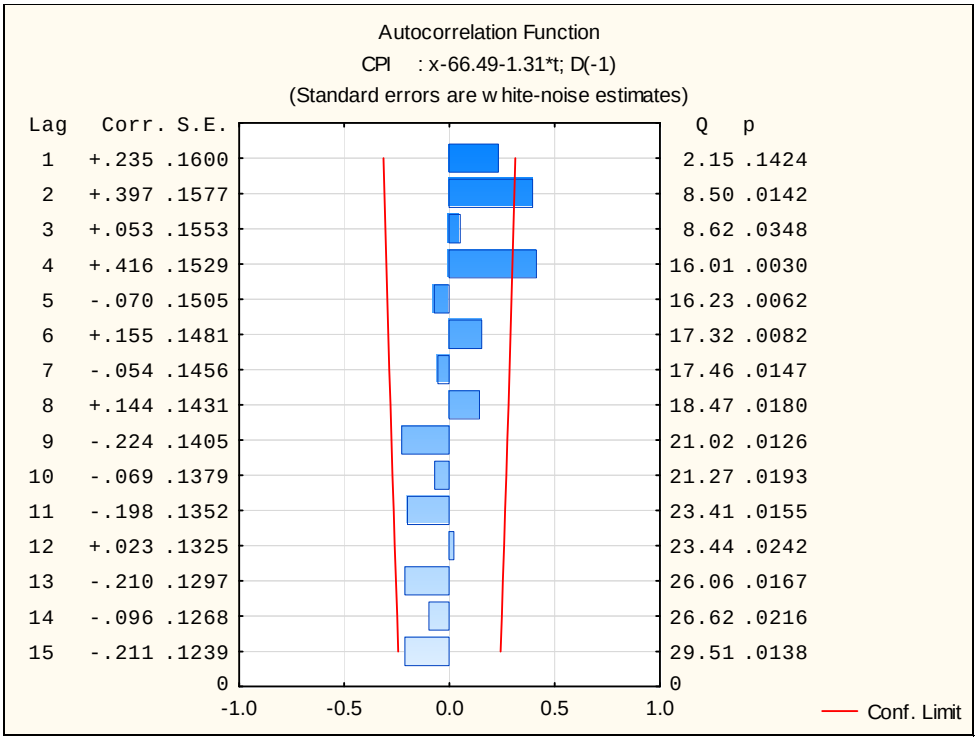


Source: Author's research

The correlogram revealed significant autocorrelation in the CPI Index for lags of one to six periods. Quarterly observations were strongly correlated with the prior period's observation. This result was not surprising giving the upward trend of the CPI series.

In order to remove the trend in the CPI series and eliminate the autocorrelation intrinsic in the series, a differenced CPI time series was produced and the results of this procedure are displayed in Figure 11.

Figure 11: Transformed CPI time series autocorrelation

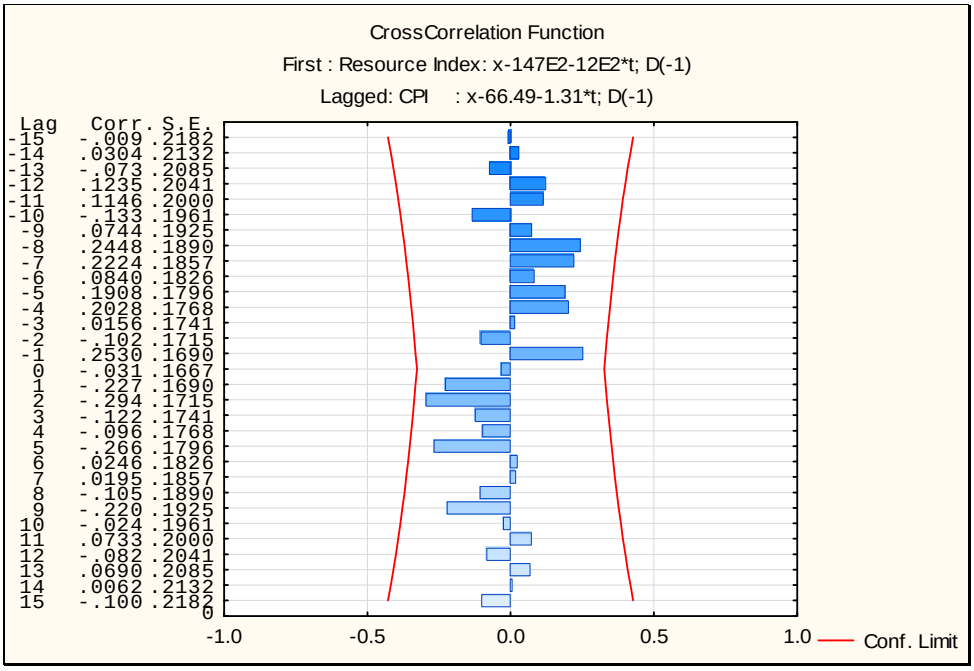


Source: Author's research

As can be observed from the plot, most of the autocorrelation had been removed from the CPI time series. The lag 4 autocorrelation that still existed could be ignored as a random autocorrelation. Inflation is not seasonal but is dependent on a number of local and international factors such as oil prices, food prices and local economic growth to name a few. As such, there was no reason for observations a year apart to be correlated.

After removing the trend from the CPI time series, the transformed series was cross-correlated with the RESI Index time series to determine the relationship between the two variables. The results of the cross correlation are displayed in Figure 12.

Figure 12: CPI and Resource Index cross-correlation



Source: Author's research

The results of the cross-correlation between the CPI Index and the RESI Index proved to be inconclusive. At the 5% confidence interval none of the correlations proved to be statistically significant, regardless of the time lag applied. The strongest correlation of -0.294 occurred when the CPI observation lagged that of the RESI Index by two quarters. There were other fairly strong, but not statistically significant correlations of -0.266 and -0.220 when the CPI lagged the RESI Index by five and nine quarters respectively.

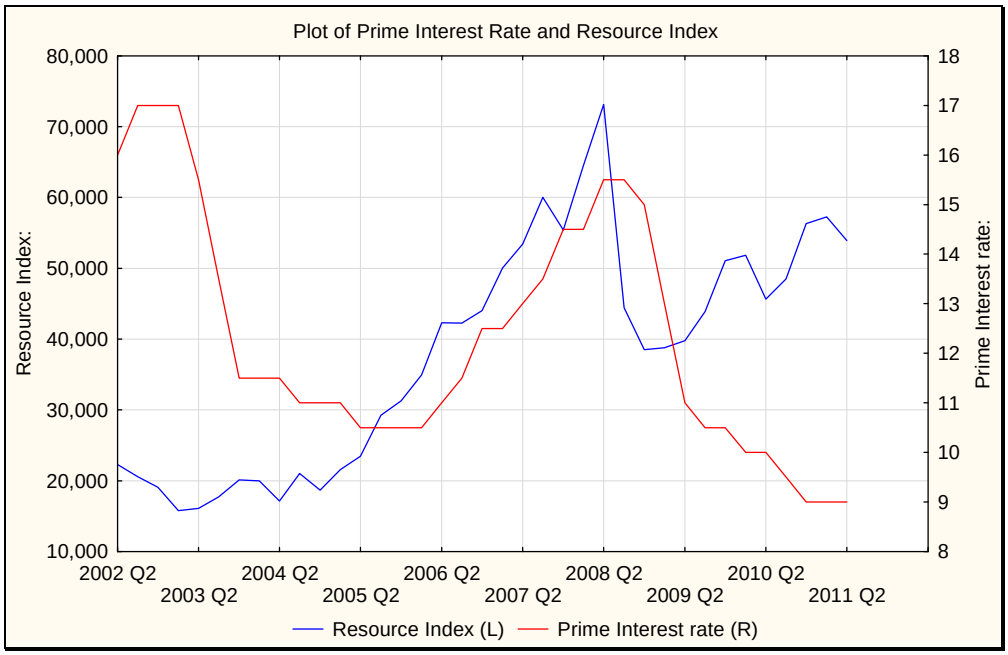
When the RESI Index lagged the CPI, there were fairly strong, but statistically insignificant, positive correlations of 0.253, 0.222 and 0.244 at lags of one, seven and eight quarters respectively. Based on the results, at the 5% confidence interval the null hypothesis that there was no correlation between inflation and the RESI Index could not be rejected.

5.5 Hypothesis 3

The null hypothesis stated that there is no correlation between interest rates and the AMR of the RESI Index. The alternative hypothesis stated that there is a correlation between interest rates and the AMR of the RESI Index.

Figure 13 displays the plot of the prime interest rate and the RESI Index for the period June 2002 to June 2011.

Figure 13: Plot of Prime interest rate and Resource Index



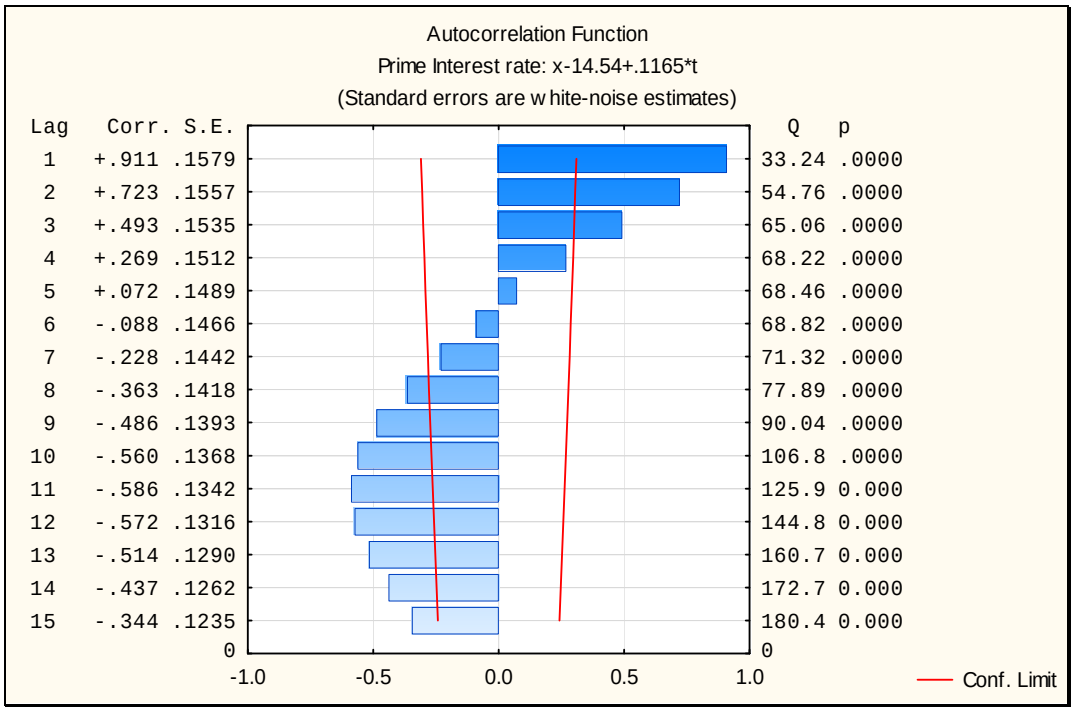
Source: Author's research

From visual inspection of the time series plots it is evident that the prime interest rate and the RESI Index tracked each other until 2009 quarter two when a divergence occurred. This is surprising as increasing interest rates are meant

to be a hindrance to economic activity, and hence one would expect the RESI Index to move in the opposite direction of the prime interest rates. That is, as interest rates rise, economic activity should slow and hence the RESI Index should fall, and vice versa. A cross-correlation test would have to be performed in order to determine the exact nature of the relationship between prime interest rates and the RESI Index however.

Before testing the cross-correlation between the two variables, a test for randomness was performed to determine the extent of autocorrelation within the interest rate time series. The results are displayed in Figure 14.

Figure 14: Prime interest rate time series autocorrelation

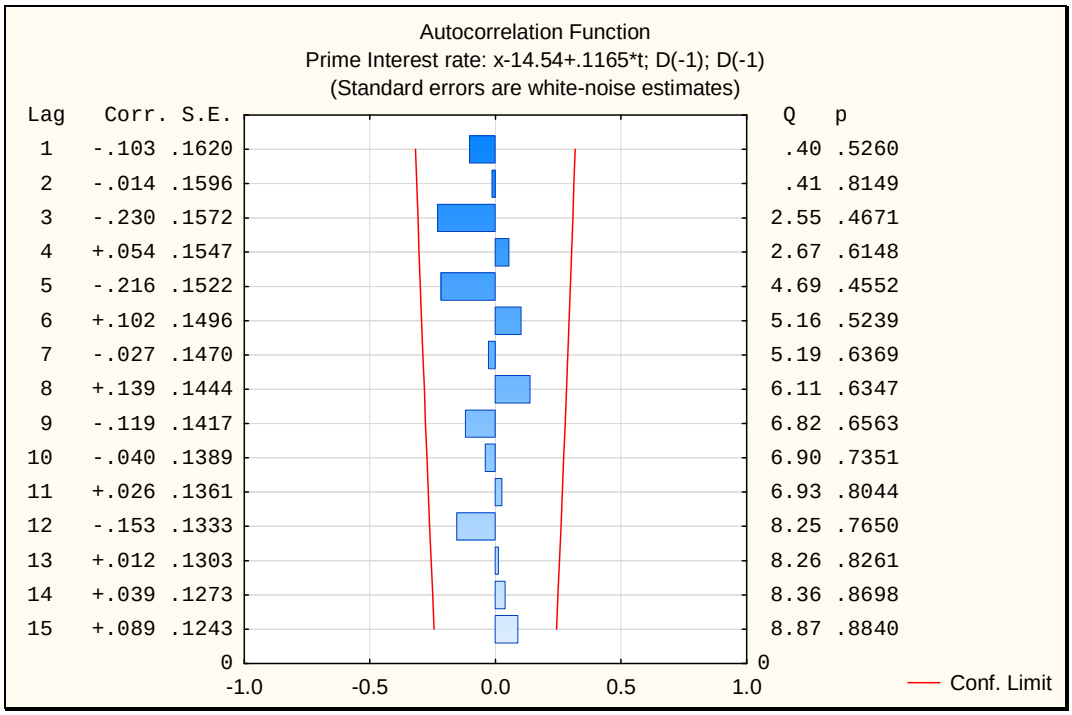


Source: Author's research

The results of the autocorrelation test reveal significant autocorrelation at lags of one to three periods. This result was not surprising given that the prime interest rate moves in small increments from one quarter to the next as determined by the Monetary Portfolio Committee (MPC) of the South African Reserve Bank (SARB). It was therefore reasonable that there would be significant autocorrelation between observations that are one to two quarters apart.

A differencing procedure was then performed to remove the trends inherent within the prime interest rate time series. The autocorrelation of the transformed time series was tested and the results of that test appear in Figure 15.

Figure 15: Transformed Prime interest rate time series autocorrelation

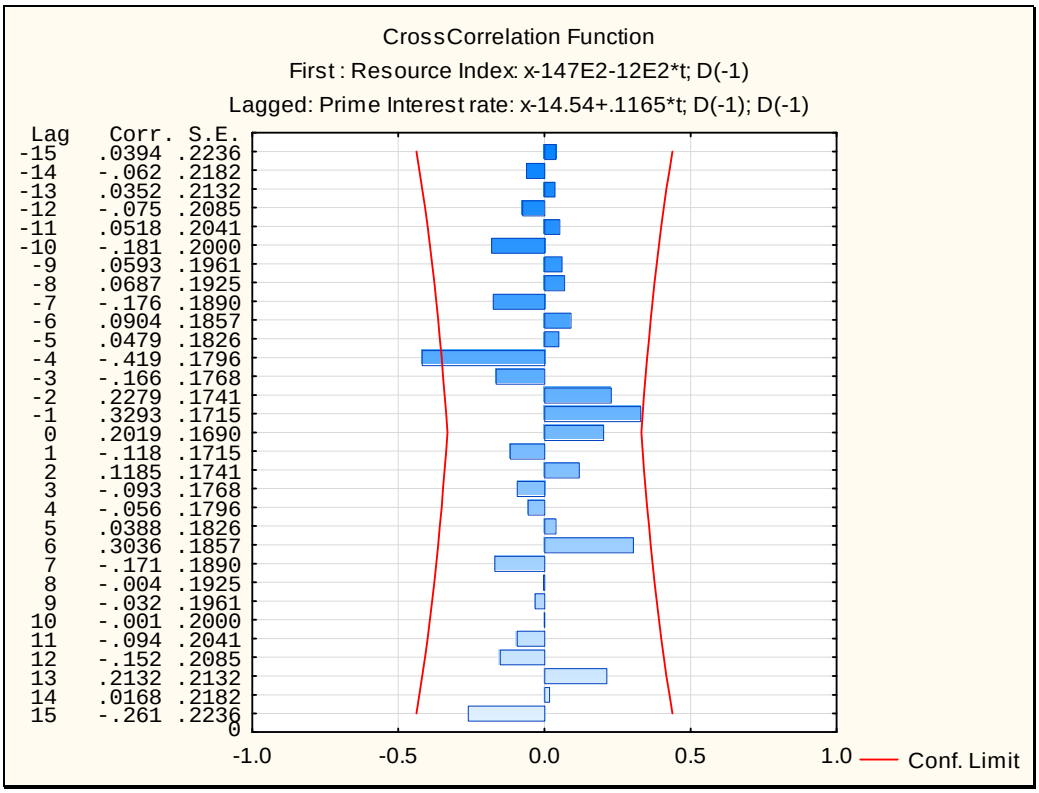


Source: Author's research

As is evident from the correlogram, all the autocorrelations have been removed from the prime interest rate time series and the transformed time series could then be used to test for correlation between the prime interest rate and the RESI Index.

The prime interest rate and the RESI Index were then cross-correlated to test the relationship between the two variables. The results of the cross-correlation are displayed in Figure 16.

Figure 16: Prime interest rate and Resource Index cross-correlation



Source: Author's research

The results of the cross correlation showed that, at the 5% significance level, there was only 1 significant correlation which was at a lag of four periods. That is, when the RESI Index lagged the prime interest rate by four quarters, there

was a significant negative correlation between the two variables of -0.419. Based on this result, the null hypothesis was rejected and the conclusion drawn that there is a negative relationship between interest rates and the RESI Index.

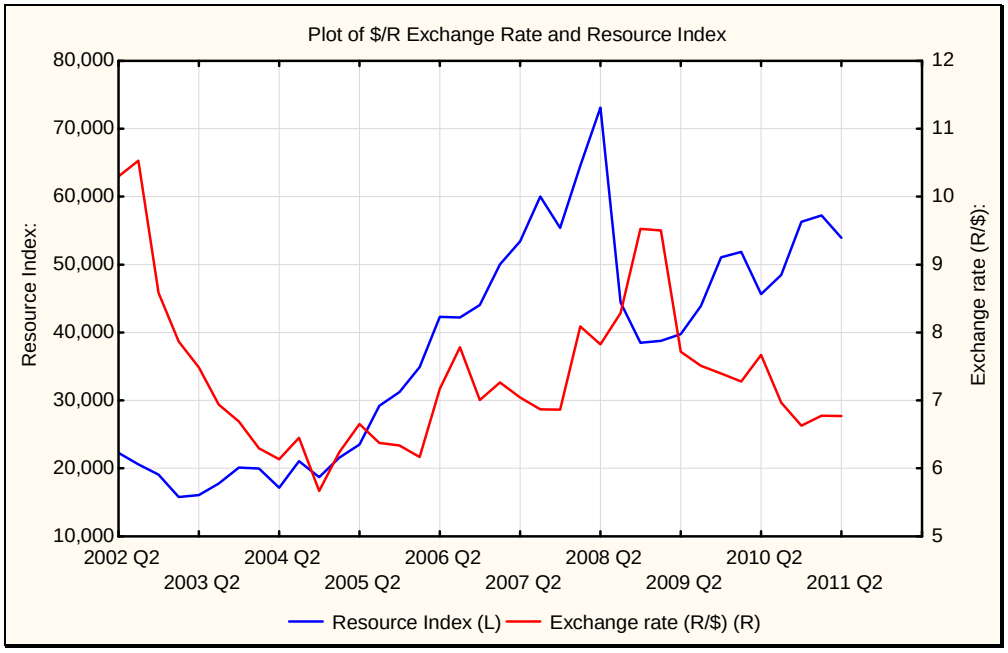
There was also a strong, but not statistically significant positive correlation of 0.329 between the variables when the RESI Index lagged the prime interest rate by one quarter.

5.6 Hypothesis 4

The null hypothesis stated that there is no correlation between the Rand/US Dollar exchange rate and the AMR of the RESI Index. The alternative hypothesis stated that there is a correlation between the Rand/US Dollar exchange rate and the AMR of the RESI Index.

To begin, the Rand/US Dollar exchange rate was plotted with the RESI Index time series to visually inspect the association between the two variables. This plot is displayed in Figure 17.

Figure 17: Plot of exchange rate and Resource Index

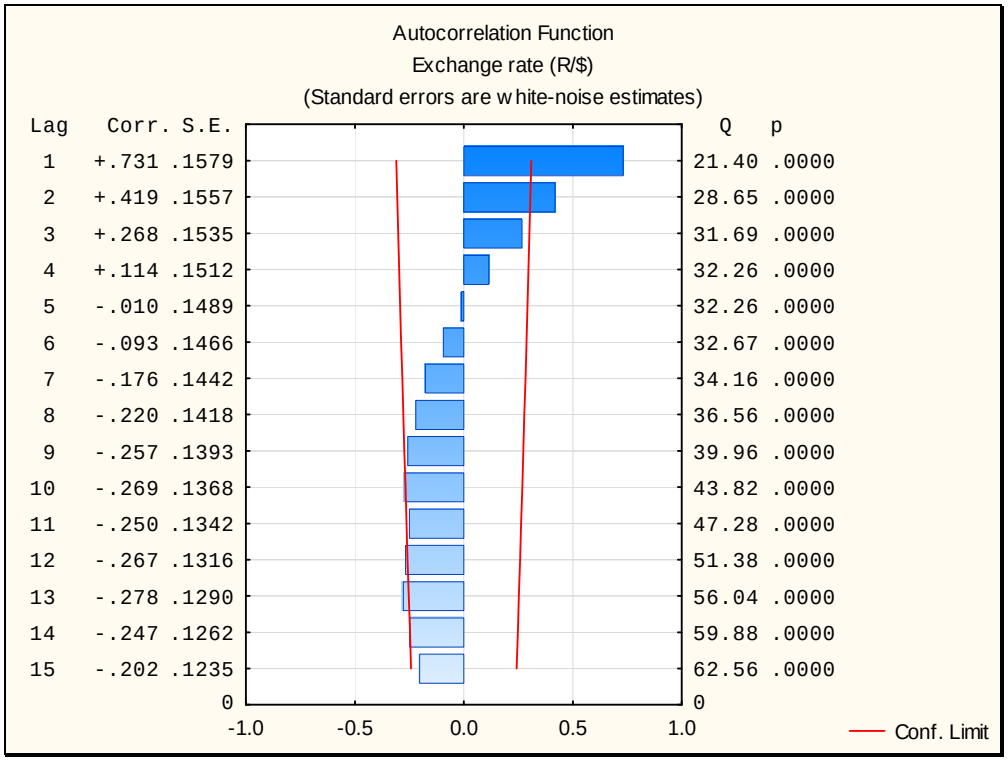


Source: Author's research

From visual inspection of the plot, the two variables seemed to track each other for the most part, until 2009 quarter two when a divergence began. However, it was difficult to determine the exact nature of the correlation between the two variables by mere inspection of the plot. A cross-correlation test would have to be performed to determine this.

Before the correlation could be tested, the exchange rate time series was tested for randomness through a test for autocorrelations. The correlogram of that test is displayed in Figure 18.

Figure 18: Exchange rate time series autocorrelation

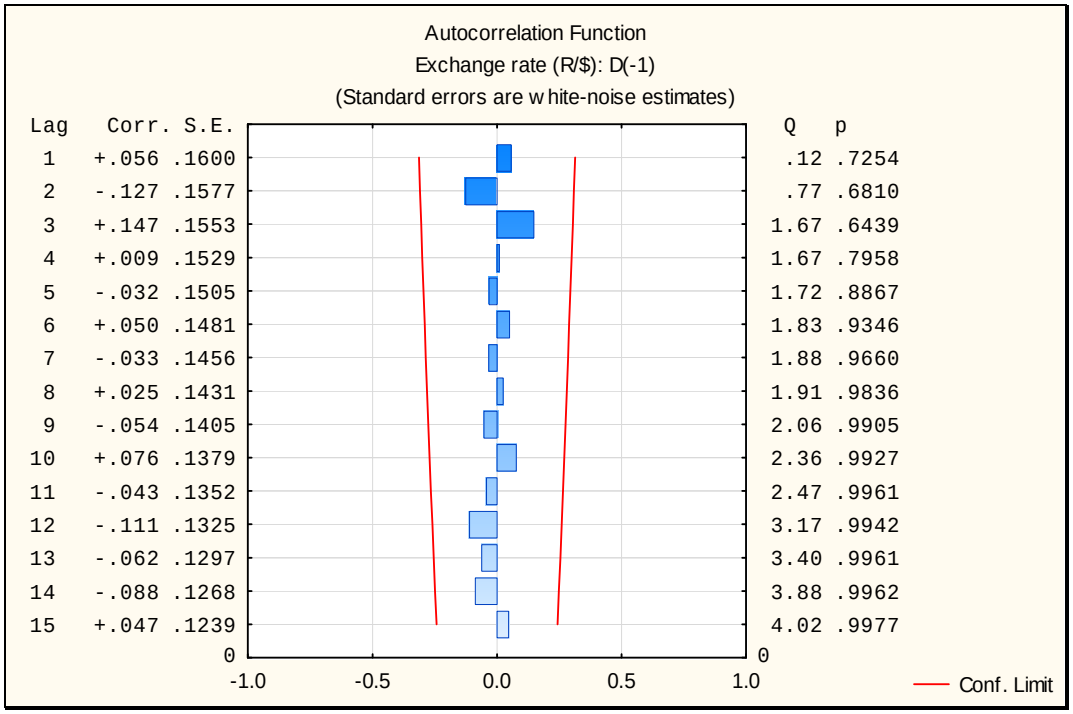


Source: Author's research

The test for randomness revealed that at the 5% confidence interval, there was significant autocorrelation between the observed exchange rate values for lags of 1 and 2 periods. This result was reasonable given that the exchange rate moves in cycles, with small increments in an upward cycle and small successive decreases in a downward cycle. It therefore made sense that there would be significant autocorrelation between successive periods' observations.

To remove the autocorrelation from the time series a differenced time series was produced. The correlogram of the transformed time series is displayed in Figure 19.

Figure 19: Transformed exchange rate time series autocorrelation

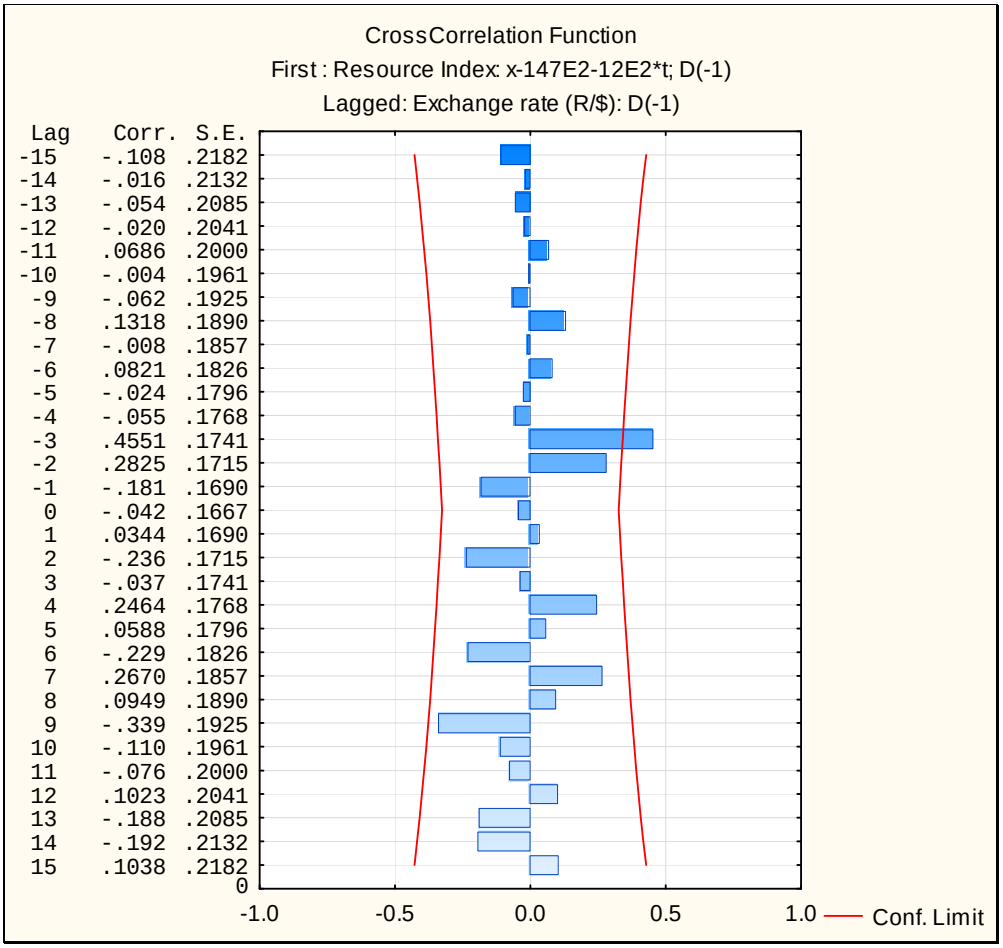


Source: Author's research

The differencing procedure removed all the autocorrelations from the exchange rate time series. From the correlogram of the transformed time series, it is evident that, at the 5% confidence interval, there were no more statistically significant autocorrelations inherent within the time series. The transformed time series was then cross-correlated with the RESI Index to determine the nature of the relationship between the two variables.

Figure 20 displays the results of the cross-correlation between the Rand/US Dollar exchange rate and the RESI Index.

Figure 20: Exchange rate and Resource Index cross-correlation



Source: Author's research

The cross-correlation between the exchange rate and RESI Index time series revealed that at the 5% confidence interval, there was only one statistically significant correlation of 0.455 at a lag of -3. That is, when the RESI Index lagged the exchange rate by three quarters, there was a statistically significant positive correlation between the two variables.

6 DISCUSSION OF RESULTS

6.1 Overview

In this chapter the research findings are interpreted and their implications are discussed. The findings are also compared and contrasted with the findings of previous studies conducted in different markets and over different time periods. Reasons are offered for any similarities or differences between the results of this and those of previous studies. This chapter follows a structure similar to that of Chapter 5, with discussions arranged in accordance with the various research hypotheses.

6.2 Hypothesis 1

The finding for this hypothesis was that there was a statistically significant positive relationship between GDP movements and movements in the RESI Index at a lag of one quarter. There was also a significant negative relationship between GDP and the RESI Index when the RESI Index lagged GDP by seven quarters. Lastly, when GDP lagged the RESI Index by 8 quarters, there was a significant negative relationship observed between the two variables. Based on these results, the null hypothesis was rejected and the alternative hypothesis of a non-zero correlation between GDP and the RESI Index was accepted.

To explore explanations for the positive correlation between GDP and the RESI Index at a lag of one quarter, the efficient market hypothesis has to be considered. This hypothesis states that profit-maximising investors in an efficient market will ensure that all relevant information currently known about changes in macroeconomic variables are fully reflected in current stock prices, so that investors will not be able to earn abnormal profit through prediction of future stock market movements (Fama,1970). Based on this, any macroeconomic information that comes to light should be assimilated into share valuations and hence share prices.

The PVM of share valuation relates share prices to future expected cash flows and the future discount rate of these cash flows (Humpe & Macmillan, 2009). Positive GDP information creates expectations of future economic growth and economic growth leads to increased profitability of companies. As such, positive GDP information leads to an anticipation of increased future cash flows and hence increased valuations of listed companies, including resource sector companies. Conversely, negative GDP information can lead to decreased cash flow expectations by the market and hence decreased valuations of listed companies, including resource companies. These expectations of future cash flows drive share prices up or down, thereby causing losses or gains.

The PVM, along with market expectations of future cash flows, suggests a possible reason as to why GDP and the RESI Index may be positively correlated in the short term. Fama (1990) and Geske and Roll (1983) hypothesized a similar positive relationship through the effects of industrial production on expected future cash flows.

At a lag of seven quarters, the RESI Index displays a significant negative correlation with GDP. Although most literature shows a positive relationship between economic output and stock market returns (Fama, 1990; Beckers *et al.*, 1992; Ferson & Harvey, 1993; Cheung *et al.,* 1997), Park (1997) suggests evidence of a negative long run relationship between output and stock market returns. Stock prices frequently respond negatively to positive news about economic activity (Park, 1997).

Park (1997) stated that the negative response of stock prices to positive economic news can be reconciled by considering policy responses. He goes further to explain that strong economic activity causes inflation and induces policymakers to implement a countercyclical macroeconomic policy such as raising interest rates. Inflation is caused by the fact that increased economic activity is usually accompanied by increased employment and hence an increase in household disposable income. Increased household disposable income results in increased aggregate demand in the economy. Many academic studies also support the importance of policy responses in explaining stock returns (Geske & Roll, 1987 and Kaul, 1987).

The findings of Geske and Roll (1983), Kaul (1987) and Park (1997) serve to suggest that in periods where economic growth leads to increasing inflation, governments or central banks may react by increasing interest rates to curb inflation. The effects of this contractionary monetary policy may only be felt several quarters later through a contraction in economic activity as the cost of borrowing increases and hence capital invesmtent decreases. On the other hand, where the economy is contracting, governments may respond by

decreasing interest rates, thereby lowering the cost of capital and inducing capital investment. This increased investment leads to increased output and cash flows for businesses.The delayed reaction of the economy to interest rate movements may be an explanation as to why there is a negative correlation between GDP and the RESI Index at a lag of seven quarters.

DeStefano (2004) in his study on stock returns at different phases of the business cycle offers another reason why stock prices may be negatively correlated with economic activity. He found that news of higher than expected economic output when the economy is already strong results in lower stock prices, whereas the same surprise in a weak economy is associated with higher stock prices. The conclusion drawn was that unanticipated increases in economic activity in a weak economy raise expectations about future cash flows, whereas the same information in a strong economy does not lead to higher expected cash flows.

DeStefano's (2004) findings shed light on the negative correlation between GDP and the RESI Index at a lag of seven quarters, although it does not explain the lag. A significant proportion of the period analysed in this study fell into a period of increasing economic activity, with the first drop in GDP occurring sometime in 2008. According to DeStefano's findings, any positive GDP news during this period of economic growth would lead to reduced resource stock prices.

The last part of the results for this hypothesis found there to be a significant negative relationship between GDP and the RESI Index when the GDP observation lagged the RESI Index observation by 8 quarters, *i.e*. 2 years.

Hassapis and Kalyvitis (2002) and Tsouma (2009) allude to the ability of stock returns to predict future real economic activity. Both however find evidence of a positive long run relationship between stock returns and future economic real activity. Stock prices are a function of future cash flows and a discount rate according to the present value model. As such, expectations of increased future economic activity, *i.e.* cash flows, result in increased current valuations and stock prices. According to this model the link between stock returns and future real economic activity should be positive. The finding in this study of a negative relationship is therefore puzzling.

A possible explanation for this conflicting finding may be the fact that the RESI Index movements are only indicative of future resource sector cash flows and not indicative of future cash flows for the economy as a whole. GDP, however, is a measure of output for the economy as a whole. This may explain the negative correlation between RESI Index returns and GDP as the RESI Index may not be the best predictor of output for the economy as a whole. The mining and oil and gas sectors operate under very unique conditions and are much more exposed to international economic conditions than the rest of the economy.

The financial crisis that occurred in 2008 and 2009 may also be a reason for the conflicting result. During the financial crisis, the RESI Index lost close to 43% of its value, without a corresponding decrease in GDP. The period of the financial crisis falls right in the time period being evaluated in this study, and this may have distorted the results of the tests.

6.3 Hypothesis 2

The results of the cross-correlation between the CPI Index and the RESI Index proved to be inconclusive. At the 5% confidence interval none of the correlations proved to be statistically significant, regardless of the time lag applied. The strongest correlation of -0.294 occurred when the CPI observation lagged that of the RESI Index by two quarters. There were other fairly strong, but not statistically significant correlations of -0.266 and -0.220 when the CPI lagged the RESI Index by five and nine quarters respectively.

When the RESI Index lagged the CPI, there were fairly strong, but statistically insignificant, positive correlations of 0.253, 0.222 and 0.244 at lags of one, seven and eight quarters respectively. Based on the results, at the 5% confidence interval, the null hypothesis that there was no correlation between inflation and the RESI Index could not be rejected.

Many authors have documented evidence of a negative relationship between stock returns and inflation (Bodie, 1976; Fama & Schwert, 1977; Jaffe & Mandelker, 1976). These studies were mainly conducted over a short term horizon. Other authors that investigated the relationship between stock returns and inflation over a long-term horizon found overwhelming evidence of a positive long run relationship (Boudokh & Richardson, 1993; Ely & Robinson, 1997; Murphy & Sahu, 2001; Choudhry, 2001; Rapach, 2002; Al-Khazali & Pyun, 2004).

To explain why there would be a negative relationship between stock prices and inflation, Maysami *et al.* (2004) hypothesize that an increase in the rate of inflation is likely to lead to economic tightening policies such as increase in interest rates. This in turn increases the nominal risk free rate and hence raises the discount rate in the PVM, leading to decreased valuations and stock prices. They further state that the effect of a higher discount rate would not necessarily be neutralised by an increase in business cash flows, primarily because cash flows do not generally grow at the same rate as inflation. Cash flows would probably decrease initially as the cost of inputs adjusts faster to rising inflation than output prices.

The existing literature points to a negative relationship between inflation and stock returns in the short-term and a positive relationship in the long-term. The results of hypothesis 2 proved to be inconclusive, revealing neither a significant positive nor negative relationship between the CPI Index and RESI Index. A striking fact about the existing literature is the periods over which the studies were conducted. The data analysed in previous studies were all for periods ranging from 19 to a 100 years. Even short term studies that indicated a negative relationship between stock returns and inflation analysed data for at least two decades. Hypothesis 2 was tested using data for only a period of nine years and it is possible that the very short time period involved may be the reason why no significant relationship between CPI and the RESI Index could be detected.

6.4 Hypothesis 3

The finding for this hypothesis was that, at the 5% significance level, there was a statistically significant negative relationship between prime interest rate and the RESI Index at a lag of four quarters. Based on this result, the null hypothesis of no relationship was rejected.

The existing literature provides ample evidence of the existence of a negative relationship between stock returns and interest rates (Mukherjee & Naka, 1995; Maghayereh, 2003; Ratanapakorn & Sharma, 2007; Humpe & Macmillan, 2009). The negative relationship was found to exist regardless of the time period or country investigated.

Maysami *et al.* (2004) posit as to why a negative relationship between interest rates and stock returns may exist. They hypothesize that interest rates can influence the level of corporate profits which in turn influence the price that investors are willing to pay for stocks through expectations of future dividend payments. Another theory is that most companies finance their capital equipment and inventories through borrowings. A reduction in interest rates reduces the cost of borrowing and thus serves as an incentive for expansion (Maysami *et al.,* 2004). Expansion results in increased profits and the amount investors are willing to pay for stocks, based on an expectation of increased future dividends. Interest rate increases however, reduce aggregate demand in the economy as the cost of borrowing for consumption increases for individuals and households.

Alam (2009) puts forward another theory for the existence of a negative relationship between interest rates and stock returns. If the rate of interest paid by banks to depositors increases, people switch their capital from share market to the money market. This results in a decrease in the demand for shares and a decrease in the price of shares. Moreover, when the rate of interest paid by banks to depositors increases the lending rate also increases, leading to decreases in investment in the economy which is also another reason for decreasing share prices. This lends credence to Maysami *et.al's* (2009) hypothesis.

The present value model estimates the price of shares by discounting a series of expected future cash flows at a particular discount rate. Fluctuations in the prime interest rate result in changes in the discount rate, leading to changes in the estimated share price. An increase in the interest rate raises the discount rate and reduces the present value of future cash flows.

From the theories presented in previous research, it becomes clear why a negative relationship exists between the prime interest rate and the RESI Index. Increasing interest rates reduce the expected cash flows of companies through increased borrowing costs and also through reduced capital investment and output. Increasing interest rates also raise the discount rate used in the present value model to value shares. Lastly, a hike in interest rates pulls investors away from the stock market towards investments in the money market. The reduced cash flow, increasing discount rate and the decreased demand for resource shares creates a potent cocktail that cause share prices and consequently returns to drop.

6.5 Hypothesis 4

The finding for this hypothesis was that, at the 5% significance level, there was a positive correlation between the Rand/US Dollar exchange rate and the RESI Index. That is, as the Rand/US Dollar exchange rate weakens resource share prices increase.

Previous literature confirms the existence of a linkage between exchange rates and stock prices, with some authors finding a positive relationship (Kanas, 2000; Nieh & Lee, 2001; Wu, 2001; Gay, 2008) and others finding a negative relationship (Mougoue, 1996; Kim, 2003).

Maysami *et al.* (2004) concur with the the theory of a positive relationship between exchange rates and stock prices. Their argument is that a deprecaition in a country's currency will result in an increase in demand for that country's exports, thereby increasing cash flows to that country, that is assuming the demand for exports is sufficiently elastic. Alternatively, if the currency is expected to appreciate, the market will attract investments, with the additional demand pushing up the stock market level. This suggests that the stock market returns will be positively correlated with changes in the exchange rate.

The explanation offered by Maysami *et al.* (2004) could explain the positive relationship between the Rand/US Dollar exchange rate and the RESI Index. Upon further consideration however, South African resource companies' exports should not change due to changes in the Rand/US Dollar exchange rate as most mineral commodities are priced internationally in Dollars and do not

become cheaper or more expensive due to exchange rate movements. Yet the very fact that commodities are priced in US Dollars offers a reason for the positive relationship between the Rand/US Dollar exchange rate and the RESI Index, though not for the reasons given by Maysami.

As commodities are priced in US Dollars, South African resource companies earn revenues in Dollars and the Rand equivalent revenue is dependent on the exchange rate between the two currencies. As the Rand depreciates, Rand revenue increases and as the Rand strengthens, Rand revenue decreases. The increase or decrease in Rand revenue from currency fluctuations adds to or reduces the bottom line of companies. It therefore makes sense that there is a positive relation between the Rand/US Dollar exchange rate and the RESI Index. As the Rand depreciates, resource companies become more profitable and increase their cash flows, leading to higher share prices.

7 CONCLUSION

7.1 Concluding Remarks

This paper set out to examine the relationship between selected macroeconomic variables and resource share price returns. Specifically, the link between the JSE RESI Index and GDP, CPI, prime interest rate and the Rand/US Dollar exchange rate was tested.

The conclusion drawn was that the RESI Index formed a positive relationship with GDP, a negative relationship with the prime interest rate and a positive relationship with the Rand/US Dollar exchange rate, with the CPI showing no evidence of a relationship. Of all the macroeconomic variables tested, the Rand/US Dollar exchange rate showed the strongest correlation with the RESI Index, followed, followed by GDP with a marginally lower correlation, and then the prime interest rate. The results were in alignment with the existing literature except for the test of the relationship between inflation and the RESI Index which proved inconclusive.

What are the implications of these results for investors, businesses and the government? The results of this paper suggest that there exist opportunities for investors to profit from the inefficiencies of stock market mechanisms. The fact that the RESI Index reacts differently to the macroeconomic variables implies that the behaviour of the stock market may indeed be predicted, contrary to EMH conclusions. There is a possibility for investors to make superior returns

by buying and selling shares as information becomes available on specific macroeconomic variables.

Of course, macroeconomic variable movements do not occur in isolation and most often occur simultaneously. For example, GDP may be rising, suggesting positive future returns on resource shares, while at the same time the Rand/US Dollar exchange rate may strengthen, signalling possible negative future returns. Any investor decisions regarding the buying and selling of resource shares would then be dependent on an investor's assessment of the potential impact of the two movements and which impact will outweigh the other.

For businesses, the results suggest that the focus should be on increasing output and profitability. By investing in capacity and increasing output, businesses can increase their future cash flows and hence stock returns. By increasing profitability, future cash flows can also be increased. The three macroeconomic variables; inflation, prime interest rate and the exchange rate are outside of the control of individual businesses.

It is in the government's interest for the stock market to be one that is thriving, where investors can make positive returns and build wealth and capital formation can be encouraged. For this to exist, an environment should be created where capital investment is encouraged, interest rates are low and the exchange rate is not too strong. These requirements create a delicate balancing act for government as any policy actions taken often have unintended consequences.

Whether to maintain a weak Rand in order to aid the manufacturing sector is one debate that has been ongoing in South Africa. While this would aid the manufacturing sector in terms of South African exports becoming cheaper to the rest of the world, there is always the threat of imported inflation as imported goods become more expensive. South Africa maintains a trade deficit which means that it imports more than exports. Any gains from increased exports due to the weakening Rand may well be wiped out by the negatives of imported inflation. Although a weaker Rand may boost resource share returns, it is questionable whether a weaker Rand is achievable or even desirable.

Regarding interest rates, the SARB follows a policy of inflation targeting which dictates the level at which interest rates are set. As such, interest rate levels are somewhat dictated by inflation levels, leaving very little room for manoeuvring.

7.2 Recommendations

This research has opened up the avenue for future studies to investigate the purported links between macroeconomic variables and resource share prices. To ensure that follow up investigations are more rigorous and to offer other avenues for future exploration, the following recommendations are made:

- Studies should be conducted over a longer time horizon and under normal economic conditions (i.e. without the effect of the global financial crisis) to obtain more reliable data pertaining to the macroeconomic variables time series and the RESI Index time series.

- This study selected four macroeconomic variables, namely GDP, Inflation, Interest rate and exchange rate as the independent variables. Further studies can be conducted using other macroeconomic variables mentioned in Section 2.5 of the literature review.
- The same study can be conducted utilising other JSE sector indexes, such as the financial sector index or the industrial sector index as the dependent variable.
- In this study, the relationship between the macroeconomic variables and the RESI Index was tested using tests of correlations. It is possible to replicate this study using other statistical tests such as regressions.
- The relationship between macroeconomic variables and resource sector indices can be tested for other countries in Africa and the rest of the world.

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