

# MONEY SUPPLY, INTEREST RATE, EXCHANGE RATE AND OIL PRICE INFLUENCE ON INFLATION IN SOUTH AFRICA

Raphael T Mpofu\*

## Abstract

Price stability is critical for South Africa's economic development strategy, and, based on previous studies, to effectively achieve this, requires a good understanding of the relationship between inflation and selected macroeconomic variables of broad money supply, interest rate, exchange rate and oil price. Monthly data are employed from January, 1999 through September, 2010. To determine this relationship, the independent variables were tested for multicollinearity, and thereafter a multiple regression model was developed. The findings from the study show that approximately 97% of the consumer price index movement is explained by the four macroeconomic variables. The study confirms that money supply and exchange rates have a strong positive relationship with inflation and have to be managed. Interest rates and oil price, on the other hand, have a significant negative relationship with inflation and should be part of a macroeconomic policy framework. This requires managing the delicate balance between a desirable level of inflation in support of economic growth and development and an unacceptable level of inflation that leads to price instability.

**Keywords:** Multicollinearity, Oil Price, Money Supply, Interest Rates, Exchange Rate, Inflation, South Africa

\* Department of Finance & Risk Management and Banking, University of South Africa, PO Box 392, Pretoria, 0003, South Africa

Tel: (+27) 12 429-4497

Fax: (+27) 12 429-4553

Email: mpofurt@unisa.ac.za

## 1. Introduction

The monetary policy of the South African Reserve Bank (Reserve Bank) is to maintain price stability via an inflation-targeting strategy. This is achieved by raising or lowering the repo rate, which in turn translates to a two-percentage manipulation of the prime rate of interest. This action also reduces or increases the amount of money supply and hence consumers' or investors' spending ability. These actions influence productivity and output and hence economic output, thereby directly increasing or reducing prices or the consumer price index. However, inflation cannot be explained fully by focusing only on the Reserve Bank's monetary policy. One major factor in the level of the inflation is the price of crude oil (Le Blanc and Chinn, 2004). This exogenous variable is beyond the control of the Reserve Bank and can completely wipe out any gains made by the Reserve Bank's monetary policy actions. The oil spot price has increased from \$11.10 per barrel of Brent crude in January 1999 to \$100.00 per barrel in January 2011. During the same period, the inflation index in South Africa has risen from 59.0 to 113.5. This might indicate that oil prices and inflation are related, which could imply that policy makers and

investors have to incorporate this information into their investment decision making process.

The literature on the determinants of inflation shows that commentators/writers have broad consensus about the role of money supply growth, either as the main driving force behind inflation or as a trigger to other factors. The monetarists (Friedman, 1970) view is that the demand for current consumption affects mostly inflation in the short run, and assumes that money supply growth will cause prices to increase. If money supply or domestic credit exceeds the desired levels, disequilibrium occurs in the market, leading to an increase in inflation as consumers, because of the abundant supply of money, bid against each other for the limited available goods. This situation is changed over time through price increases (Lim and Papi, 1997) as suppliers increase production to compensate for shortages in the market leading to a more competitive market and accompanying price competition. This would hopefully lead to a drop in the inflation rate.

Another theory is that under conditions of poor revenue collection strategies, government revenue collection mechanisms lead to an increase in inflation. This approach looks at the large fiscal imbalances created by a lack of understanding, or poor implementation, of the collection mechanisms of the

domestic or international financial markets. This results in an increase in governments' reliance on local tax revenue collection mechanisms as a primary source to finance the budget deficit. Where the tax base is very narrow, government spending becomes more reliant on government borrowing. This increase in government borrowing leads to a deficit, which increases inflationary pressure and could lead to a higher inflation rate. (Catao and Terrones, 2001).

Catao and Terrones (2001) also look at the role played by wages and other factors, such as exchange rate regimes, that lead to higher inflation. The study of wages and inflation over time has led to the conclusion that wage escalations, via increased cost inputs, lead directly to an increase in production costs, hence an increase in inflation (Catao and Terrones, 2001). Romer (1993) found a negative link between inflation and exchange rate openness, a term used to refer to an economy that has a floating currency and limited controls on imports and exports. While more open economies tend to have lower inflation rates, a study by Terra (1998) found that small open economies are more vulnerable due to the pressure on their exchange rates. In this current study on which this article is based, wages have not been included in the model based on findings in previous studies by Brada and Kutun (1999), Barbakadze (2008), and Grigorian et al. (2004), who found that wage increases have a negligible impact on inflation. Although Coorey et al. (1996), Hernandez-Cata (1999), and Kim (2001) found that nominal wages were one of the influential determinants of inflation; there is a very high correlation between nominal wages and money supply. In addition, Perovic (2009) found that wages can influence inflation only if wage increases are higher than productivity increases.

The study on which this article is based examined how macroeconomic variables affect inflation in South Africa and their relative contribution to inflation, specifically looking at money supply, interest rates, exchange rates and oil prices. By doing so, the study intends help policy makers to keep inflation under the inflation-targeting regime that officially started in February 2000, in order to achieve greater price stability in a more transparent manner. This study aimed at determining causal relationships between broad money supply, prime interest rates, exchange rates and the oil price on the inflation, as well measuring the magnitude and persistence of the responses in the inflation due to changes in these macroeconomic fundamentals.

The aim of the study was not to provide specific strategies for policy makers and investors, but to provide additional information that could be blended with other information in order to generate more effective approaches to policy decisions and better strategies when making investment decisions. Despite the huge number of studies on the linkages between oil prices and inflation in developed countries, there are relatively fewer studies in emerging markets and

developing countries. The results from this study will, hopefully, fill this gap.

## 2. Review of Related Literature

Monetary policy is concerned primarily with price stability. This goal is achieved in a number of ways, for example through control of the money supply (Haug & Lucas, 1996; Carlson, et al., 2000), inflation targeting (Svensson, 1997), interest rates (Bong-Soo, 1992), wages (Robinson and Eatwell, 1973), and asset price controls (Ingves, 2007). According to Bong-Soo (1992), interest rates are the most used monetary policy instrument. He advocates that there is a relationship between inflation and interest rates, and both variables move in tandem (Bong-Soo, 1992).

Rozeff (1974); Moosa (1998); Fama (1981) and Malliaris and Urruita (1991) have shown that there is a relationship between macroeconomic variables and the rate of inflation. Some of the variables of interest include money supply, short-term interest rates, exchange rates and oil prices. In their studies, they demonstrate a direct relationship between changes in monetary aggregates and oil price. They also show that there is a relationship between the U.S. stock market indices, inflation rate, interest rates and Gross Domestic Product (GDP) growth. Malliaris and Urruita (1991) show that excess liquidity (money supply) increases activity and market volumes in the stock market, and in addition, show that the impact of monetary policy actions on prime interest rates produce immediate reactions in the increase or reduction of money supply.. These variables have an immediate impact on market activity and are discussed in more detail in this article. In this study, it was important to get a good understanding of the consumer price index (CPIX) and how the Bank manages inflation via an inflation targeting framework. This discussion endeavoured to be a foundation for understanding how the macroeconomic variables being studied affect inflation and the extent of the relationship. This is useful to policy makers when designing and implementing monetary and economic policies.

In the 1990s, countries such as New Zealand, Australia, Brazil, Canada, Chile, Mexico, Sweden and the United Kingdom adopted inflation targeting as their monetary policy framework (van der Merwe, 2004). South Africa formally adopted this strategy in February 2000, although it had already been implementing it unofficially since the 1990s. The rationale for adopting a formal inflation-targeting framework was supported by four reasons, namely to create certainty on the Reserve Bank's monetary policy stance, to improve the co-ordination between monetary policy and other economic policies, to increase the Reserve Bank's accountability, and finally to directly target investors' inflationary expectations, which is expected to lead to a reduction in the rate of inflation. The monetary policy tool

applied by the Reserve Bank is short-term interest rates. The Reserve Bank determines what it regards as the most appropriate level of short-term interest rates to contain the rate of inflation within a certain target range (van der Merwe, 2004).

In addition to understanding the broad monetary policy framework of South Africa, interest rates and how they affect inflation was a focal point in this study. South Africa targets the CPIX or overall inflation in metropolitan and other urban areas because it can be easily understood by consumers. The CPIX excludes any direct effects that changes in the repurchase rate could have on prices. According to van der Merwe (2004), the rates at which the Reserve Bank discounts financial securities are decided from time to time in consultation with the government in line with the Minister of Finance who makes announcements of the target level of inflation. An increase in interest rates is designed to reduce the pressure on future inflation and a reduction in interest rates seeks to have a positive impact on economic growth (Carneiro et al., 2002; Phylaktis and Blake, 1993).

Interest rates affect inflation and movements reflected in stock market indices. Understanding the impact of interest rates on movements reflected by indices is important, as the effect of these movements play a major role in economic growth (Carneiro et al., 2002). Economic theory shows that an increase in short-term interest rates adversely affects stock market returns. Ajayi and Mougoue (1996) argue that a rising stock market price is an indicator of higher inflation expectations. This increase in interest rates raises financing costs, and thus reduces future corporate profitability (Mukherjee and Naka, 1995).

Another variable of interest in the study was the exchange rate. According to Terra (1998), open economies experience high imported inflation as a result of imported goods. An increase of imported goods leads to increased pressure on the domestic currency, and a depreciation or loss of value against trading partner currencies. This is an important aspect for South Africa, being a small and open economy compared to its major trading partners like the United States of America, Europe and China. Under conditions of currency depreciation, interest rates are normally increased to prevent higher inflation.

Bahmani-Oskooee and Malixi (1992) observed that Egypt is regarded as a small open economy, and for monitoring and regulating price level stability, stability of the exchange rate is critical for the Egyptian economy. Their findings are that increases in foreign price level pushes up domestic inflation although such changes in the domestic consumer prices do not seem to be highly sensitive to changes in import prices. This has been attributed to subsidies used by the Egyptian government to shield the poor against inflationary impacts. This, in a way, confirms that governments do need to manage exchange rates,

which have an impact on domestic prices via imported inflation.

Milton Friedman stated that "Inflation is always and everywhere a monetary phenomenon" (1992: 262). Lucas (1980), Dwyer and Hafer (1988), Friedman (1992), Barro (1993), McCandless and Weber (1995), Dewald (1998), Rolnick and Weber (1997), Dwyer (1998) also found that money supply and inflation are closely related. The question is, given the numerous studies on the relationship between these two variables, why is there still lack of agreement among commentators and researchers? Some researchers have found a relationship between money supply and inflation only in the long-run, a period which can be as long as 30 to 40 years. This period is unfortunately too long for policy makers to test the impact of their policy decisions. But because some research studies have shown that this relationship does exist in the short-run, say over five years (Dwyer and Hafer, 1988), there is still interest to continue to investigate the impact of money supply on inflation.

The money supply's impact on inflation is also linked to an increase in stock prices through portfolio substitution or inflationary expectations. An increase in the money supply may raise the interest rate through inflationary expectations, which in turn, reduces stock prices as investors move their investments away from the stock market. It should however be noted that other researchers found that an increase in money supply could enhance stock prices via the liquidity effect, i.e. higher liquidity in the economy leads to a higher demand for stocks, which in turn leads to higher stock prices (Cheung and Ng, 1998).

Given the importance of these variables and their impact on inflation, understanding this relationship and the extent of the relationship is critical for investors and for the South African Reserve Bank's inflation targeting framework. The economists' popular view is that the most basic factors that influence price of commodities are demand and supply factors. According to this view, an increase in money supply leads to a high demand for goods and services, which leads to an increase in prices as a lot of money, is chasing too few goods in the short-run before equilibrium is established.

Oil is a critical input into manufacturing and fuels economic growth. The recent trends in high crude oil prices have translated into higher manufacturing costs. This leads to lower household incomes, reduced spending power and a depressed economy. In order to recoup their input costs, companies tend to increase retail prices of goods, hence leading to an increase in inflation (Kaul and Jones, 1996; Sadorsky, 1999). The last ten years also saw western countries increase money supply via credit extension and a dependency on credit for development. The downside of this credit extension was the use of borrowed money for current consumption. This resulted in huge defaults by borrowers, due to the economic downturn and

increased interest rates during the late 1990s, and the eventual collapse of a number of financial institutions during the period 2007 to 2009. During this period of high oil prices, most developing countries used up a lot of their long-term food and foreign exchange reserves as they imported white goods, oil and motor vehicles. With the drop in profitability of companies and a significant drop in tax revenues, companies and countries have seen their market dominance and competitive advantages eroded in a very short time space (Öhman and Remond-Tiedrez, 2009). Crude oil prices have been increasing sharply since 1985, when there was a temporary collapse of the Organization of Petroleum Exporting Countries (OPEC). The price of Brent crude has risen from US\$31 in 1985 to US\$100 per barrel in February 2011. In early 2011, turmoil in North Africa, mostly in Tunisia, Egypt and Libya, and other Arab countries such as Yemen and Saudi Arabia have added pressure to the price of oil; with April 13, 2011 Brent crude oil price edging past the US\$120 per barrel mark (Bloomberg, 2011).

In their study, Kaul and Jones (1996) show that markets respond negatively to oil shocks. Beyer et al. (2009) note that energy prices are the main driver behind the high levels of inflation. In their study, LeBlanc and Chinn (2004) show that oil prices have an immediate and significant effect on inflation and real output, but tend to have a direct impact only in the short-run and an insignificant relationship in the long-run.

If the oil price affects real output, increases in oil price depress aggregate stock price by lowering expected earnings. This leads to lower household incomes, reduced spending power and a depressed economy. In order to recoup their input costs, companies tend to increase retail prices of goods, hence leading to an increase in inflation (Kaul and Jones, 1996; Sadorsky, 1999). Huang, Masulis, and Stoll (1996), who investigated the impact of oil prices on the U.S. stock market found significant Granger causality effects from oil futures to stocks of individual oil companies. Other studies (Mork, 1989; Hamilton, 1996, 2000; Balke et al., 1999; Mork, 1994; Hiemstra and Jones, 1994; Faff and Brailsford, 1999; and Ciner, 2001) have confirmed that there is a significant relationship between oil price, oil futures, stock market indices and inflation.

The oil price variable is critical for this study in that oil prices have a direct bearing on production costs and stock market prices. It is therefore of great

importance to understand the relationship between these variables if portfolio managers and policy planners are to effectively executing their duties. The article demonstrates how oil prices have affected inflation in South Africa and proposes a model of getting a better understanding of the possible impact oil price has on inflation.

The purpose of this research was to examine the relationship between prime interest rate, exchange rate, money supply and the oil price and inflation and to investigate whether changes in these variables contribute positive or negatively to inflation. The effect of these variables on inflation is well supported by empirical studies in developed countries but very little is known in developing countries, especially South Africa that has a small but open economy.

The research also examined whether there were any positive or negative relationships between variables and how these relationships affected CPIX. Consequently, the research accounted for the impact of these variables on inflation, especially oil prices which depict unexpected price fluctuations.

### 3. Materials and Methods

The basic assumption underlying the model is that macroeconomic variables have a deterministic impact on inflation in South Africa. The statistical tests were carried out on monthly time series data on the overall inflation index which excludes the effects of changes in mortgage costs (also known as the CPIX). While the South African Reserve Bank uses CPIX to measure the target inflation, this is done fully realising that such a broad measure has the disadvantage that it could be affected by exogenous shocks over which monetary policy has no control. The CPIX was the dependent variable and was tested against the following independent variables: money supply, prime overdraft rate (PRIME), as representing the interest rate at which investors borrow or lend money, the rand exchange rate against the US dollar (USAX) and the price of Brent crude oil (OIL).

#### 3.1. The hypothesized model

The independent variables were then used to test certain a hypothesis shown below. The general model tested is as follows:

**The model is represented as:**

$$\ln CPIX_t = a + b \ln M2_t + c \ln PRIME_t + c \ln USAX_t + d \ln OIL_t + e_t$$

Where:

- *CPIX is the overall inflation index that excludes mortgage interest rates,*
- *M2 is the broad money supply measure,*
- *PRIME is the prime overdraft interest rate*
- *USAX is the rand dollar exchange rate, and*
- *OIL is the price per barrel of Brent crude oil.*

**The hypotheses tested are:**

- There is a positive relationship between the CPIX and M2
- There is a positive relationship between the CPIX and USAX
- There is a negative relationship between the CPIX and PRIME
- There is a no significant relationship between the CPIX and OIL

It was hypothesised that there is a positive relationship between the CPIX (dependent variable) and M2 and USAX (independent variables) because the relationship between the money supply (M2) and inflation is that excess supply of money leads to an increase in expenditure on goods as well as other financial assets, including stocks (Rozeff, 1974; Moosa, 1998; Fama, 1981; Malliaris and Urruita, 1991) which leads to a short-run increase in the price of goods and services. The huge appetite for imported goods leads to increased pressure on the price of domestic goods, and a huge demand for foreign currency. This could lead to a loss of value of the local currency (USAX) against foreign currencies of major trading partners.

However, an increase in the oil price (OIL) in the short-term leads to a sharp increase in the price of domestic energy but in the long-run, consumers adjust their spending in light of increased energy costs by redirecting disposable income away from luxury goods. Where expected inflation is high, raising interest rates removes excess liquidity and curbs further lending and borrowing, leading to a reduction in inflation.

The literature review and the theoretical framework discussed formed the basis for the methodology adopted in the study. In the next section, the methodology is discussed, with emphasis being placed on the statistical techniques used and the assumptions made.

### **3.2. Methodology**

The CPIX is compiled only for metropolitan and urban areas in South Africa. This is done by looking at prices of twelve categories of consumers' expenses less mortgage interest rates. For the study, it is important to note that oil energy costs are not included in the CPIX. It is for this reason that the relationship between oil price and CPIX was important. All the data used in the study was obtained directly from Stats SA that compiles the monthly data. The data series is from January 1999 to September 2010. The CPIX data has been re-based to 2008 due to a change in the calculation of the inflation index by Stats SA, as well as the basket of goods used in the composition of the CPIX.

Macroeconomic variable data was obtained from Statistics South Africa and the South African Reserve

Bank. The data was verified and tested for accuracy by comparing similar data over the time series for accuracy. The data for all macroeconomic variables is available from the 1960s except for the oil prices, which are only available from 1999. The choice of the oil price variable was based on the most commonly imported oil into South Africa. While other studies adopt different types of crude oil, for example, Brent, West Texas Intermediate, and Dubai; the Brent crude oil price is used as our primary proxy for the world price of crude oil due to its heavily traded nature and use as a benchmark for crude oil prices. South Africa imports the majority of its crude oil from members of the OPEC, namely Saudi Arabia (29%), Iran (23%), Nigeria (16%) and Angola (15%). The monthly averages are calculated by the South African Reserve Bank.

This study employed a multiple regression approach in analysing the time series data to determine the relationship between the CPIX index and the macroeconomic variables. In a multiple regression model, where more than two independent variables are analysed, multicollinearity between variables may not be ruled out. The literature on multicollinearity can be divided into three major topics: (1) under what conditions multicollinearity will occur; (2) how multicollinearity problems can be detected; and (3) how multicollinearity should be managed. Mason and William (1991) have documented the conditions under which multicollinearity may pose problems in regression. They show that multicollinearity leads to inaccurate estimates of coefficients and standard errors as well as inference errors, but they also argue that the problem should not be viewed in isolation, and that a high  $R^2$  and large sample size can offset the problems caused by multicollinearity. Mason and William (1991) conclude that increasing the "explained variance" in the dependent variable mitigates the effects of multicollinearity. Removing measurement error should increase the amount of variance explained by the structural model and therefore reduce multicollinearity.

Kaplan (1994) reviews several general methods that can be used to detect multicollinearity, including inspection of the (1) correlation matrix of the predictor variables, (2) correlation matrix of the path coefficients, (3) determinant of the correlation matrix of the predictor variables, (4) sign of the path coefficients, and (5) variance inflation factors.

Schmidt and Muller (1978) discuss three specific methods for assessing multicollinearity: (1) the multiple correlations between the independent variables; (2) the Haitovsky test, which assesses singularity of the correlation matrix of the independent variables; and (3) the determinant and Eigenvalues of the correlation matrix of the independent variables. However, these methods have limitations because they do not provide clear

guidelines about when multicollinearity is likely to cause inference errors.

Jagpal (1982) developed partial-least-squares (PLS)-based ridge estimator to deal with multicollinearity in structural equation models. Multicollinearity can cause problems under certain conditions, specifically:

- (1) When multicollinearity is extreme, Type II error rates are generally unacceptably high (over 80%),
- (2) When multicollinearity is between 0.6 and 0.8, Type II error rates can be substantial (greater than 50% and frequently above 80%) if composite reliability is weak, explained variance  $R^2$  is low, and sample size is relatively small. However, as reliability improves (0.80 or higher), explained variance  $R^2$  reaches 0.75, and sample becomes relatively large, Type II error rates become negligible.
- (3) When multicollinearity is between 0.4 and 0.5, Type II error rates tend to be quite small, except when reliability is weak,  $R^2$  is low, and sample size is small, in which case error rates can still be high (greater than 50%).

A multicollinearity test was conducted for all the independent variables. After standardizing the data set using natural logarithms, a correlation matrix using Pearson Coefficient of correlation was developed. In accordance with Jagpal (1982), all the variables with VIFs greater than 10 were dropped from the study.

## 4. Results and Discussion

The next sections contains an analysis of the findings using standard descriptors (mean, standard deviation, skewness and Kurtosis) which were used to examine the likely distribution of data on each variable. Thereafter, summary statistics for all the macroeconomic variables in this study are presented. The section is concluded by looking at the question of multicollinearity. Where more than two independent variables are tested for a relationship with a dependent variable, multicollinearity between variables has to be tested.

### 4.1. Multicollinearity tests

A multicollinearity tests were conducted for all the independent variables using the Pearson coefficient of correlation. Table 1 below shows the results of the multicollinearity tests in the form of a VIFs and Eigenvalues. Variance inflation factors (VIFs) in the collinearity table are less than seven and their Eigenvalues that are less than 0.025. From the table, it is clear that there is very little multicollinearity and the regression model serves the purpose of the study, which was to determine if there is a relationship between CPIX and PRIME, USAX, M2 and OIL.

**Table 1.** Multicollinearity Statistics

	Collinearity Statistics		Eigenvalue
	Tolerance	VIF	
Money Supply	0.148	6.746	0.022
Prime Overdraft Rate	0.607	1.647	0.005
Rand-US\$ Exchange	0.735	1.360	0.002
Brent Crude Oil Price	0.155	6.443	0.000

### 4.2. Descriptive Analysis

Table 2 provides the summary statistics for all the macroeconomic variables in this study. It reveals that the distribution of the series could be considered as slightly dispersed as represented by the standard deviation values, which are small when compared to the mean. On the other hand, the skewness of the distributions was considered as approximately normal as its values were closer to zero. Normal distributions produced a skewness statistic of about zero. The results from this analysis also revealed that the kurtosis values for PRIME, USAX and OIL variables were less than 1 and so are acceptable, and M2 has a value of 1.395, which is also acceptable. The negative

kurtosis values indicated the possibility of a platykurtic (flat) distribution. This finding provided a general indication that the distributions of the series of variables were normal.

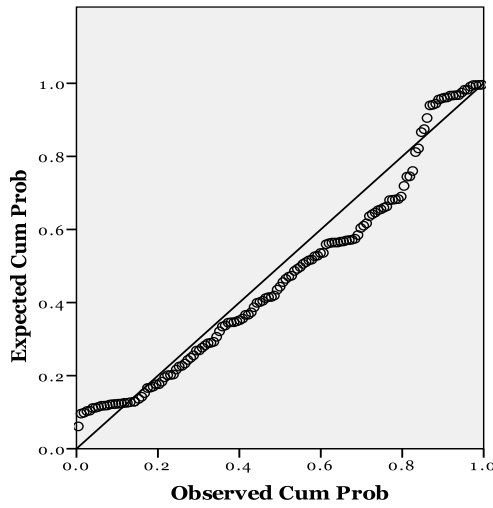
The information concerning the normality distribution of the series for macroeconomic variables could also be observed in the normal probability plot as shown in Figure I. The fitted line in the normal probability plot was more or less a straight line for all macroeconomic variables. This finding demonstrated that the macroeconomic variables were normally distributed.

**Table 2.** Descriptive Statistics for All Macroeconomic Variables

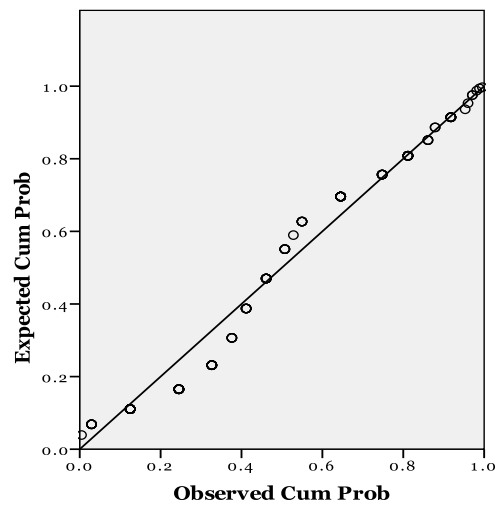
						Skewness	Kurtosis
	N	Minimum	Maximum	Mean	Std. Deviation	Statistic	Statistic
Money Supply	141	12.8475	14.2828	13.6288	0.47266	-0.022	-1.395
Prime Overdraft Rate	141	2.2513	3.0910	2.5788	0.18592	0.245	-0.716
Rand-US\$ Exchange	141	1.7461	2.4517	2.0061	0.16822	0.893	0.222
Brent Crude Oil Price	141	2.3618	4.8968	3.7368	0.55685	-0.060	-0.807
Consumer Price Index	141	4.0775	4.7221	4.3819	0.19357	0.178	-0.977
Valid N (listwise)	141						

**Figure I.** Normal Probability Plots

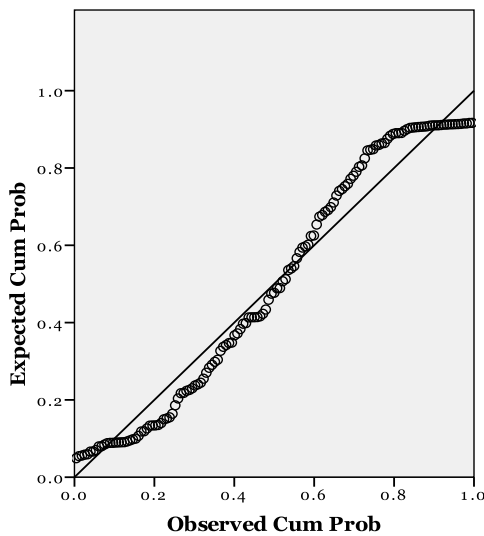
**Normal P-P Plot of Rand-US\$ Exchange**



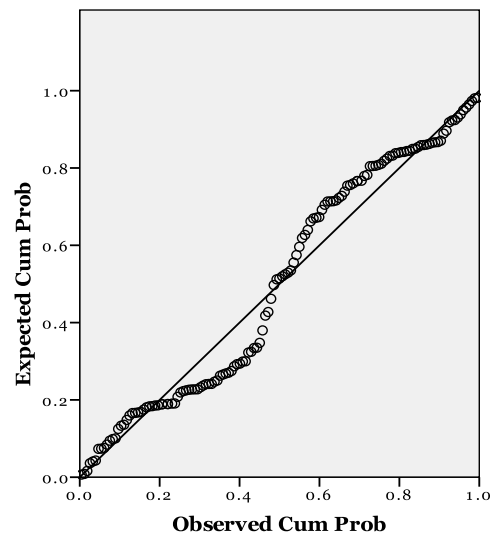
**Normal P-P Plot of Prime Overdraft Rate**



**Normal P-P Plot of Money Supply**



**Normal P-P Plot of Brent Crude Oil Price**



### 4.3. Discussion of Findings

The first step in the statistical analysis was to look at multicollinearity. A multicollinearity test was conducted for all the independent variables using the Pearson coefficient of correlation. Table 1 above shows that the variables exhibit very little correlation which means that the model can be relied upon. The VIFs and Eigenvalues are all within acceptable bounds. The variance inflation factors (VIFs) observed in the collinearity table are less than seven and their Eigenvalues are less than 0.025. The descriptive statistics used are the mean, standard deviation, skewness and the Kurtosis statistic. They examine the

distribution of data on each variable. All the data shows that the series of independent variables is normally distributed and can be used to create a robust model for understanding the relationship between the dependent variable and the independent variables. The final part of the analysis was done by running a regression model on the dependent variable CPIX against the independent variables PRIME, USAX, M2 and OIL. The regression model exhibits results that are in line with the hypotheses discussed earlier. Tables 3 to 5 show the results of the regression analysis.

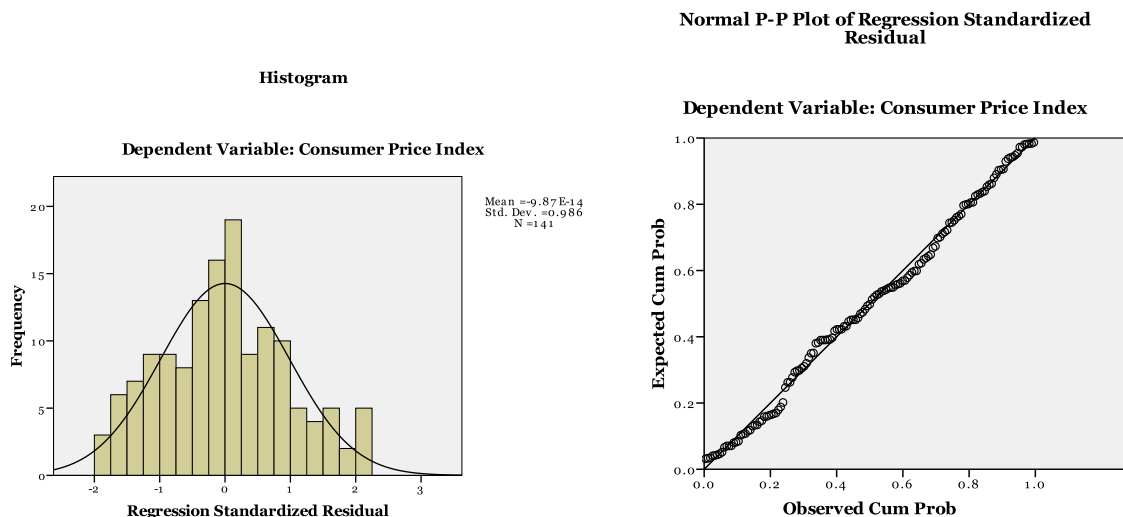
**Table 3.** Regression model summary

Model	R	R Square (R <sup>2</sup> )	Adjusted R Square	Std. Error of the Estimate
	0.985 <sup>a</sup>	0.969	0.969	0.0343299

The R<sup>2</sup> of 96.9% indicates that the model is a good predictor of the dependent variable. It implies that the model can be used for estimating CPIX and that 96.9% of the CPIX can be explained by the independent variables. The standard error of the estimate is very small, implying that there is a three percent error in estimating CPIX. The standard error of the estimate is a measure of the accuracy of predictions made with a regression model ([bionicturtle.com](http://bionicturtle.com), 1998). For example, in the

research, the standard error of the estimate would be calculated from the difference between the estimate of CPIX as calculated from the regression equation, and the CPIX actual values. Figure II shows a plot of the deviations of the predicted CPIX scores from actual CPIX values. It also shows the normal probability plot of regression standardized residuals that indicate an almost perfect goodness-of-fit line of expected versus observed CPIX values.

**Figure II.** Regression standardized Residuals of CPIX





**Table 4.** Analysis of variance (ANOVA)

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	5.085	4	1.271	1078.711	0.000 <sup>a</sup>
Residual	0.160	136	0.001		
Total	5.246	140			

The "F value" of 1078.7 is large and has a significance value close to zero. The sig. (F) is the probability that the null hypothesis for the model is

true and would imply that the regression equation does have some validity in fitting the data.

**Table 5.** Regression coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t-stat.	Sig. (t)
	B	Std. Error	Beta		
(Constant)	-1.448	0.181		-8.016	0.000
Money Supply	0.432	0.016	1.054	27.080	0.000
Prime Overdraft Rate	-0.031	0.020	-0.030	-1.562	0.121
Rand-US\$ Exchange	0.083	0.020	0.072	4.139	0.000
Brent Crude Oil Price	-0.038	0.013	-0.108	-2.847	0.005

The "t" statistic is a measure of the possibility that the actual value of each of the independent variables in the model is less likely to be zero. The sig. (t)" also indicates that it is less likely that the actual parameter value is zero. For example, in the model above, the variable money supply has a t-value of 27.080 and a sig.(t) of 0.000. The larger the absolute value of t, the less likely that the actual value of the parameter could be zero. This indicates that there is a less than 0.1% chance that the parameter could be zero, and eliminating the money supply variable from the model would be incorrect.

#### 4.4. Analysing the hypothesis

The following hypotheses are accepted:

- There is a positive relationship between the CPIX and M2
- There is a positive relationship between the CPIX and USAX
- There is a negative relationship between the CPIX and PRIME
- There is a no significant relationship between the CPIX and OIL

Based on the results of the regression model, the model proposed earlier is presented as follows:

$$\ln CPIX_t = -1.448 + 0.432 \ln M2_t - 0.031 \ln PRIME_t + 0.083 \ln USAX_t - 0.038 \ln OIL_t + 0.181$$

It can be interpreted from the model that the CPIX is highly sensitive to variation as indicated by  $R^2$  of 0.969. In other words, according to the model developed from the data, almost 97% of the variation in the CPIX is explained by the four macroeconomic independent variables. The variability as measured by the coefficient of variation ( $\beta$ ) is positive for M2 (1.054), USAX (0.072) and is negative for OIL (-0.108) and PRIME (-0.030).

The positive M2 and USAX's coefficients in relation to the CPIX are in agreement with other studies (Ibrahim and Hassanuddeen, 2003; Mukherjee and Naka, 1995; Chaudhuri and Smiles, 2004). The relationship between PRIME and CPIX also confirms the initial hypotheses that there is a negative

relationship between these variables. This would imply that an increase in interest rates leads to a decrease in CPIX. The relationship between OIL and CPIX also differs from the initial hypotheses that there is no relationship between these variables. This would imply that an increase in oil prices leads to a decrease in the CPIX. This is still in line with findings by Jones and Kaul (1996) and Beyer et al. (2009).

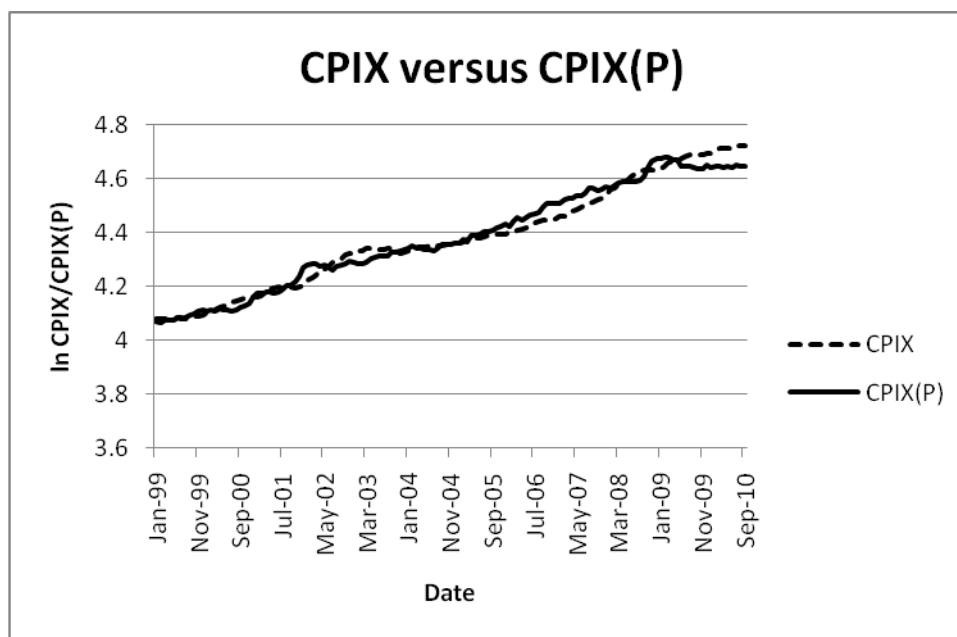
The  $\beta$  values for PRIME and OIL were found to be negative. The  $\beta$  for PRIME was -0.030 with a t-value of -1.562. The t-value for PRIME was less significant at 0.121 compared to that of OIL, which was more significant at 0.005 and had a  $\beta$  value of -0.108. This result confirm the hypothesis that interest rates do affect inflation and do play an important role

in price stability but also indicates that oil prices do affect domestic inflation in South Africa significantly.

The relationship between M2 and CPIX has a positive  $\beta$  of 1.054 and a low p-value which is statistically significant. Because of findings from developed countries that show that money supply does play an important role in determining inflation the high significance is expected. Finally, the hypothesis that foreign exchange rate affects the CPIX significantly is also accepted and has a positive  $\beta$  of 0.072 a very low p-value. The results suggest that all the variables considered do have a bearing on CPIX and, hence, can be relevant in predicting the direction of CPIX in the future.

As a test of the model fit, the regression equation was used to estimate CPIX (labelled as CPIX(P) in the Figure II below). It should be noted that the rationale for this exercise was not to test the accuracy of the model developed. Rather, it is to test if the model can be used to determine the direction of movement of CPIX given expected values of the predictor variables. Although the predicted line does not directly coincide with the actual data, it is quite clear that the model is a good estimate of the true movement of CPIX and can be used for predicting the future direction of movement of inflation in South Africa. Figure III illustrates this graphically.

**Figure III.** CPIX versus CPIX(P)



\* CPIX(P) is calculated from the regression equation.

For the purpose of the study, these results are satisfactory, and a summary conclusion is presented in the next section.

## 5. Conclusion

Research reports on factors that influence inflation have shown broad consensus about the role of money supply growth, either as the main driving force behind inflation or as a trigger to other factors. The monetarists' view is that the demand for current consumption affects mostly inflation in the short run, and assumes that money supply growth will cause prices to increase. Terra (1998) also found that exchange rates, especially in small, open economies like South Africa, experience high imported inflation as a result of imported goods. As imports of imported goods increase, this leads to increased pressure on the domestic currency, and a depreciation or loss of value against trading partner currencies. Another important variable in the study is how interest rates are used to

control money supply and also to inject a positive impact on economic growth (Carneiro et al., 2002; Phylaktis and Blake, 1993). Finally, oil price has a direct bearing on manufacturing production costs and provides an impetus for economic growth.

The findings of the study do support the position adopted by the South African Reserve Bank's monetary policy programme of inflation targeting. Money supply seems to have a very strong positive relationship with inflation and needs to be controlled and managed closely. Interest rates, on the other hand, have a significant relationship with inflation but can be effectively used as a control measure for money supply by the Bank. By increasing interest rates, the Bank can reduce the amount of available credit and lending, which can lead to a downward push on inflation. In fighting inflation it is critical for the government to control the money supply and credit facilities. High nominal interest rates seem to exert inflationary pressures by impacting on costs and discouraging investment.

Exchange rate stability could in one hand help to stabilize price levels in South Africa; however, it could also result in a long term real exchange rate appreciation and consequently damage the country's external competitiveness. Striking a balance between these two objectives should be the core of South Africa's foreign exchange rate management.

Given the negative impact of growth on inflation, structural reforms and infrastructural improvements to increase the country's productive capacity should be considered as important elements of an overall stabilization program to fight inflation. Results of the study suggest that fighting inflation will not be an easy task, because some of the policies to control inflationary pressures may be contradicted, e.g. control of money supply will necessarily lead to two effects; higher nominal interest rates and exchange rate appreciation. The former is expected to feed inflation as mentioned above, while the appreciation of the rand may result in reducing inflation pressures, it would in turn have a negative impact on the country's international competitiveness.

Empirical results of this study have several implications for policy makers and investors. The behaviour of the oil price profoundly impacts on the price of goods and services which leads to a contraction on spending and investment, hence reducing inflation. However, a delicate balance is required on the level of inflation that can be tolerated in support of economic growth and development.

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