AN EXPLORATORY STUDY OF THE RELATIONSHIP BETWEEN GOLD INVESTMENTS AND DOMESTIC INFLATION FROM A SOUTH AFRICAN PERSPECTIVE

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In partial fulfilment
of the requirements for the
Masters of Business Administration Degree

by
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Supervised by: SEAN GOSSEL
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ABSTRACT

This paper investigates the relationship between local gold investments and domestic inflation within a South African context for the period 1995-2011. The analysis utilizes a basic statistical methodology involving linear regression and correlation analysis in order to examine foreign factors that may influence the rand gold price such as the US dollar index as well that the rand/dollar exchange rate.

The results of the analysis strongly suggest that there is no relationship between inflation and gold within South Africa, and that the gold price may be driven by other external factors beyond the scope of this research paper. The results lend support to the international literature that concludes that with the exception of the US, gold does not provide an effective hedge against domestic inflation. Furthermore, strong evidence is found that suggests that there is a relationship between the rand/dollar exchange rate and the rand gold price.
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GLOSSARY OF TERMS

**ZAR Gold Price**: This represents the spot price of gold in rands.

**Newgold ETF**: This represents an exchange traded gold fund managed by ABSA Bank and started in November 2004. The fund is directly correlated with the rand gold price with each share representing a pro rata amount of physical gold held by ABSA.

**JSE Gold Mining Index**: This represents a trade weighted index of major gold mining shares that currently trade on the Johannesburg Stock Exchange.

**US Dollar Index**: Represents an index (or measure) of the value of the United States dollar relative to a basket of foreign countries. It is a weighted geometric mean of the dollar’s value compared only with:

- Euro (58.6% weighting)
- Japanese Yen (12.6% weighting)
- Pound Sterling (11.9% weighting)
- Canadian Dollar (9.1% weighting)
- Swedish Krona (4.2% weighting)
- Swiss Franc (3.6% weighting)
ACKNOWLEDGEMENT

This report is not confidential and may be used freely by the Graduate School of Business.

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A special word of thanks to my three children Shirag, Aric and Arya who put up with not seeing their dad whilst working on this research paper.
1. INTRODUCTION

1.1 BACKGROUND

Precious metals have been used as a media of exchange and a store of value for millennia yet despite gold’s popularity as part of investment portfolios, there has been very little research on its performance relative to the literature of stock and bond performance (Mc Cown and Zimmerman, 2006). The dissolution of the Bretton Woods Agreement in 1971 meant that gold no longer played a central role in the world monetary system. However, gold is still viewed as an important store of value and will continue to hold significant symbolic value, due to its historical role in monetary system history. (Wang et al, 2011).

For many investors, portfolio diversification in order to minimise asset volatility and risk is of primary importance. Hence, gold is considered to be a fundamental diversification asset because, unlike domestic bonds and stocks, it is able to maintain its international price irrespective of fluctuations in the domestic exchange rate (Wang and Lee, 2011).

Although the gold price has remained relatively benign throughout most of the last 25 years, as can be seen from Figure 1 below, the recent performance of gold has been meteoric. After surpassing the $500 per oz barrier in December 2005 (for the first time since 1981) and rising to $600 per oz shortly thereafter, the gold price peaked at $1912 per oz on August 22, 2011, fuelled by the recent global debt crises (Iceland, Greece, Spain) coupled with Standard & Poor’s recent downgrading of the US dollar.

![Figure 1: 15 Year Gold Price in Rands per ounce](chart)
According to Worthington and Pahlavani (2006), this behaviour has been driven by a variety of supply and demand factors that include a dollar weakened by high current and capital account deficits, the cost of the war in Iraq, as well as the decade-long reduction in global production, sales by central banks, booming demand for jewellery in India and China, and gold’s traditional hedge status as a counter to global currency and inflation risks.

At the same time, inflation has been a primary factor affecting individual investor’s efforts to preserve both real value and accumulated earnings in major industrial countries (Chua and Woodward, 1982). Hence, conventional wisdom dictates that the physical nature of commodities is one of the most beneficial means of hedging against inflation. Furthermore unlike many other physical commodities, gold is durable, relatively transportable, universally acceptable and easily authenticated (Worthington and Pahlavani, 2006). However, the inflationary characteristics of major industrialised countries differ considerably, and thus the effectiveness of gold as an inflationary hedge remains an area of ongoing research (Chua and Woodward, 1982).

1.2 RESEARCH PROBLEM

Gold is a sensitive commodity which can be affected in value on a minute-by-minute basis by supply, demand and financial market activities around the world. The widely accepted benchmark for gold pricing is controlled by the London Bullion Market Association (LBMA).

Although the gold price is fixed twice a day by the LBMA, the price changes almost immediately as trades are made based on a new price fix converted into other currencies (especially the US Dollar). This fixed price in turn serves as a point of reference or benchmark for financial institutions and related gold industries and in the case of South African investors, the dollar price of gold is converted into South African rands (ZAR).¹ Hence, in addition to the prevailing fixed gold price, the current spot exchange rate also plays a crucial role in determining the domestic gold price in rands.

¹ www.lbma.org.uk
Almost all of the literature examining the relationship between gold and inflation does so within the US economy. Even though South Africa is one of the leading producers of gold worldwide, there is almost no literature that examines the relationship between the rand price of gold and domestic inflation from a South African perspective. Chua and Woodward (1982) examine the effectiveness of gold as an inflation hedge against six major industrial countries namely, Canada, Germany, Japan, Switzerland, United Kingdom and the United States for the period 1975-1980 for both expected and unexpected inflation. They concluded that only US investors could hedge themselves against inflation using gold. They also found that returns on gold were not systematically related to inflation rates in any of the other five countries with no significant relationships determined via linear regression analysis. Thus their results call into question the generally held belief that gold has been a universal hedge against inflation.

In order to determine the price for gold that would be required to keep up with South African inflation, Figure 2 plots the month on month domestic CPI changes against the actual rand gold price for the period 1995 -2011. As can be seen, up until the beginning of 2005, the rand gold price remained relatively benign by just keeping up with inflation at around the R2,000 per ounce level. Thereafter however, there is a dramatic increase in the rand gold price that far outperforms the price required for gold to be an effective hedge against South African inflationary pressures. From 2006 to mid-2011 the inflation hedge rate rises from R4,000 to just under R14,000 per ounce, while over the same period, the nominal gold rand price rises from approximately R2,200 to R3,900 per ounce.

Thus Figure 2 indicates that gold has been an effective hedge against inflation from a South African perspective by outperforming its inflation hedge adjusted price by a factor of 3.5. However it must be emphasized that this outperformance of the nominal gold price has only occurred after 2006 with prior performance merely keeping up with inflation hedge adjusted price. However, empirical literature that explores the actual relationship between inflation and the rand gold price is relatively uncommon, raising the crucial question: are movements in the South African inflation rate associated with changes in the gold price or are there other factors at play? Thus, it is the goal of this research to quantitatively explore the relationship
South African inflation and various forms of local gold investments in order to determine whether there are any significant associations between their movements.

**FIGURE 2:** South African Annual Nominal Gold Price vs Inflation [Hedge] Gold Price 1999-2010

1.3 PURPOSE AND SIGNIFICANCE

Although numerous international studies have examined the performance of gold against inflation,² none have analysed the data from a South African perspective. Thus, this research seeks to (i) conduct an exploratory investigation of whether investing in gold in rand terms would have provided an effective hedge against domestic inflation over the period 1995-2011 (post liberalisation); and (ii) examine whether there is a relationship between gold investments and inflation.

Hence, this research will contribute to the literature by providing among the first investigations of the extent to which gold is an inflationary hedge in post-liberalisation South Africa as well as quantifying the nature of the relationship.

² For example see Chua and Woodward, 1982.]
1.4 RESEARCH QUESTIONS

The two research questions are:

1. Is there a relationship between the three major forms of gold investment available in South Africa and domestic inflation?
2. Which form of gold investment has performed best against domestic inflation?

In addition, other variables will also be examined through basic graphical analysis to examine whether there are any significant correlations that explain the out-performance of the rand gold price against inflation in recent years.

1.5 RESEARCH LIMITATIONS

Due to technological and time constraints, the primary limitation of this methodology is that it represents a basic statistical and graphical analysis as opposed to a modern econometric one. However given the fact that this is an exploratory study determining whether relationships exist as opposed to quantifying them, should still be a valuable contribution to literature for which there is currently none.

1.6 RESEARCH ASSUMPTIONS

The empirical analyses conducted in this study include the following key assumptions:

- An autocorrelation was performed for the data used in the regression analysis and the variables were not found to be non-autocorrelated. However, co-integration of the data was not tested due to time and technological constraints and it is thus assumed that the data is not co-integrated.\(^3\).
- It is assumed that the cost of carrying physical gold is significant, thus justifying the inclusion of the Newgold ETF and the Randgold Price.
- It is assumed that the JSE Gold Mining Index provides a fair representation of gold mining stocks on the JSE.

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\(^3\) Future research may use econometric analysis techniques for co-integrated variables.
1.7 RESEARCH ETHICS

I hereby acknowledge that I have read and understood the commerce faculty ethics in research policy document (annexure 6 in research methodology handbook) and promise to abide by them. Furthermore I also undertake that in no way shall I use or disseminate any of the research for material gain without the express permission of the university faculty.
2 LITERATURE REVIEW

There can be no other criterion, no other standard than gold. Yes, gold which never changes, which can be shaped into ingots, bars, coins, which has no nationality and which is externally and universally accepted as the unalterable fiduciary value par excellence. (Charles de Gaulle)

The literature review below will first present a brief overview of studies devoted to the historical use of gold within the monetary system as a whole before examining studies in favour or against the use of gold as an inflation hedge, and then considering the implications of carrying cost.

2.1 HISTORIC CONTEXT

Earlier literature comparing the macro performance of the last three monetary systems, namely, the classical gold standard, Bretton Woods and the current floating system, yield mixed results. Bordo (1981) and Cooper (1982) report that the classical gold standard was associated with greater price level and real output volatility than post World War 2 arrangements for the US and the UK. On the other hand, Klein (1975) and Schwartz (1986) present evidence that the gold standard provided greater long term stability than did the post World War 2 arrangements. Bordo and Eichengreen (1993: [45]) argue that the reason the classical gold standard failed was that it focussed on an in-elastically supplied precious metal and an elastically-supplied foreign exchange to meet the world economy’s incremental demand for reserves and hence was “intrinsically fragile, prone to confidence problems and a transmission belt for policy mistakes.”

Although gold does not play a significant formal role in the present day monetary system, it nevertheless remains an important investment asset for most market players and central banks. Previous studies on the subject can be divided into two broad camps, namely, the long term relationship between gold and inflation, and the impact of inflation on gold prices. Within these two groups, there are both arguments for and against gold’s effectiveness and relevance as an inflation hedge.
2.2 ARGUMENTS IN FAVOUR OF GOLD AS AN IMPORTANT INVESTMENT COMPONENT

Traditionally, gold has played an important role during times of political and economic uncertainty by responding with higher prices (Tully and Lucey, 2006). Hence, Smith (2002) examines gold’s market behaviour during the period surrounding the September 11th terrorist attacks and finds that while the FTSE All Share Index closed 9% down, the closing gold price moved upwards by 7.45%. Thus, he concludes that “when the economic environment becomes more uncertain, attention turns to investing in gold as a safe haven” Smith (2002: [1]).

Although literature regarding the interaction between the gold price and South African inflation are still relatively uncommon, Melvin and Sultan (1990) examined political unrest and oil prices by empirically indexing them to the prevailing gold price. Their results show that gold did indeed react to sudden changes in both factors and thus they conclude that political unrest in South Africa coupled with oil price volatility, did induce forecast errors in the price of gold.

According to the literature, gold offers a range of investment benefits. Sherman (1982) reports that in historical portfolio simulations, gold achieved the dual objectives of lowering a portfolio's volatility, as well as improving the overall portfolio returns. Thus he concludes that gold should be at the centre of a portfolio strategy on the basis of prudence, performance and modern portfolio theory. Jaffe (1989) examines the inclusion of gold and gold stocks in order to diversify a portfolio. He concludes that gold has a negative correlation to almost every other asset class, thus implying an associated reduction in a portfolio’s risk-return profile. However, the results also show that the returns from investing in gold stocks rather than physical gold itself provide substantially superior returns and that these returns justify a higher volatility and associated risk profile.

Chua et al. (1990) expand on these studies by examining the effect of physical gold and gold stocks on the overall beta of a portfolio US based stocks for the period 1971 – 1988. Examining the monthly data from the 1970’s and 1980’s and applying a linear regression model to compare the correlation co-efficients between gold and common stocks, they concluded that although the inclusion of gold stocks in a common stock portfolio would have
reduced the overall systematic risk in the 1970’s, it would have had the opposite effect in the 1980’s. Nevertheless, Chua et al. conclude that the inclusion of physical gold did however reduce the risk of a portfolio irrespective of the time period by reducing the correlation coefficient of the overall portfolio.

Using multivariate auto-regression and co-integration modelling techniques to examine the interaction between the dollar vs. pound sterling, yen and deutsche mark over the period 1976-1990, Dooley et al. (1995) conclude that gold prices also affect exchange rates especially during country specific shocks. Capie et al. (2004) similarly argues that although gold has served as a hedge against fluctuations in the foreign exchange value of the dollar, it has only done so to a degree that seems highly dependent on unpredictable political attitudes and events. Capie et al. (2005) explored the relationship between gold and various currencies against the US dollar over the period 1971-2002, paying particular attention to the hedging properties of gold during periods of economic or political turmoil. The results show that gold could be a hedge in two ways: First, as a hedge in the internal purchasing power of a domestic currency and second, as a hedge in the external purchasing power of a domestic currency. Hence gold can offer protection against both a weak domestic currency and rising domestic inflation.

Tully and Lucey (2006) use gold cash and futures data over the period August 1998 to September 2003 to examine the attractiveness of gold in an equity portfolio. Their results confirm that the US Dollar is the primary, and in many cases, the sole macroeconomic variable affecting gold prices. Thus, considered in combination with the results of Capie et al. (2005), gold thus offers protection against a weak domestic currency but also against the US dollar, widely regarded by mainly as the de-facto global currency.

More recently, Ozturk and Acikalin (2008) use similar auto-regression techniques to investigate both the internal and external hedging effectiveness of gold against the Turkish Lira\textsuperscript{4}. The results show that gold acts as an effective hedge against both currency depreciation and rising domestic inflation. Furthermore, the study shows that gold is a good indicator of expected inflation and hence a useful tool for formulating monetary policy. Capie et al.

\textsuperscript{4}This study was particularly important and relevant with regards to this paper as it examined a country and currency very similar to that of South Africa.
suggest that there are two reasons for using gold as a hedging instrument or safe asset against exchange rate risk. First, a number of financial products are available that track the price of gold even though they do not involve the property of the physical commodity. Second, gold is advocated as a protection against currency fluctuations. Furthermore the results of their analysis shows that the hedging power of gold for the U.S. Dollar has varied widely since 1971, and thus they argue that the degree of protection offered by the Dollar depends on largely unpredictable events. As the above studies attest to, the investment related dimensions of gold not only impact inflation and currencies but are also related to interest rates as espoused by Koutsoyiannis (1983), who concludes that the price of gold is strongly related to the US interest rate.

Worthington and Pahlavanui (2006) analyse the monthly US price of gold, the US CPI and the ‘inflation hedge’ price of gold over the period of 1945-2006 and 1973-2006 in order to test the stable long-run relationship between the monthly price of gold and inflation in the US. Because of significant structural breaks in the gold market and consumer prices during this period, they adopted the Zivot and Andrews (1992) test procedure to identify the most significant structural breaks impacting the relationship. The results show that there is a significant co-integrating relationship between gold and inflation, and that gold is a useful inflation hedge in post-World War II and post-1970’s periods where inflation demonstrated signs of increased acceleration.

Whilst there is literature illustrating the relationship between gold and inflation as detailed above, the relationship between gold prices and expected inflation is less clear. (Blose, 2010). Among the earliest studies to examine this relationship is Moore (1990), who compares the gold price to a leading inflation indicator index and found that gold does indeed positively react to expected inflationary pressures. Koch et al. (2000) use intra-day closing prices for gold during the period 1992-1995 in order to analyse the reactions of the gold price to 23 historic episodes of macro-economic shocks, including government bond sale announcements and the release of inflation data. The results show that gold is most sensitive to the release of the monthly CPI data, reinforcing the literature of Worthington and Pahlavanui (2006) as well as Zivot and Andrews (1992), which finds that gold must rise in price in the face of rising inflation in order to maintain its purchasing power, thereby reinforcing its reputation as an inflationary hedge.
Worthington and Pahlavanui (2006: [2]) aptly sum up their argument as follows: “The conventional wisdom is that because commodities are physical assets, they are the best way to hedge against rising prices which reduce the returns of purely financial assets like stocks and bonds. However unlike most commodities, gold is durable, relatively transportable, universally acceptable and easily authenticated.”

2.3 ARGUMENTS AGAINST GOLD AS AN INFLATION HEDGE AND INVESTMENT COMPONENT

Few asset classes invoke the passions of both bulls and bears alike, as gold does. The argument for and against gold’s relevance in the economic landscape has been continuing for decades.

Fama and Schwert (1978) examine the historical returns on a number of different assets, including gold, over the period of 1933-1971 in order to determine which, if any, of the assets could have been utilised by investors as a hedge against both expected and unexpected inflation. The results show that only private residential real estate, not gold, was a perfect hedge against both components of inflation over the period in question. Similarly, Chua and Woodward (1982) examine gold as an inflation hedge in a comparative study of six countries (US, Canada, Germany, Japan, Switzerland and the UK). They find that gold has been an effective inflationary hedge but only for US for investors with investment horizons between one and six months. In the case of the five remaining countries, returns on gold were not found to be systematically related to the inflation rates. Hence, Chua and Woodward conclude that the belief that gold is a universal hedge against inflation is questionable.

Taylor (1998) studies the long-run and short-run hedging ability of gold based on the Fisher (1930) analysis who asserted that the real rate of interest earned on an investment is the difference between the nominal or money rate, and a rate to compensate for inflation. The Fisher Hypothesis, which can be generalised to the return on any asset, asserts that the nominal rate of return on an investment will be positively related to the expected inflation rate and should in fact vary directly with it on a one to one basis, ensuring that investors are compensated for changes in the expected inflation rate. The results of Taylor’s study show
that gold is an effective short-run hedge against inflation, but only during periods within the last eighty years concentrated around the Pre-World War II period and the second OPEC oil crises in 1979.

Studies have also called into question the assertion that gold is a leading indicator of inflation or is not either uncorrelated or negatively correlated with expected inflation. Jaffe (1989) regressed gold against expected inflation and finds that gold prices do not predict future changes in the CPI. Garner (1995) tests the performance of an index consisting of five leading indicators of inflation, including gold, using a regression analysis designed to predict the magnitude of future inflation. The results find only weak support for the predictive power of gold with regards to unexpected inflationary pressures.

Larsen and McQueen (1995) similarly use US Treasury Bill rates to estimate the correlation between gold and unexpected inflation. In accordance with Jaffe (1989) and Garner (1995), Larsen and McQueen also report that the relationship between gold and unexpected inflation is weak. Mahdavi and Zhou (1997) examine the extent to which gold and other commodity prices are leading indicators of inflation and although they find that gold was quick to incorporate news and events that affect the inflation rate, they conclude that gold’s contribution to inflationary predictions is not statistically significant because no evidence of a co-integrating relationship between CPI and the London gold price was found over the period 1970 – 1994. Mahdavi and Zhou further argue that gold reacts quickly to incorporate news and events that may affect the inflation rate, whereas prices of goods and services included in the CPI basket react much slower and thus they conclude that the gold price may exhibit significantly more volatile price movements than the general price level.

More recently, Cecchetti et al. (2000) use an auto-regression model to test the usefulness of certain indicator variables such as gold in forecasting inflation. The results show that when gold is included as a leading indicator of inflation, it enters the model with a negative coefficient, suggesting that higher gold prices are associated with lower expected inflation, thus contradicting studies such as Worthington and Pahlavanui (2006) as well as Zivot and Andrews (1992) amongst others.
Lawrence (2003) uses a vector auto-regression approach covering the period of 1975-2001 in order to examine the significance of the relationship between gold and other financial. The results show that there is no statistically significant relationship between returns on gold and changes in the Producer Price Index (PPI) thus supporting the results of Jaffe. In addition, Tkacz (2007) examines 14 different currencies over the 1995 to 2004 period and concluded that changes in gold prices lead inflation only in countries that have adopted a formal inflation targeting monetary policy. Hence, this finding may prove especially useful in the analysis of results for South Africa where a formal inflation targeting monetary policy is adopted by the Reserve Bank. Thus these studies show that the relationship between gold and inflation is not always a consistent one and that there are periods when there is significant discourse from the literature that claims a permanent and stable relationship between gold and inflation.

2.4 IMPLICATIONS OF THE CARRYING COST OF GOLD

Although the papers discussed previously analyse the interaction between gold and both expected and unexpected inflation, none take the carrying cost of gold into account. Blose (2009) argues that upward revisions in expected inflation will cause some investors to purchase gold, either to hedge against the expected decline in money or to speculate in the associated increase in the price of gold. Thus, buying pressure will cause an immediate increase in the price of gold at the time of the revision in expected inflation. According to Blose these dynamics have three implications. First, the current spot price of gold will depend on expectations of future inflation. Second, it is possible to use gold prices to determine the market anticipated inflation level. Third, changing inflation expectations will be accompanied by a changing gold price.

Hence, Blose deducts that investors who have superior knowledge regarding future inflation should be able to make a speculative profit by buying (or selling) gold in anticipation of market adjustments to the changes in expected inflation. However, he further asserts that the expected inflation effect hypothesis does not address the impact of inflation on interest rates and the cost of holding gold. Investments into gold are funded either by borrowing or by diverting owned capital from other investments. Irrespective of the funding mechanism, the cost of investing in gold will be affected by interest rates. An increase in expected inflation will cause the expected future price of gold to be higher than otherwise as supported by the
earlier studies of Taylor (1998), Worthington and Pahlavanui (2006) as well as Zivot and Andrews (1992), but it will also cause interest rates to be higher as well. The higher interest rates will increase the cost of holding gold.

Therefore any speculative profit derived from holding gold during inflationary periods will be offset by the higher interest costs. Furthermore any incentive for buying gold will be reduced leading to a lower gold price reaction to the revised inflation expectations. Blose refers to this scenario as the *carrying cost hypothesis*.

Empirical research by Ross and Zimmerman, using the Capital Asset Pricing Model (CAPM) and testing for co-integration between gold and inflation, found that gold has a market beta of zero or even slightly negative. Assuming that the beta is zero, Blose then argues that the capital asset pricing model should predict that gold should provide a return equal to the risk free rate. Furthermore since gold does not pay a dividend, the return on gold is realized by price appreciation each period for which gold should increase at the risk free rate. Hence in order to buy gold, the investor must tie up funds that could have be invested in other risk free investments and it is this return on the alternative risk free asset that is the opportunity cost of investing in gold. Using this argument Blose concludes that both the opportunity cost of investing in gold and the benefit of investing in gold are the same i.e. the risk free rate. According to Fisher (1896), should inflation expectations change upward, then the risk free rate will also increase thereby negating any appreciation in the gold price due to the higher cost of holding gold. Thus Blose concludes that the investor is no better off than before the change in inflation expectations and there is no incentive to buy the gold when inflation expectations change. Accordingly gold price will not be affected by changes in expected inflation.

If either of the assumptions that the beta of gold is zero or that the market correctly prices risk according to the capital asset pricing model is wrong, then gold may appreciate at a rate different from the risk free rate. If so, Blose argues that the expected gain from the change in expected inflation might be only partially offset by the change in the cost of carry. The results of his empirical study did indeed show that gold prices do not react in anticipation of future inflation. This “cost carrying hypothesis” even though obvious, has never been widely studied in academic literature.
2.5 CONCLUSION

Table 1: Research that examines the impact of expected inflation on gold prices. (Blose, 2009)

<table>
<thead>
<tr>
<th>Authors (date)</th>
<th>Span of study</th>
<th>Holding period</th>
<th>Calculation of inflation expectations</th>
<th>Does expected inflation affect gold?</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sherman (1983)</td>
<td>1970 through 1980</td>
<td>Annual</td>
<td>18 mo moving avg CPI</td>
<td>Yes</td>
<td>Regressed annual gold prices against unexpected inflation. Found a significant ($t = 2.06$) positive relationship</td>
</tr>
<tr>
<td>Jaffe (1989)</td>
<td>September 1971 to June 1987</td>
<td>Month</td>
<td>T bills</td>
<td>Mixed</td>
<td>Gold price movements are not predictive of future changes in CPI</td>
</tr>
<tr>
<td>Moore (1990)</td>
<td>1970 through 1988</td>
<td>Month</td>
<td>N/A</td>
<td>Yes</td>
<td>Gold prices are predicted by a leading indicator of inflation</td>
</tr>
<tr>
<td>Garner (1995)</td>
<td>1973 through 1994</td>
<td>Month</td>
<td>N/A</td>
<td>No</td>
<td>Tests the extent to which gold and other leading indicators of inflation predict changes in the CPI. Found that the” Indicators</td>
</tr>
</tbody>
</table>
by themselves, have not been successful in predicting the magnitude of CPI inflation in recent years.”

<table>
<thead>
<tr>
<th>Study</th>
<th>Sample Period</th>
<th>Frequency</th>
<th>Method</th>
<th>Integration</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Larsen and McQueen (1995)</td>
<td>January 1972 to August 1992</td>
<td>Month</td>
<td>T bills ARIMA Naïve</td>
<td>Mixed</td>
<td>Regressed return against expected and unexpected inflation. Coefficient of unexpected inflation is significant and positive but F-statistic is not significant</td>
</tr>
<tr>
<td>Mahdavi and Zhou (1997)</td>
<td>1970 through 1994</td>
<td>Quarter</td>
<td>N/A</td>
<td>No</td>
<td>No evidence of a co-integrating relationship between the CPI and gold price. Concludes that gold price is not useful as a leading indicator of inflation</td>
</tr>
<tr>
<td>Cecchetti et al. (2000)</td>
<td>1975 through 1984</td>
<td>Quarter</td>
<td>N/A</td>
<td>No</td>
<td>Gold prices do not provide accurate signals of inflation</td>
</tr>
<tr>
<td>Cecchetti et al. (2000)</td>
<td>1992 through</td>
<td>Intra-day</td>
<td>MMS Forecasts</td>
<td>Yes</td>
<td>Gold Futures reaction to unexpected changes in</td>
</tr>
<tr>
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<td>Time Period</td>
<td>Frequency</td>
<td>Model</td>
<td>Lead</td>
<td>Conclusion</td>
</tr>
<tr>
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<td>------------------------------</td>
<td>-----------</td>
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<td>------</td>
<td>----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Lawrence (2003)</td>
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<td>Quarter</td>
<td>N/A</td>
<td>No</td>
<td>Found that gold does not react to changes in the Producer Price Index</td>
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<tr>
<td>Adrangi et al. (2003)</td>
<td>January 1968 to December 1999</td>
<td>Month</td>
<td>ARIMA</td>
<td>Mixed</td>
<td>Gold has a positive relationship with expected inflation but no relationship with unexpected inflation.</td>
</tr>
<tr>
<td>Tkacz (2007)</td>
<td>September 1994 to December 2005</td>
<td>Month</td>
<td>N/A</td>
<td>Mixed</td>
<td>Examines gold as a leading indicator of inflation in 14 countries. Finds that gold signals inflation in some countries over some lead times.</td>
</tr>
</tbody>
</table>
3 RESEARCH METHODOLOGY

3.1 RESEARCH APPROACH AND STRATEGY

This study investigates two research questions:

1. Is there a relationship between the three major forms of gold investment available in South Africa and domestic inflation?
2. Which form of gold investment has performed best against domestic inflation?

The methodology used to investigate these research questions is based on Chua and Woodward (1982), adapted for South Africa. The initial steps involve the production of month-on-month percentage change of the average closing monthly prices of all gold investments (in Rands and US Dollars) and the domestic South African Consumer Price Indices (CPI). After producing the monthly change data, the monthly gold returns of the various forms of gold investment relative to inflation rates for South Africa are examined using the following two equations:

The return on gold investment in South Africa \( R_{G,SA}^C \) measured as the change in gold prices (after exchange rate adjustments) in percentage terms:

\[
R_{G,SA}^C = \frac{P_{G,SA,t}^C}{P_{G,SA,t-1}^C} - 1
\]

where \( P_{G,SA,t}^C \) and \( P_{G,SA,t-1}^C \) are the rand prices of gold in South Africa (SA) at time period \( t \) and \( t-1 \).

Similarly, the rate of inflation is calculated as the percentage change in the domestic CPI based on the following equation:

\[
CPI_{SA} = \frac{CPI_{SA,t}^C}{CPI_{SA,t-1}^C} - 1
\]
where $CPI_{A,t}$ and $CPI_{A,t-1}$ refer to the value of the South African consumer price index (CPI) at time period $t$ and $t-1$.

Thereafter, basic statistical analysis is conducted in order to compare the mean return on gold (and associated standard deviation) with the average monthly inflation rate so as to determine by how much on average, the returns on gold have been above or below the average inflation rates. In addition, the degree of volatility of gold prices is assessed by comparing the difference between the monthly mean return on gold and the computed standard deviations over the sample period.

The effectiveness of an inflation hedging asset is primarily determined by the degree to which the returns on that asset move systematically with the contemporaneous or lagged inflation rate (Chua and Woodward, 1982). Unfortunately, the results permutated from the analysis as described above will provide limited information as to the inflation hedging value of gold in South Africa. Hence, in order to determine the inflation hedging value of gold in greater detail, the two metrics set out in equations (1) and (2) will be applied in the following regression model:

$$R_{G,t}^{G} = \alpha_{G,t} + \beta CPI_{G,t} + \varepsilon$$

(3)

Thus it is hypothesised that if gold offers a significant degree of protection against inflation in South Africa then the estimated slope coefficient ($\alpha$) in equation (3) will be positive and statistically significant; implying that increases in domestic inflation are associated with a contemporaneous increase in the return on gold. A statistically significant value of $\beta$ less than 1 indicates that gold is only a partial hedge against domestic inflation, whereas values of $\beta$ greater than or equal to 1 indicates that gold is a complete hedge.

Thus in summary, the empirical approach to be used to answer the research questions will include regression analysis of the relationship between the dollar index and the gold price to determine whether there is an inverse relationship, thus confirming gold’s ability to act as an inflation hedge; and analysis of the relationship between the dollar index and US CPI against the various forms of domestic gold investment to determine whether foreign inflation possibly
drives the domestic price of gold and its associated investments. In addition to statistical analysis, graphical analysis will also be used to provide additional insight.

3.2 RESEARCH DESIGN, DATA COLLECTION METHODS AND RESEARCH INSTRUMENTS

All of the data included in the empirical analysis has been obtained from Bloomberg and the South African Reserve Bank (SARB), as well as Statistics South Africa. London gold prices will be used as the base value and converted to South African Rands, using the end-of-period exchange rate. The average monthly closing prices were used as opposed to the last month end traded price to fully take into account any volatility that transpired throughout the month.

The raw month-on-month data for inflation as well as returns for gold were changed to a percent month-on-month change before running the regressions and the correlation analysis.

Furthermore the Newgold exchange traded fund was only started in November 2004; hence there is no data for a substantial period of this study. In addition, as a result of gold’s meteoric rise shortly thereafter, the price appreciation of Newgold shares has been skewed upwards (this is further discussed in the data analysis section).

The variables used in this study consist of the following:

- Gold data:
  - AV GOLD ZAR, which is the average monthly price of spot gold per ounce in rands.
  - NEWGOLD ETF, which is an exchange traded gold fund managed by ABSA bank and started in November 2004.
  - JSE INDEX GOLD, which is a trade weighted index comprising of the major gold miners currently listed on the JSE.
  - USD GOLD, which is the price of spot gold per ounce in dollars.
  - ZAR GOLD, which is the price of spot gold per ounce in rands.
• Other:
  o CPI, which is the consumer price index in South Africa
  o USD Index, which is trade weighted basket of currencies against which the dollar is measured.
  o USD/ZAR, which is spot rand/dollar exchange rate.

4 RESEARCH FINDINGS

4.1 INTRODUCTION

The regression analysis conducted in this study examines the relationship between South African month-on-month CPI against the three local gold investments in order to determine whether there is a significant relationship between CPI and the gold price.

Firstly to give some idea of the monthly returns available on gold relative to inflation rates for the three gold investments considered in this study, Table 1 below presents the mean return on gold (and associated standard deviation) for each gold investment contrasted with the monthly inflation rates.

<table>
<thead>
<tr>
<th>Investment</th>
<th>Gold Rates of Return</th>
<th>Inflation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (%)</td>
<td>Std. Deviation</td>
</tr>
<tr>
<td>Av. Gold ZAR</td>
<td>1.2</td>
<td>0.0425</td>
</tr>
<tr>
<td>Newgold ETF</td>
<td>2.1</td>
<td>0.0611</td>
</tr>
<tr>
<td>JSE GOLD INDEX</td>
<td>1.1</td>
<td>0.1096</td>
</tr>
</tbody>
</table>

TABLE 1: Means and Standard Deviations of Returns on Gold and Inflation
The descriptive statistics indicate how much, on average, the returns of on gold were above the average inflation rate for each of the three gold related investments. The results show that the Newgold ETF has out-performed the ZAR gold price and the JSE Gold Index two-fold. However, it must be borne in mind that the Newgold ETF fund only started in 2004, shortly before gold’s meteoric rise, thus skewing the average return upwards. Nonetheless, the results do provide an indication that all three gold investments have significantly outperformed inflation on a month-on-month basis.

However, although the return on gold is on average higher than the mean inflation rate for each of the three investments, this is not necessarily sufficient for gold to be considered an effective hedge against inflation. The reason being, the quality of an inflation hedging asset is determined by the extent to which the returns on the particular asset move systematically with the inflation rate (Chua and Woodward, 1982). Thus the results presented in Table 1 do not provide sufficient information of the inflation hedging ability of gold in each of the investments classes under consideration because the above results only indicate absolute returns and do not illustrate any causal relationship between gold and inflation.

4.2 REGRESSION RESULTS

The next step of the empirical analysis makes use of a regression model in order to investigate the inflation hedging value of gold, as well as examine the relationship between the three local gold investments and domestic CPI. It is hypothesised that if gold offers some protection against inflation for investors in its various forms, then the estimated slope co-efficient of the regression model should be positive and statistically significant, which implies that increases in domestic inflation lead to contemporaneous increases in the return on gold. Hence, in accordance with Chua and Woodward (1982), a statistically significant value of $\beta_i$ between 0 and 1 implies that gold is only a partial hedge against domestic inflation, whereas values of $\beta_i$ greater than or equal to 1 implies that gold is a complete hedge.

The insignificant $\beta$ coefficients and $R^2$ values, as set out in Table 2, indicate that gold as an investment in any of the three common forms in South Africa, has not been a hedge against domestic inflation. Hence this result confirms that there is no significant relationship between... 

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5 See Appendix A for the full results of the regression models.
gold and domestic inflation. These results accord with Chua and Woodward (1982), who find that with the exception of the US, gold has not been an effective inflation hedge in Canada, Germany, Japan, Switzerland and the UK. Furthermore the returns of gold are not systematically related to the inflation rate of any of the countries studied. Similarly Larson and McQueen (1995) also report that the relationship between gold and unexpected inflation is weak. Consequently, the results suggest that additional factors other than domestic inflation explain the returns on gold.

<table>
<thead>
<tr>
<th>Investment</th>
<th>( a_i )</th>
<th>( \beta_i )</th>
<th>Standard Error</th>
<th>t-statistic</th>
<th>( R^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Av. Zar gold</td>
<td>0.0117</td>
<td>0.0013</td>
<td>0.0426</td>
<td>0.2084</td>
<td>0.0002</td>
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<tr>
<td>Newgold</td>
<td>0.0260</td>
<td>-0.0093</td>
<td>0.0614</td>
<td>-0.5587</td>
<td>0.0038</td>
</tr>
<tr>
<td>JSE Gold</td>
<td>0.0115</td>
<td>-0.0004</td>
<td>0.1098</td>
<td>-0.0233</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

**TABLE 2: REGRESSION RETURN OF GOLD INVESTMENTS ON INFLATION**

4.3 **RESEARCH ANALYSIS AND DISCUSSION**

The empirical model regressed changes in monthly CPI on changes in the monthly returns of the gold investments. However, the results show that the domestic South African inflation rate has no influence on the gold price, which thus raises an additional question: If South African inflation does not have a significant association with the gold price then is gold associated with foreign inflation instead?

In seeking to answer this additional research question, it is important to consider that although the gold price is set in London, it is the United States and more specifically the dollar that historically has a major influence on the price movements of gold and its related investments as the studies of both Tully and Lucey (2006) and Capie et al (2005) confirm. Hence, in order to examine the relationship between the gold price and foreign inflation, the correlation coefficient between the US Dollar Index and the US Dollar gold price is examined (Figure 3). The results presented in Table 3 below show that the coefficient is highly significant and
inversely correlated (-70.1%) in accordance with Tully and Lucey (2006) and Capie et al. (2005).

<table>
<thead>
<tr>
<th>USD Gold</th>
<th>USD/ZAR Exchange</th>
</tr>
</thead>
<tbody>
<tr>
<td>-0.701</td>
<td></td>
</tr>
<tr>
<td>JSE Gold Index</td>
<td>0.504</td>
</tr>
<tr>
<td>-0.483</td>
<td></td>
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<td>Newgold ETF</td>
<td>0.504</td>
</tr>
<tr>
<td>-0.572</td>
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<tr>
<td>ZAR Gold</td>
<td>0.499</td>
</tr>
<tr>
<td>-0.097</td>
<td></td>
</tr>
</tbody>
</table>

**TABLE 3: Correlation Co-efficients Between Variables**

![Figure 3: USD Index and USD Gold Price](image)

Thus, the results imply that gold is a hedge against US dollar devaluation. However, this finding then raises an additional question: What is the implication of this finding for South African gold related investments? To answer this question, the correlation between the US Dollar/ South African Rand exchange rate versus the JSE Gold Index are examined. The correlation coefficient is found to be a moderately significant 50.4%, which can be seen from Figure 4 below.
In accordance with prior expectations, the correlations between the USD/ZAR exchange rate against both the Newgold ETF and ZAR Gold are highly significant, indicating that as the Rand depreciates against the dollar, the rand gold prices of both Newgold ETF and ZAR Gold adjust accordingly as they are directly associated. Furthermore, JSE gold shares are more geared than physical gold to rand depreciation and hence more attractive. The increased volatility of the gold shares more than compensates for by the increased share price appreciation.

In order to confirm these relationships, correlations between the USD Dollar Index and the JSE Gold Mining Index are also examined (Figure 5). The results find that there is a moderately negative and inverse correlation of -48%, thus confirming that dollar strength is
associated with gold depreciation, and a lower JSE Gold Mining Index. Hence, this result suggests that a possible explanation for the high volatility of the gold mining index is the dual effect of world gold price and exchange rate movements.

Due to the inverse correlation between the dollar index and dollar gold a weakening dollar may cause dollar gold to increase. However a weaker dollar may also cause the rand to appreciate which would counteract the increase in the dollar gold price by resulting in a lower rand gold price. This explains why the exchange rate correlates well with the mining index (see graph above) and the huge jump in the gold mining index in 2001 serves as an apt illustration, a period when South Africa experienced a currency crises with the Rand making spectacular losses against the dollar as well as other currencies.

5 RESEARCH CONCLUSIONS

This research sought to determine (i) whether there is any relationship between gold investments and CPI in South Africa, and (ii) which gold investment performed best.

Firstly, regression analysis of South African CPI against the three domestic forms of gold investments was conducted covering the period of 16 years (post liberalisation). The results of the empirical analysis find that there is no significant relationship between the rand gold price and domestic inflation, and thus the superior gold performance can be attributed to factors other than inflation, which are beyond the scope of this study.

Secondly, examining the performance of the three gold investments on a purely return basis shows that the Newgold ETF has outperformed the other gold asset classes. However this does not conclusively prove that Newgold offers the best returns of all gold investment asset classes in South Africa because the JSE Gold Mining Index represents a cross section of various gold shares on the JSE on a trade weighted basis. Thus, it is possible that individual gold shares may have achieved superior returns via gearing, especially post 2006.

Although the methodology used in this paper conclusively proves that there is no relation between domestic inflation and the rand gold price, the results raised the question of what was actually driving the gold price to consistently outperform inflation. After analysing the
correlation between the rand/dollar exchange rate and the performance of rand denominated gold investments, it can be concluded that there is a relationship between the exchange rate and the local gold investments. Of the three gold investments, the JSE Gold Mining Index is found to be the only one with no direct link to the exchange rate.

Hence, the correlation analysis finds in accordance with the international literature, that the US dollar is inversely correlated to the dollar gold price, implying that there is a link between currency exchange rates and the price of gold.

6 FUTURE RESEARCH DIRECTIONS

Due to constraints technological and time constraints, this study made use of statistical methods of analysis rather than econometric methods. Thus, future research on the topic of this study could consist of the following:

- Following Levin et al (2006), the analysis could be run using an Error Correction Model (ECM) or Vector Error Correction model (VECM) to investigate the short-run and long-run determinants of the price of gold, as well as the effects of shocks using impulse-responses and variance decomposition analysis.

- A threshold model could be employed to examine the impact, jointly and singularly of a range of factors that could include sectoral, macroeconomic and behavioural economic so as to identify the barrier points that shape movements in the gold price.

- The correlation analysis conducted in this study has not taken any lead and lag times into account. Since it is possible that there is a lead or lag time before the various factors react to associated movements in the gold price or inflation, future research could thus conduct the analysis using cross-correlation rather than contemporaneous correlation analysis.
APPENDIX A: REGRESSION RESULTS

A(1): SA CPI vs AVERAGE GOLD ZAR

\[ y = 0.0013x + 0.0117 \]
\[ R^2 = 0.002 \]

SUMMARY OUTPUT

<table>
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<tr>
<th>Regression Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple R</td>
</tr>
<tr>
<td>R Square</td>
</tr>
<tr>
<td>Adjusted R Square</td>
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<tr>
<td>Standard Error</td>
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<td>Observations</td>
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<table>
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A(2) : SA CPI vs NEWGOLD ETF

SUMMARY OUTPUT

Regression Statistics

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<tr>
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<th>Adjusted R Square</th>
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ANOVA

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Coefficients

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</table>
A(3): REGRESSION ANALYSIS 1c: SA CPI vs JSE GOLD INDEX

SUMMARY OUTPUT

Regression Statistics

| Multiple R | 0.001676 |
| R Square   | 2.81E-06 |
| Adjusted R Square | -0.00515 |
| Standard Error  | 0.109849 |
| Observations  | 196 |

ANOVA

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BIBLIOGRAPHY


