AN ANALYSIS OF THE STATISTICAL RELATIONSHIP BETWEEN PRECIOUS METALS PRICES AND OTHER MONETARY POLICY VARIABLESAND INFLATION IN SOUTH AFRICA

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Abstract

This study looked at the statistical relationship between precious metals prices, oil prices, money supply, interest rates and exchange ratesandinflation. It particularly looked at how inflation was influenced by these variables over time. The findings in this study were consistent with the hypothesis that the values of these variables influence inflation in the short-term and long-term. One of the findingsthat could be of interest especially for South Africa indicates that precious metalsprice changes, especially gold,could act as signals of pending changes to inflation and are also statistically related to interest rate movements. However, it was also found that the relationship between exchange rates movements during the financial crisis era between 2008 and 2010 did affect the other variables like prime, precious metals prices and oil prices which led to significant spikes in inflation. It should be emphasized that these finding of a statistical relationship is only consistent with observed data pertaining to South Africa and not proof of such behaviour prevailing in other markets. Even then, such a conclusion would require the isolation of a number of country specific behaviours and factors that may be correlated with precious metals prices, oil prices, exchange rates and interest rates and that may simultaneously affect inflation, which this study did not factor in. However, knowledge of statistical relationships can help in informing monetary policy responses and designing appropriate portfolio strategies although these findings do not provide unambiguous proof of any underlying behavioural hypothesis.

Keywords: South Africa, Inflation, Precious Metals, Monetary Policy, Interest Rates

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1. Introduction

Studies by Lastrapes and Selgin (1995) on the impact of precious metal prices, especially gold, on monetary policy variables have shown that these prices tend to affect inflation significantly in the long-term. Other studies have also shown that the exact opposite is also true. For instance, changes in liquidity caused by repurchase operations by a central bank tend to put inflationary pressures on the economy. As a result of this, it is also observed that market participants tend to react in part by using their surplus funds to buy assets such as precious metals, thereby inducing a demand for these assets and leading to a surge in precious metal prices. On the other hand, if the central bank interprets an upward movement in the price of precious metals as indicative of an excess supply of money, it could restrict liquidity by increasing interest rates, and thereby reducing the inflationary pressures.

Numerous studies have explored the investment benefits of adding precious metals to portfolios of equities, and many find that positive allocations improve overall performance (Jaffe, 1989; and Chua, Jess, Sick and Woodward, 1990). They found that benefits are typically ascribed to precious metals' low return correlation with US equities and the natural hedge they provide against inflation. However, other studies have found that the benefits have at times been small or non-existent (Johnson and Soenen, 1997).This study sought to look for possible informational signals contained in the movement of precious metals prices so as to assist central banks and policy makers in designing appropriate monetary policy responses to short-run or long-run changes in precious metal prices and macroeconomic variables under study.

There is of course academic literature on monetary policy and the behaviour of most central banks. Most of this literature focuses on how the instruments of monetary policy react to changes in policy variables: how inflation, unemployment and output react to oil prices, money supply, interest rates and exchange rates. In contrast, little attention has been paid to the possible role of precious metal prices in guiding monetary policy decisions. One such precious metal that has received little attention of late as a leading indicator of inflation is the price of gold. In fact, gold is more often analysed as a commodity, but unlike other commodities it is sometimes used as a store of value and hedge against inflation. If viewed as a financial asset, one may therefore wish to determine whether it should be monitored as a leading indicator of inflation. Recent studies that have examined various leading indicators for inflation, such as Stock and Watson (1999), Cecchetti, Chu and Steindel (2000), Boivin and Ng (2006) and Banerjee and Marcellino (2006) have not considered the price of gold as a candidate leading indicator.

This study uses techniques of time-series analysis to identify and estimate the magnitude of the statistical linkages between inflation and precious metals prices of gold, platinum and silver prices. Time series data used in the study covered the period 1 January 2003 to 31 December 2011.

The literature on the determination of factors that influence macroeconomic variables like inflation and interest rates shows that researchers 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.

In recent years, because of increasing international diversification, the global financial crisis, gradual abolishment of capital inflow barriers and foreign exchange restrictions or the adoption of more flexible exchange rate arrangements in emerging countries, the developed and less developed markets have become interdependent. Phylaktis and Ravazzolo (2005) note that globalization has made exchange rates play an even bigger role in influencing stock prices.

With more open economies, the diminishing dominance of the US dollar, with certain Asian countries, notably China and Russia coming out strongly against using the US dollar as a currency of trade (Pravda, 2009); the challenges facing the European Union and the Euro; the opening up of capital movements in China, Russia and former eastern-bloc countries; have all made the importance of monitoring exchange rates that more important. These changes have increased the variety of investment opportunities as well as the volatility of exchange rates and risk of investment decisions and management of portfolios and diversification strategies.

For this study, the prime overdraft rate represents the money market interest rates. Interest rates play an important role in stock price movements, pricing of precious metals and the perceived future value of investments on precious metals, thus, they are included in the model. Economic theory indicates that the increases in short-term interest rates have a negative impact on asset prices and returns. An increase in interest rates may raise financing costs, and then reduce future prices and returns. Mukherjee and Naka (1995) found a positive relation between Japanese stock prices and the short-term interest rates represented by call money rates.

The consumer price index is used as a measure of the level of inflation. Ajayi and Mougoue (1996) argue that a rising stock market price is an indicator of higher inflation expectations. The money supply discussed earlier can be linked to portfolio substitution or inflationary expectation. An increase in the money supply may lead to an increase in interest rates through inflationary expectations and, in turn, increaseprecious metals prices. Alternatively, a decrease in money supply could reduce precious metal prices via the liquidity effect, i.e. lower liquidity in the economy may lead to increases in interest rates and, consequently lead to lower precious metals prices (Cheung and Ng, 1998).

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 Kutan (1999), Barbakadze (2008), and Grigorian, Khachatryan, and Sargsyan, (2004), who found that wage increases have a negligible impact on inflation. Although Coorey, Mecagni and Offerdal, (1996), Hernandez-Cata (1999), and Kim (2001) found that nominal wages were one of the most critical determinants of inflation; there is a very high correlation between nominal wages and money supply. In addition, Malešević-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 the relationship between precious metals prices and monetary policy variables of inflation and interest rates. It particularly looked at how these monetary policy variables were influenced by precious metal prices over time. A study on the relationship between macroeconomic variables and precious metals prices in South Africa is vital in enabling policy makers, investors and portfolio managers to optimally manage economic growth make optimal asset allocation decisions and track portfolio performance. South Africa, which is regarded as one of the most dynamic emerging markets and one of the world leaders in the production of precious metals cannot afford to ignore this relationship.

Basic time series data covering the period 2003-2011 was used in the study. The relationship between precious metals prices and the macroeconomic variables was tested using linear regression. The model was analysed to test for fit using regression coefficients, correlation matrix, R^2, standard error of the estimate, analysis-of-variance table, predicted values, and residuals. Also, 95%-confidence intervals for each regression coefficient, variance inflation factor, Durbin-Watson test and normal probability plots were used. The signs of the coefficients were as expected, and most of the macroeconomic variables showed significant relationships with the precious metals prices.

The aim of the study was not to provide specific strategies for policy makers and investors, but also sought to provide a further understanding of the role played by precious metals prices that could be blended with other economic, social and political 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 precious metal prices and macroeconomic variables in developed countries (Lastrapes and Selgin, 1995), there are relatively fewer studies in emerging markets and developing countries. The results from this study will, hopefully, fill this gap.

The next section provides the literature review on the relationship between precious metals prices and other variables and how they influence monetary policy variables of inflation and interest rates.

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 and Lucas, 1996; Carlson, Hoffman, Keen and Rasche, 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. Bong-Soo advocates that there is a relationship between inflation and interest rates, and both variables move in tandem (Bong-Soo, 1992). This finding implies that it is therefore statistically possible that if precious metals prices have a statistical relationship with one of these variables, say for example, interest rates, then this relationship can be deemed to exist with the other variable.

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.

A study by Hillier, Draper and Faff (2006) examined the relative benefits of supplementing an investment in the S&P 500 with gold, silver or platinum over the period 1976 to 2004. They found that portfolio performance in general improved during this period, particularly those portfolios with a higher weighting of gold than silver. Tufano (1998) found that North American gold mining companies' equity price exposure to the price of gold varied substantially over time and across firms. They found that the company's leverage played an important role.

Jensen, Mercer and Johnson (1996) suggest that a change in the Federal Reserve Bank's discount rate can be used as a policy signal to broadly define overall Federal Reserve Bank policy intentions. They found that monetary aggregates and various measures of economic and banking activity are significantly different across periods of expansive-versus-restrictive policy. Mahdavi and Zhou (1997) examined the predictive power of gold and other commodity prices and found a cointegrating relationship between commodity prices and inflation but none between gold and inflation.

Precious metals average prices have been increasing sharply since 1973, rising from double digit figures of US$97.39 per ounce to US$1,571.52 in 2011, while the price of silver has increased from US$1.95 in 1973 to US$43.84in 2011 and platinum prices have risen from under US$190 in 1973, a surge brought about by demand for platinum and palladium in automobile catalytic converters in the United States since the introduction of catalytic converters in 1974, to over US$1850in 2011.

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 South African Reserve Bank's monetary policy stance, to improve the co-ordination between monetary policy and other economic policies, to increase the South African 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 South African Reserve Bank is short-term interest rates. The South African 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, Divino and Rocha, 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" (Friedman, 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.

The other variable of interest is the price of Brent crude oil. 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).Recent studies have found that the relationship between oil price and inflation was a negative one (Kaul and Jones (1996),Beyer, Haung and Dewald, (2009, Mpofu, 2011). This implies that an increase in oil prices would lead to a decrease in the inflation.

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

The study also examined whether there were any positive or negative relationships between variables and how these relationships affected inflation. Consequently, the studylooked at the impact of these macroeconomic variables and the magnitude of this impact on inflation, with special focus on the impact of precious metals prices.

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 (M2), 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), the price of Brent crude oil (OIL), the price of gold (GOLD), the price of silver (SILVER) and the price of platinum (PLAT).

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:

$$\ln CPIX_t = a + b\ln M2_t + c\ln PRIME_t + d\ln USAX_t + ...$$
$$f\ln OIL_t + g\ln GOLD_t + h\ln SILVER_t + k\ln PLAT_t + e_t$$

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,*
- *OIL is the price per barrel of Brent crude oil,*
- *GOLD is the price per ounce of gold,*
- *SILVER is the price per ounce of silver,*
- *PLAT is the price per ounce of platinum, and*
- *e is a random error term.*

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 negative relationship between the CPIX and GOLD
- There is a negative relationship between the CPIX and SILVER
- There is a negative relationship between the CPIX and PLAT
- 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, USAX, GOLD, SILVER and PLAT (independent variables). This is based on the assumed relationship between the money supply (M2) and inflation in 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. Gold, silver and platinum are seen as deflationary hedges, meaning that in times of high inflation, investors' perceptions are such that they see these metals as representing a store of value. High precious metals prices would there be expected to have a negative correlation with inflation. On the other hand, studies such as Kolluri (1981), Laurent (1994) and Ghosh, Levin, Macmillan and Wright (2002) have all argued that gold could still be a good long-run inflation hedge.

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 2003 to December 2011. 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 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.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.

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 section 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 that were done using Variance Inflation Factors (VIF) and Eigenvalues. After calculating the VIFs, it was found that the VIF for GOLD was extremely high (51) signifying that GOLD was highly correlated with other independent variables. So as to eliminate multicollinearity, the independent variable GOLD was dropped from the study. The VIF shows how much the variance of the coefficient estimate is being inflated by multicollinearity. Findings by Liao and Chen (2009) show a strong correlation between gold price and oil prices. They observed that gold prices are affected by the severe fluctuations in the oil. In this case, a VIF score of 51 would lead to a very large standard error. In addition, as stated earlier in the introduction, the precious metal gold is often viewed as a store of value and an effective deflationary commodity.

One of the possible reasons why GOLD may not be a good indicator of inflation movements is that some authors have noted that its indicator properties for inflation deteriorated during the 1980s relative to the 1970s. Garner (1995) found that the R^2statistic on an equation linking the current inflation rate to lagged gold prices dropped from 0.43 over the 1973 to 1994 period to 0.02 over the 1983 to 1994 period. A problem cited by the author with the use of gold as an indicator is that inflation expectations by market participants may simply be wrong if they are formed using incorrect information, such as poorly measured initial estimates of key macro variables. It is for this reason that GOLD was left out of the analysis in this study. GOLD is however revisited during the discussion section so as to provide a "what-if" scenario, in other words, assuming that there was no risk of multicollinearity, what the statistical relationship of GOLD to CPIX would be.

The remaining variables had VIFs of less than twenty and very small (close to zero) Eigenvalues. 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, OIL, PLAT and SILVER.

Table 1. Multicollinearity Statistics

	Collinearity Statistics		Eigenvalue
	Tolerance	VIF	
(Constant)			6.946
Money Supply	.072	13.825	.047
Prime Overdraft Rate	.280	3.573	.003
Rand-US$ Exchange	.212	4.718	.002
Brent Crude Oil Price	.107	9.306	.001
Platinum Price per once	.079	12.601	.000
Silver Price per ounce	.060	16.532	2.494E-005

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. USAX and PRIME have extremely low standard deviations, with SILVER having a 58% standard deviation.

Table 2. Descriptive Statistics for All Macroeconomic Variables

	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Money Supply	13.968062	.3245875	-.413	.233	-1.356	.461
Prime Overdraft Rate	2.457669	.1817699	.442	.233	-.757	.461
Rand-US$ Exchange	1.977041	.1185972	.844	.233	1.075	.461
Brent Crude Oil Price	4.126772	.4344857	-.319	.233	-.733	.461
Consumer Price Index	4.527119	.1580145	.206	.233	-1.544	.461
Platinum Price per once	7.055151	.3242771	-.047	.233	-1.080	.461
Silver Price per ounce	2.490854	.5832358	.220	.233	-.615	.461
Valid N (listwise)						

Also of importance is the skewness of the distributions which indicates that they are approximately normal as

the individual variables' skewness factors are 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, OIL and SILVER variables had kurtosis values less than 1, which is very good and indicative of normal distributions. The negative kurtosis values indicate the possibility of a platykurtic (flat) distribution for all variables except USAX. These overall findings provide a general indication that the distributions of the individual variables are normal.

Further analysis of the USAX variable was done by calculating the z-scores of all variables and charting a box plot to identify any unusual movements. Figure I below shows a box plot and clearly shows data points of unusual movement around data points 70 to 75.

Figure I. Boxplot of z-score values

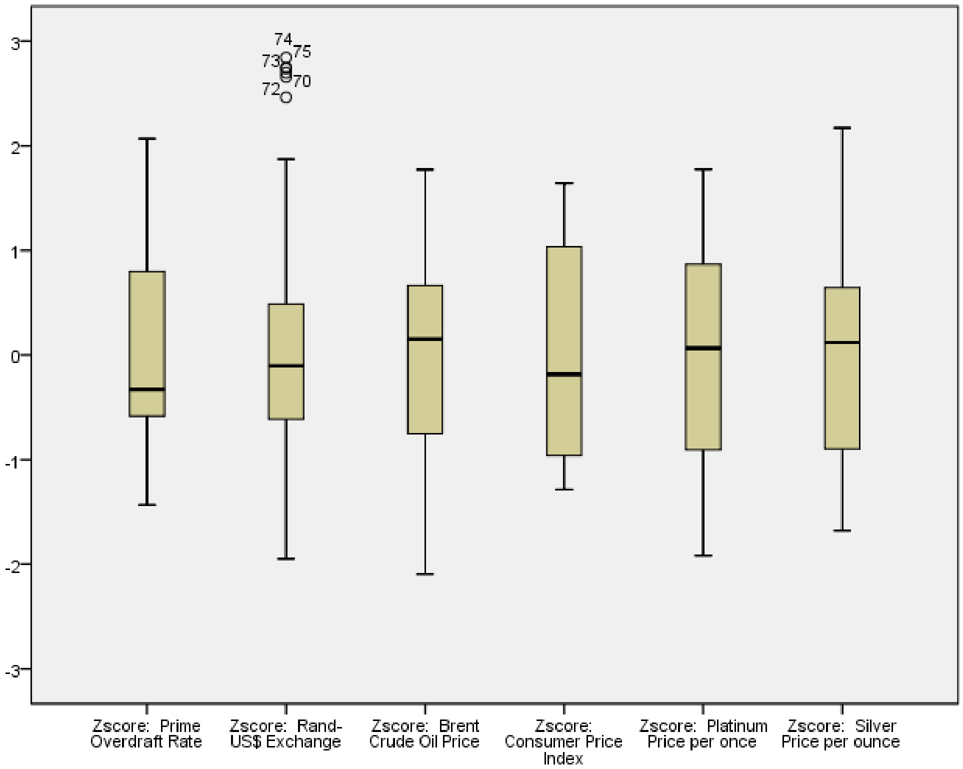


Table 3 below shows the raw data extract indicative of unexpected movement in USAX from October 2008 to March 2009:

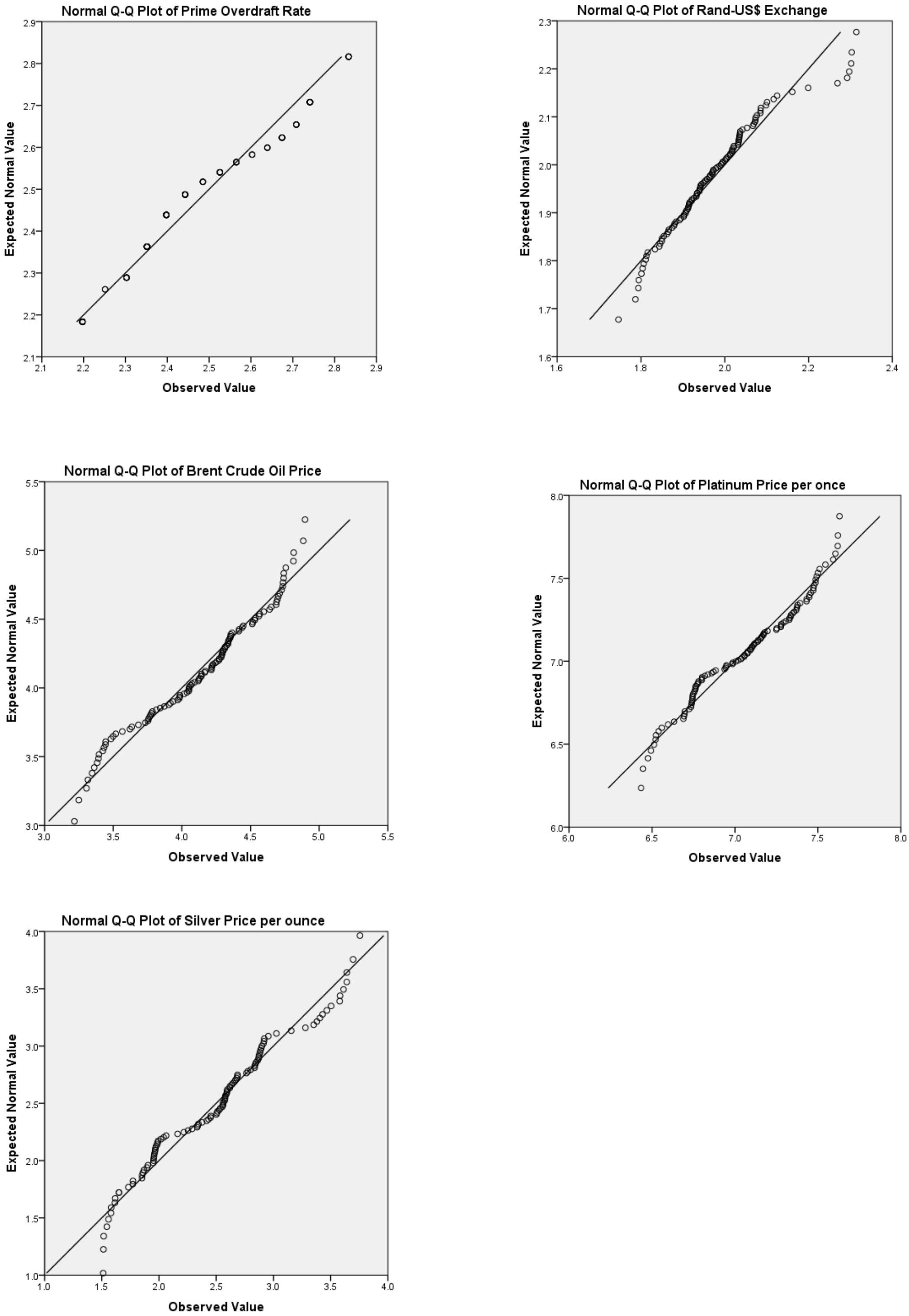
Table 3. USAX movements between October 2008 and March 2009

DATE	USAX
2008/08	2.0357
2008/09	2.0853
2008/10	2.2692
2008/11	2.3143
2008/12	2.2971
2009/01	2.2922
2009/02	2.3032
2009/03	2.3019
2009/04	2.1992
2009/05	2.1249

A further investigation reveals that this was the beginning of the financial sub-prime crisis which began in earnest after Lehman Brothers' failure in mid-September 2008. This led to an appreciation of the South African rand against the US dollar but stabilised a few months int0 2009.

The final test for normality was done via normal probability plots as shown in Figure II. The fitted line in the normal probability plots was more or less a straight line for all macroeconomic variables. This finding demonstrated that the macroeconomic variables were normally distributed.

Figure II. Normal Probability Plots



4.3. Discussion of Findings

4.3.1. Case A: Without GOLD as an independent variable

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 multicollinearity table is less than twenty and their Eigenvalues are less than 1. 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, OIL, PLAT and SILVER. The regression model exhibits results that are in line with the hypotheses discussed earlier. Tables 4 to 6 show the results of the regression analysis.

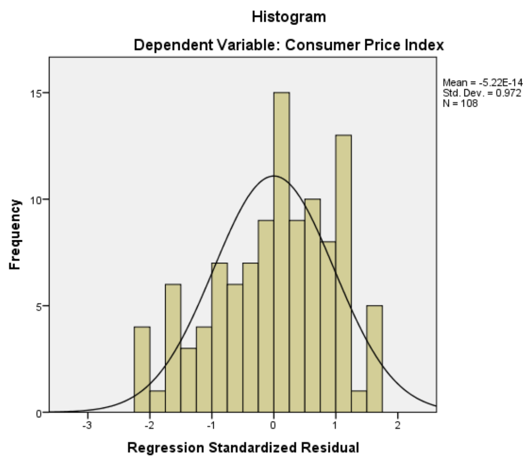
The same procedure was again followed but this time used all the variables, including GOLD. The results of this regression analysis was also analysed, with conclusions and recommendations on each model made.

Table 4. Regression model summary

Model	R	R Square (R^2)	Adjusted R Square	Std. Error of the Estimate
	0.973	0.948	0.945	0.0372

The R^2 of 94.8% 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 95% 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. 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 III. Regression standardized Residuals of CPIX



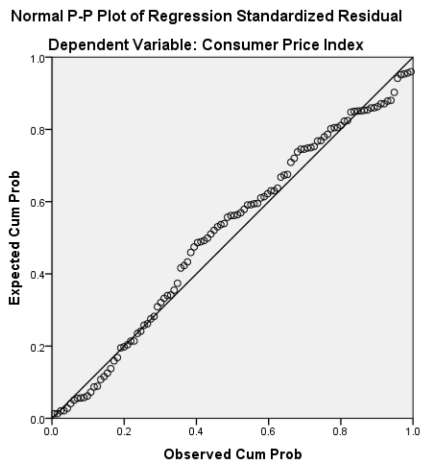


Table 5. Analysis of variance (ANOVA)

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	2.532	6	.422	304.626	.000[b]
Residual	.140	101	.001		
Total	2.672	107			
a. Dependent Variable: Consumer Price Index					
b. Predictors: (Constant), Silver Price per ounce, Rand-US$ Exchange, Prime Overdraft Rate, Brent Crude Oil Price, Platinum Price per once, Money Supply					

The regression sum of squares is considerably larger (2.532) than the residual sum of squares (0.140), which indicates that most of the variation in CPIX is explained by the model. The model above clearly accounts for almost 95% of the data from independent variables. The F value of 304.626 is large and has a significance value close to zero. The significance value shows that the regression equation does have some validity in fitting the data.

Table 6. Regression coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	*βeta*		
(Constant)	.437	.447		.979	.330
Money Supply	.264	.041	.543	6.415	.000
Prime Overdraft Rate	-.159	.037	-.183	-4.260	.000
Rand-US$ Exchange	.320	.066	.240	4.858	.000
Brent Crude Oil Price	-.036	.025	-.098	-1.410	.161
Platinum Price per once	.010	.039	.021	.254	.800
Silver Price per ounce	.093	.025	.344	3.712	.000

The "t" statistic shown in Table 6 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 6.415 and significancecloser to zero. 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. The significance value for PLAT is greater than 0.05 and is indicative of the possibility that platinum may have a little influence in determining inflation. The same applies to OIL which has a significance of 0.161.

4.3.2. Case B: With GOLD as an independent variable

The same procedure was again followed but this time used all the variables, including GOLD. The results of this regression analysis was also analysed, with conclusions and recommendations on each model made.

The analysis similar to that for Case A (excluding the variable GOLD) 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 regression model exhibits results that are in line with the hypotheses discussed earlier. Tables 7 to 9 show the results of the regression analysis.

Table 7. Regression model summary

Model	R	R Square (R^2)	Adjusted R Square	Std. Error of the Estimate
	0.990	0.980	0.979	0.0228

The R^2 of 98% indicates that the model is anextremely improved predictor of the dependent variable with the introduction of the variable GOLD. It implies that the model can be used for estimating CPIX and that 98% 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. 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.

Table 8. Analysis of variance (ANOVA)

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	2.620	7	.374	717.930	.00[b]
Residual	.052	101	.001		
Total	2.672	107			
a. Dependent Variable: Consumer Price Index					
b. Predictors: (Constant), Silver Price per ounce, Rand-US$ Exchange, Prime Overdraft Rate, Brent Crude Oil Price, Platinum Price per once, Money Supply, Gold Price per ounce					

The regression sum of squares is considerably larger (2.620) that without GOLD (2.532). The model above clearly accounts for almost 98% of the data from independent variables. The F value of 717.93 is large and has a significance value close to zero. The significance value shows that the regression equation does have some validity in fitting the data and is a better model that without the variable GOLD.

Table 9. Regression coefficients

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	*βeta*		
(Constant)	1.390	.284		4.898	.000
Money Supply	.071	.029	.145	2.403	.018
Prime Overdraft Rate	-.020	.025	-.023	-.803	.424
Rand-US$ Exchange	.058	.045	.044	1.283	.203
Brent Crude Oil Price	.010	.016	.028	.650	.517
Platinum Price per once	-.064	.025	-.131	-2.567	.012
Gold Price per ounce	.422	.032	1.295	12.977	.000
Silver Price per ounce	-.110	.022	-.404	-4.997	.000

The significance value for PLAT which was 0.810in Case A (without GOLD) is now 0.012 which is a big improvement. However OIL has worsened with a significance of 0.517, as well as PRIME, M2 and USAX. While the predictive ability of the model has generally improved, the significance of the t-values of the independent variables has worsened for all the variables except for GOLD and SILVER. The independent variable GOLD is therefore dropped from the analysis as previously suggested.

4.4. Analysing the hypothesis

Based on the results of the regression analysis presented in Table 6 earlier, the following table shows the accepted and rejected hypotheses.

Table 10. Summary of hypotheses tested

Hypotheses	**Accept / Reject**
There is a positive relationship between the CPIX and M2	Accept
There is a positive relationship between the CPIX and USAX	Accept
There is a negative relationship between the CPIX and PRIME	Accept
There is a negative relationship between the CPIX and SILVER	Reject
There is a negative relationship between the CPIX and PLAT	Reject
There is a no significant relationship between the CPIX and OIL	Accept
There is a negative relationship between the CPIX and GOLD	Variable Dropped

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

$$\ln CPIX_t = 0.437 + 0.264 \ln M2_t - 0.159 \ln PRIME_t + 0.320 \ln USAX_t - 0.036 \ln OIL_t + 0.010 \ln PLAT_t + 0.093 \ln SILVER_t + 0.447$$

It can be interpreted from the model that the CPIX is highly sensitive to variation as indicated by R^2 of 0.948. In other words, according to the model developed from the data, almost 95% of the variation in the CPIX is explained by the six macroeconomic independent variables. The variability as measured by the coefficient of variation (*βeta*) is positive for M2 (0.543), USAX (0.240), PLAT (0.021), SILVER (0.344) and is negative for PRIME (-0.183) and OIL (-0.098).

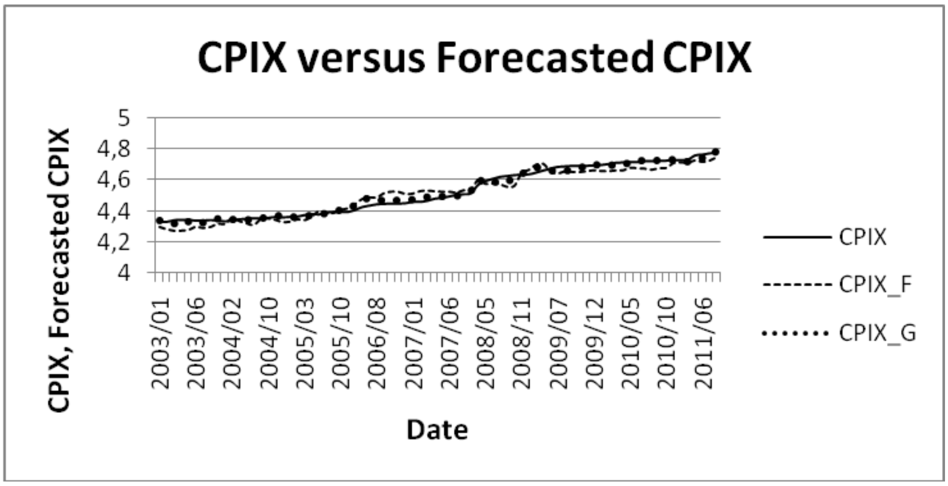
The positive M2 and USAX's coefficients in relation to the CPIX are in agreement with other studies (Ibrahim and Hassanuddeen, 2003; Mukherjee and Naka, 1995; Chaudhuri and Smiles, 2004). The relationship between PRIME and CPIX also confirms the initial hypotheses that there is a negative relationship 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 Kaul and Jones (1996) and Beyer et al. (2009).

The *βeta* values for PRIME and OIL were found to be negative. The *βeta* for PRIME was –0.183` with a t-value of -4.260 and significance very close to zero. The t-value for OIL was less significant at 0.161 and a *βeta* value of -0.098. This result confirms 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 *βeta* of 0.543 and a p-value of 6.415 and statistically significance close to zero. The hypothesis that foreign exchange rate affects the CPIX significantly is also accepted and has a positive *βeta* of 0.240and a significant p-value of 4.858. While PLAT has a positive *βeta* of 0.021, this is not statistically significant. SILVER on the other hand is statistically significant with a *βeta* of 0.344 and a t-value of 3.712. The results suggest that most of the variables under study do have a bearing on CPIX except for OIL and PLAT, and can be relevant in predicting the direction of CPIX in the future.

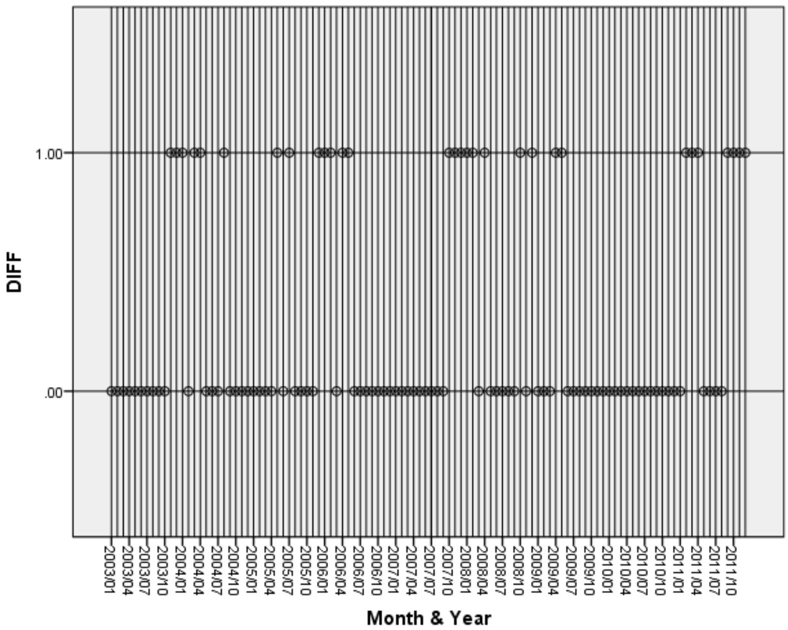
As a test of the model fit, the regression equation was used to estimate CPIX. It should be noted that the rationale for this exercise was not to test the accuracy of the model developed. Rather, it is to test if the model can be used to determine the direction of movement of CPIX given expected values 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 fit of the true movement of CPIX and can be used for predicting the future direction of movement of inflation in South Africa. It should also be noted that the estimated CPIX-G, not only is it moving in tandem with CPIX, it is much closer to the actual CPIX values and seems to be a more accurate reflection of the movement of CPIX compared to the model that excludes GOLD.Figure IV illustrates this graphically.

Figure IV. CPIX versus CPIX-F* and CPIX-G*



* CPIX-F estimates CPIX using all variables <u>excluding</u> GOLD while CPIX-G <u>includes</u> GOLD

Figure V. Deviation graph of CPIX-F and CPIX-G



Finally, an analysis of the deviation of CPIX-F and CPIX-G from CPIX show that in 78 out of 108 (or 72%) of the observations, CPIX-G was closer to the actual CPIX values. In Figure V, the upper bound is for those data points that were predicted by CIPX-G further than the prediction by CIPX-F and the lower bound is for those predictions that were the closest. This further affirms that GOLD variable is an important predictor of inflation in South Africa, despite the strength of multicollinearity observed earlier. For the purpose of the study, these results are satisfactory, and a summary conclusion is presented in the next section.

5. Conclusion

The evidence from this study seems to suggest that the South African Reserve Bank does take into account the role of precious metals prices in setting monetary policy during the period 2003 and 2012. However, the relationship appears to be stronger for silver than for gold or platinum. This is especially so when the issue of multicollinearity is taken into account. When multicollinearity is ignored, the relationship between gold and inflation seems much stronger.

While there is some evidence in this study that the South African Reserve Bank should consider precious metals prices when setting monetary policy, there is no claim made this relationship could be attributed to other unobserved variables that affect both policy instruments and precious metals prices. Further research should be aimed at examining the current period of policy more closely, and controlling for other factors that may affect the behaviour of the South African Reserve Bank so to better understand causality. Despite this possible deficiency in the model, awareness of the relationship herein documented can assist in the design of appropriate monetary policy responses, optimal investment strategies and general asset allocation decisions.

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 Bank 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.

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. In addition, although statistically the gold price seems to be highly collated with other variables, for example, oil prices, there seems to be a very strong relationship between gold prices and inflation. It would be interesting to research this further to determine if gold prices act as a leading indicator of inflationary levels or monetary policy decisions or gold prices are merely reactive of such movements.

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