ISBN 978-0-9925622-1-2

AN EVALUATION OF GOLD AS AN INFLATION HEDGE: EMPIRICAL EVIDENCE FROM SOUTH AFRICA

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ABSTRACT

The plague of inflation eating into investor returns is one that is experienced universally by all investors. Gold has historically proven to be a good inflationary hedge, with its appreciating prices in times of high inflation. However, in recent years, the effectiveness of gold as a hedge against inflation has been questionable. The purpose of this study is therefore to thoroughly examine the use of gold as an inflationary hedge in the South African environment. The study extends over the period of 2000 – 2014, and utilizes both gold and the krugerrand as possible hedges, whilst also differentiating between actual, expected, and unexpected inflation. The results of the study overall showed that whilst neither gold not the krugerrand was found to be an effective hedge against any form of inflation in the short run, both these investment alternatives were found to hedge against actual and unexpected inflation in the long run.

JEL Classifications: G11, G15
Keywords: Gold, Krugerrand, South Africa, Hedging, Inflation, Inflation targeting.
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INTRODUCTION

The South African financial environment has become extremely volatile over the last decade, experiencing high levels of inflation and an unstable exchange rate mainly due to factors such as contagion, political risk and labour unrest. Inflation in particular, is an extremely important risk for investors to consider, as inflation volatility spreads to the stock and bond markets, but also because the presence of inflation reduces the purchasing power of investors, and thus their overall returns. In South Africa, this has been identified as a key factor, and since February 2000, the Monetary Policy Committee of South Africa has adopted an inflation targeting approach. Whilst their aim is to keep the Consumer Price Index (CPI) between 3% and 6%, figure 1 below indicates that the inflation rate breaches these bands frequently. It can also be seen that since 2000 (which is when inflation targeting was introduced), CPI has thrice reached double figures – once post the September 11 attacks, once during the sub prime crisis, and again more recently in 2014.

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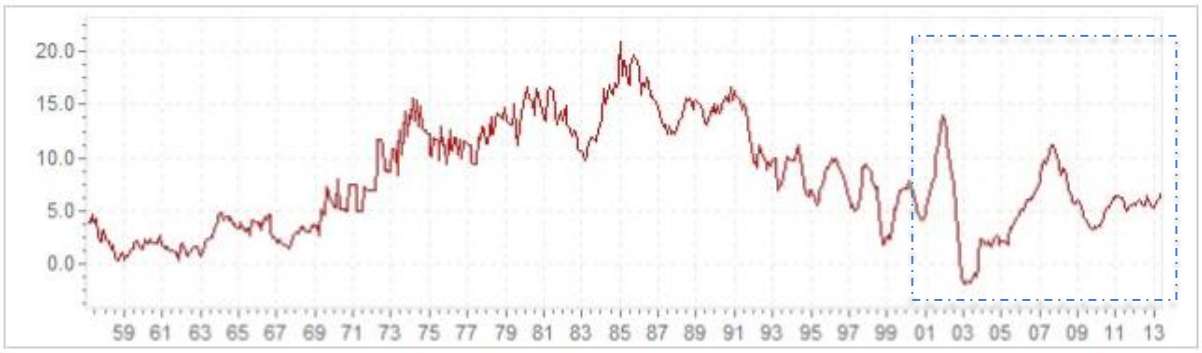
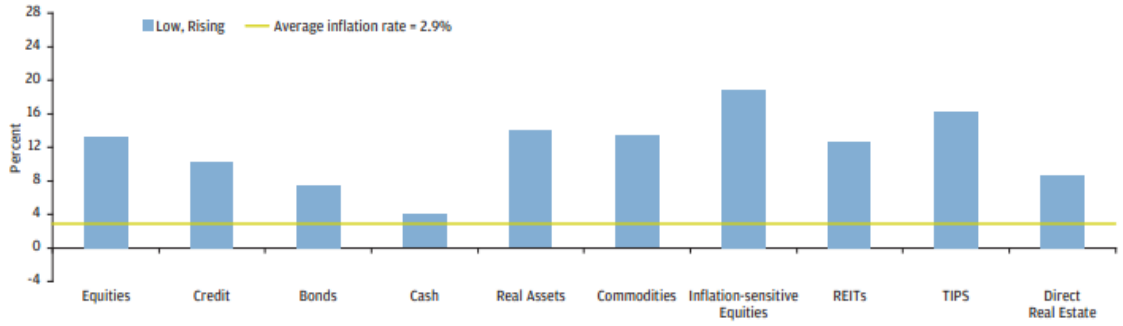
FIGURE 1: THE HISTORICAL CPI OVER THE PERIOD OF 1959 TO 2013



(Inflation.EU, 2014)

In order to protect their investments from inflation risk, investors therefore need to make use of hedging. According to Baur and Lucey (2010) a hedge is an instrument or asset that needs to be negatively correlated or uncorrelated on average, which means it can be positively correlated during extreme situations however during normal market conditions it needs to be negatively correlated. One of the most commonly used inflationary hedges is the general class of commodities, which are regarded as a consumable and usually comprise of precious metals, energy products, food, livestock and finally industrial metals (Greer, 2006). These commodities are considered to reflect inflationary expectations since these prices respond to changes in information faster than consumer prices (Worthington and Pahlavani, 2006). Figure 2 and Figure 3 both provide strong evidence that commodities outperform all other asset classes during periods of high inflation. It can be seen from these graphs that commodities were able to outperform other generally accepted inflation hedges such as real estate indexes and TIPS in high inflationary periods.

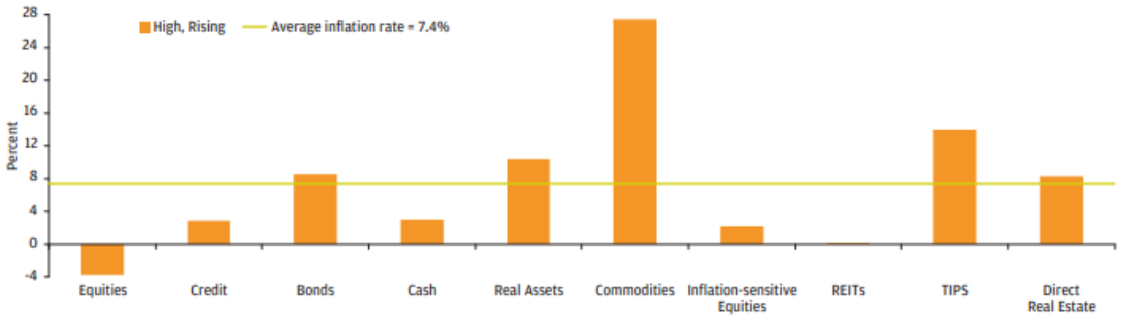
FIGURE 2: PERFORMANCE OF ASSETS IN LOW-RISING INFLATIONARY ENVIRONMENTS



Source : (Dessner et al., 2012)

ISBN 978-0-9925622-1-2

FIGURE 3: PERFORMANCE OF ASSETS IN HIGH-RISING INFLATIONARY ENVIRONMENTS

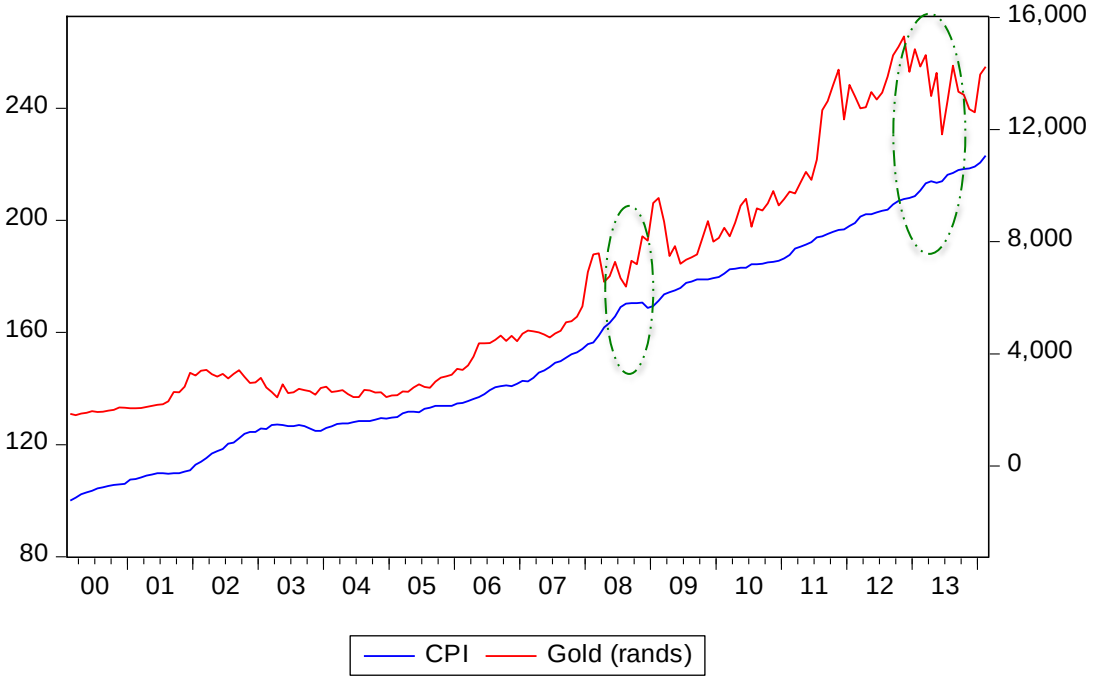


Source : (Dessner et al., 2012)

Gold in particular is a commonly used hedge by both governments and investors as it is easily transportable, durable and universally accepted (Worthington and Pahlavani, 2006). According to Ghosh et al (2004), the demand for gold can be divided into two types: "use demand" which refers to the demand of gold for jewellery or commercial purposes, as well as "asset demand" which refers to its use by governments, asset managers and general investors as a store of value in periods of uncertainty. Whilst "use demand" fluctuates with the business cycle, "asset demand" is thought to react counter-cyclically as investors flock to gold in times of financial crises. Since the supply of gold is relatively inelastic due to the complicated extraction process and the difficult creation of new mines, the price of gold mainly fluctuates with the change in demand levels.

Figure 4 below shows the fluctuation in the price of gold as well as the CPI index over the period 2000 – 2014. It can be seen that even though both seem to be increasing together over the entire period, there are deviations from this, like in 2008 when the gold price decreased amidst rising inflation, and again in the more recent years when gold plummeted in 2012, again amidst rising inflation.

FIGURE 4: GRAPH OF CPI INDEX AND GOLD PRICE (RANDS) OVER THE PERIOD 2000-2014



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South African investors have a choice of two core options when investing in gold. The first option is the standard gold per ounce (gold bullion) which is the internationally traded form of gold. The second option being the Krugerrand, which was the world's first ounce denominated gold bullion coin (JSE, 2014). Krugerrands are issued by the South African Reserve Bank and are considered a legal tender however they do not possess any monetary face value (JSE, 2014). Krugerrands can be traded on the Johannesburg Stock Exchange in the same manner as any other equity.

LITERATURE REVIEW

The past decade has seen an increase in the amount of literature pertaining to gold as an inflationary hedge, due to the increase of inflation experienced worldwide. Furthermore the relevance of gold has becoming more apparent due to its increase in price historically and especially during the 2007/2008 financial crisis. The overall studies provide varying evidence across the different countries and sample periods.

Ghosh, Levin, Macmillan and Wright (2004) investigated the relevance of gold as an inflation hedge in the US market over the period of 1976 – 1999. They found that overall, gold provides a good long run hedge for inflation, whilst in the short run this relationship may be hampered by other variables such as the real interest rate and default risk.

Worthington and Pahlavani (2006) conducted a similar study in the US market over the period of 1945 to 2006, whilst accommodating for a structural break in January 1973, to account for the breakdown of the Bretton Woods system. They found strong evidence of a cointegrating relationship between gold and the inflation rate during both sample periods utilised.

Dempster and Artigas (2009) conducted their study by utilising multiple different assets which are conventionally used as inflation hedges, to see which one is superior in the US market. They utilised monthly data consisting of a gold spot price in U.S. dollars per ounce, commodity indexes, real estate indexes, Standard and Poor (S&P) GSCI and TIPs over the period of 1974 to 2008. Their overall conclusion was that gold is a hedge against inflation due to its strong positive correlation and also as a profitable long-term asset to hold. Dempster and Artigas (2009) further state that in periods of high inflation in the US, gold would be able to outperform other inflation hedges. Other findings showed that gold produced lower volatility compared to real estate indexes and the S&P GSCI which may contradict public opinion that gold is a risky asset (Dempster and Artigas, 2009).

Hoang (2012) utilised two different forms of gold in his study of the French economy: the first being the price of gold ingots[i], as well as Napoleon coins over the period 1949 – 2011. This study also had the unique feature of utilising the gold prices in the domestic currency and not expressed in terms of the dollar. Their Pearson and Spearmen correlation test showed no correlation between either gold variable and the inflation rate over the entire period, a result which was echoed by their linear regression of each variable against the inflation rate.

ISBN 978-0-9925622-1-2

Whilst these two results provided evidence that gold is not a good hedge against inflation in the short run, the results of their cointegration test also indicated that there are no long run hedging capabilities of gold priced in the domestic currency. Thus the overall opinion of the author is that domestically priced gold does not provide the same protection against inflation as gold priced in dollars.

Shahbaz, Tahir and Ali (2013) and Tufail and Batool (2013) analysed the relationship between inflation and gold in Pakistan. Shahbaz et al (2013) looked at the long run relationship over the period of 1997 to 2011, and their conclusion based on their results was that gold is a suitable hedge against inflation in Pakistan. Tufail and Batool (2013) extended their analysis to the period of 1960 – 2010 and differentiated between expected and unexpected inflation. Their study was similar to that of Hoang (2012), as they also included the price of gold in the domestic currency (Pakistani rupees). The results of their analysis showed that gold was a suitable hedge against unexpected inflation but not against expected inflation (Tufail and Batool, 2013).

Ghazali et al (2013) also utilised the price of gold in the domestic currency of Malaysia, and found that whilst CPI had a positive correlation over the 2001 – 2008 period of their study, this correlation became negative from 2008 – 2011. The overall findings of the study are that domestic gold prices do not produce high enough returns compared to the gold listed on the NYSE and LSE thus it is unable to overcome the effects of inflation (Ghazali et al., 2013). Therefore gold priced in the domestic currency has no systematic relationship with CPI over a short period which is roughly how long most Malaysians would hold the asset thus it cannot be considered a hedge in the short run (Ghazali et al., 2013).

Dee, Li and Zheng (2013) conducted their study in China over the period of December 2002 to March 2012, and found evidence overall that whilst gold is not a suitable hedge in the short run, it does prove to be a reliable hedge in the long run. Long, Ceuster, Annaert and Amonhaemanon (2013) extended his analysis to distinguish between expected inflation, unexpected inflation, and actual inflation. He found that in the long run, gold was an effective hedge against all three types of inflation in Vietnam.

The preceding analysis indicates that whilst there are many studies which analyse the effectiveness of gold as both a short run and long run hedge, these results vary across the different forms of inflation, different time periods, and different countries. To the author's knowledge there are no studies in South Africa on the subject, which is a gap in the literature that this study aims to fill.

METHODOLOGY AND DATA

Methodology

The relationship between gold and inflation is important in both the long run and short run as it offers a more comprehensive understanding regarding the effectiveness of gold as a hedge. According to Hoang (2012) the suitability of gold as a hedge against changes in consumer price index (i.e. inflation) stems from the movement in gold prices which co-move upwards with inflation. It can therefore be deduced that if the correlation between

ISBN 978-0-9925622-1-2

gold and inflation is both strong and positively significant, this is evidence that gold is a viable hedge against inflation.

Preliminary tests

Since many financial variables used empirically are known to be non-stationary, stationarity tests will be required for each of the variables used (viz. actual/expected/unexpected inflation, and the price series of Gold and the Krugerrand). The Augmented Dickey Fuller (ADF) test will therefore be used to determine what order of integration each of the variables display. The hypothesis for the ADF test is as follows:

H_0: the series contains a unit root

H_1: the series does not contain a unit root

The variables will also be compared to one another in the form of a Pearson correlation coefficient test. Hoang (2012) indicates that correlation can be calculated using the following formula:

$$r_{x,y} = \frac{\sum_{t=1}^{T}(x_t - \bar{x})(y_t - \bar{y})}{\sqrt{\sum_{t=1}^{T}(x_t - \bar{x})^2 \sum_{t=1}^{T}(y_t - \bar{y})^2}} \quad (1)$$

Where: $r_{x,y}$ refers to the Pearson correlation coefficient of variables x and y over period t; x_t is equal to the returns of variable x over period t; y_t is equal to the returns of variable y over period t; and $\bar{x}_t, \bar{y}_t$ are the arithmetic averages of variables x and y respectively (Hoang, 2012).

In order for gold to be considered a hedge, the correlation coefficients between gold returns and the different forms of inflation needs to be positive.

Short run tests

Fisher (1930) first showed that expected nominal asset returns are made up of both expected returns and expected inflation rates, which could be interpreted as a rise in expected inflation will cause a rise in asset return. The simplified version of this equation is as follows:

$$E_{t-1}(R_t) = E_{t-1}(r_t) + E_{t-1}(\pi_t) \quad (2)$$

Where E_{t-1} is the conditional expectation operator at time t-1, R_t portrays the nominal return of an asset at time t-1 to t; r_t is the real return of an asset from time t-1 to t and π_t is the inflation rate from t-1 to t. Dee et al. (2013) and Long et al. (2013) therefore derived the following model, which can be used to determine the relationship between actual inflation recorded by the country being tested and the price of gold which in this case is gold per ounce and the Krugerrand.

$$Rg_t = \alpha + \gamma[CPI_t] + \epsilon_t \quad (3)$$

Where: Rg_t are the nominal gold returns over the period t-1 to t, α is the constant term, γ will display the effectiveness of the inflationary hedge (cross-price elasticity), CPI_t is actual inflation based on consumer price index at time t and ϵ_t is the error term.

ISBN 978-0-9925622-1-2

The value that β represents provides valuable information regarding the relationship between gold returns and inflation. If β is equivalent to one, Long et al. (2013) and Ghazali et al. (2013) considers this be a complete Fisher effect and also indicates that the returns of gold are a perfect hedge against inflation. If β is of a value greater than one it is considered to be more than complete. However if β is a value between one and zero it is regarded as a partial hedge against inflation. Finally a value for β that is negative would indicate that no hedging properties reside in gold. The value for β are also required to be significantly different from the value of zero in order for a relationship to exist (Ghazali et al., 2013).

According to Amason and Persson (2012) inflation can be divided into three parts; actual inflation, expected inflation and finally unexpected inflation. Based upon what was established by Fama and Schwert (1977) there is confirmation that actual inflation is formed by the addition of expected and unexpected inflation

- Expected inflation

  The expected inflation rate generally refers to the value that the public expects inflation to be, given the fact that actual inflation statistics are only reported after one month. Kloosterman (2009) indicates however, that expected inflation is not openly visible, in which case a proxy such as the Treasury bill rate must be used. Fama and Schwert (1977) asserts that the returns on a bill may be equivalent to the expected real return as well expected inflation rate provided the expected real returns of the bill remain constant over time, and the bond market maintain a high level of efficiency (Kloosterman, 2009). This can be mathematically expressed as:

$$GB_t = E(i) + E(\bar{\Delta}_t|\emptyset_{t-1}) \quad (3)$$

  which, when rearranged is:

$$E(\bar{\Delta}_t|\emptyset_{t-1}) = GB_t - E(i) \quad (4)$$

Source: Fama and Schwert (1977)

Where GB_t is the nominal returns on the chosen Government Bond (T-bill) at time t, $E(i)$ portrays the constant expected real return and $E(\bar{\Delta}_t|\emptyset_{t-1})$ is the expected inflation rate.

According to Kloosterman (2009) equation (3) above can be tested as follows:

$$\bar{\Delta}_t = \alpha + \beta[GB_t] + \bar{\varepsilon}_t \quad (5)$$

Since theory states that β = 1 and $E(\bar{\Delta}_t|\emptyset_{t-1})$ = 0, one can conclude that if there are any changes in the nominal returns of the government bond (GB_t), this is able to mimic the variation that occurs in the expected inflation rate ($E(\bar{\Delta}_t|\emptyset_{t-1})$ (Fama and Schwert, 1977, Kloosterman, 2009). Due to this finding one can use the nominal returns of a government bond as a proxy for the expected inflation rate for the specific period t (Fama and Schwert, 1977, Kloosterman, 2009). Since the return on a 3 month government treasury bill is usually used, this study makes use of the 91 day t-bill as a proxy for expected inflation.

ISBN 978-0-9925622-1-2

- Unexpected inflation

  Unexpected inflation generally occurs when the actual inflation rate is higher than the predictions of the public. Wurtzebach et al. (1991) therefore denotes the formula for unexpected inflation (UEI_t) as being the difference between actual inflation (CPI_t) and the last periods expected inflation (EI_{t-1}).

$$UEI_t = CPI_t - EI_{t-1} \quad (6)$$

In order to test the short run effectiveness of gold as a hedge, we therefore need to conduct a linear regression with gold as the dependent variable, and expected and unexpected inflation being the independent variables. The regression equation is therefore expressed as follows:

$$Rg_t = \alpha + \beta_1[EI_t] + \beta_2[UEI_t] + \epsilon_t \quad (7)$$

Where: Rg_t represents the nominal gold returns over the period t-1 to t, EI_{t-1} depicts the expected inflation measured by government bonds, CPI_t indicates the actual inflation based on consumer price index at time t, β_1 shows the effectiveness against expected inflation, β_2 shows the effectiveness against unexpected inflation and ϵ_t is the error term[ii].

Source: Long et al. (2013) and Kloosterman (2009)

According to Fama and Schwert (1977) there are three unique cases that could occur, the first being β_1 equalling one which indicates that it is a complete hedge against the expected inflation in South Africa, the second being β_2 equalling one which means that it is a complete hedge against unexpected inflation in South Africa and finally if both β_1 and β_2 equal one, this would indicate that gold is a complete hedge when compared to inflation as a whole in South Africa. Since the statistical significance of the coefficient is also an important factor, hypothesis tests of each variable used in the study will be conducted using a t-test.

Long run tests

If a long run relationship exists between the price of gold and inflation and the relationship is both positive and significant it can be established that gold is able to sufficiently hedge against inflation, since when inflation increases so too does the price of gold. If the two variables move together they are said to be cointegrated with one another, which indicates that there exists a long run equilibrium, and any deviations from this equilibrium relationship will only occur in the short run. In order to test for the existence of a cointegrating relationship between Gold/Krugerrand and Expected and Unexpected inflation, we utilise Johansen's Cointegration test. The two tests which indicate whether there are any cointegrating relationships in the data, and if there are, how many are present, are known as the Trace Test and the Maximum Eigenvalue test.

The trace test is regarded as a joint test that utilises the trace of the matrix which is made up of all the eigenvalues added together. The test works by means of using the transformed eigenvalues that fall above the hypothesis rank and then multiplies these values by the total sample size (Brooks, 2011). The null hypothesis used by the test is set to have the number of co-integrating vectors being less than or equal to the hypothesised

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rank and the alternative hypothesis has the no of co-integrating vectors being larger than the hypothesised rank. The following is the formula utilised by the test:

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{g} ln(1 - \widehat{\lambda_i}) \tag{8}$$

Where: $\widehat{\lambda_i}$ is the estimated value for an i^{th} ordered eigenvalue residing in the Π matrix; r refers to the number of cointegrating vectors that are being tested by the null hypothesis; and T is equal to the number of obsrvations in the sample.

If the statistic generated by the trace test is found to be greater than the critical value, it can be concluded that the hypothesised rank must be rejected in favour of a larger unspecified rank. If the test indicates that the null hypothesis cannot be rejected when is set so that the hypothesised rank is less than or equal to zero, then it can be established that there are no co-integrating vectors.

The maximum eigenvalue test is very similar to the trace test but differs slightly as it tests each successive eigenvalue individually. The following is the formula utilised by the test:

$$\lambda_{max}(r, r+1) = -Tln(1 - \hat{\lambda}_{r+1}) \tag{9}$$

The maximum eigenvalue test is conducted by setting the null hypothesis to have the number of co-integrating vectors being less than or equal to the hypothesised rank which happens to be the same as the trace test however the alternative differs as it has the no of co-integrating vectors being equal to the hypothesised rank plus one (Brooks, 2011). The test confirms whether the hypothesised rank plus the addition of one is appropriate size in order conclude that the value is non-zero and that its true rank is equivalent to the number of cointegrating vectors plus one (Brooks, 2011). Therefore the test statistic is regarded as the transformed eigenvalue multiplied by the sample size. The maximum eigenvalue test follows the same reasoning with statistic and critical values as the trace test, where the null hypothesis would be rejected if the test statistic is greater than the critical value at a specified level of significance.

If cointegration is found according to the Trace and Maximum Eigenvalue tests, the system of variables can be expressed in terms of a Vector Error Correction Model (VECM).

$$\Delta y_t = \Pi y_{t-k} + \Gamma_1 y_{t-1} + \Gamma_2 y_{t-2} + \cdots + \Gamma_{k-1} y_{t-(k-1)} + u_t \tag{10}$$

Where: y_t is a matrix of the gold/krugerrand returns, as well as the values of expected and unexpected inflation; $\Pi = \left(\sum_{i=1}^{k} \beta_i\right) - I_g$; $\Gamma = \left(\sum_{j=1}^{k} \beta_j\right) - I_g$ (Coefficient of lags); g refers to the number of variables in first differenced form; and u_t is the error term.

In the event that at least one cointegrating relationship is found, $\Pi = \alpha\beta'$. The corresponding beta (β) matrix therefore contains the details of the cointegrating relationships, whilst the alpha (α) provides the adjustment

ISBN 978-0-9925622-1-2

parameters, viz. the extent of the reaction of each variable in the event of a short run deviation from the long-run equilibrium.

Data

The period which was chosen for this study was from February 2000 – February 2014. The reason the year 2000 was chosen as the starting date was because in this year, the South African Reserve Bank (SARB) introduced inflation targeting with the aim of keeping CPI between the stipulated bands of 3% to 6%. Monthly data was used as this is the form which many of the studies reviewed[iii] have used. The values of the headline CPI[iv] was utilised as a proxy for actual inflation, whilst the government bond proxy for unexpected inflation was chosen to be the 91 day t-bill.

The CPI variable was reindexed twice in the period concerned: once when the base year was changed from 2000 to 2008, and the second time in December 2012. The equation used to re-index the data to the base year of 2000 is as follows:

$$CPI_{x+1/year} = \frac{CPI\ of\ the\ old\ base\ year}{100} \times CPI\ of\ the\ new\ base \quad (11)$$

Where:

$CPI_{x+1/year}$ = Re-Indexed CPI.

Source: Hoang (2012)

There were two different gold variables used, to proxy for two of the options that are available to South African investors, viz. the price of gold bullion in the domestic currency (Rands), as well as the price of Krugerrands, also expressed in the domestic currency. All data was transformed into logs to ensure ease of comparison between the different variables.

EMPIRICAL ANALYSIS

This section deals with inflation and utilises both long run and short run models in order to find evidence that gold is able to hedge against inflation.

Preliminary analysis

The first preliminary method used to evaluate the relevance of gold as a short run hedge against inflation is by analysing Pearson correlation coefficients, which is displayed in table 1.

TABLE 1: PAIRWISE PEARSON COEFFICIENT OF CORRELATION

	Gold	**Krugerrand**	**Actual Inflation**	**Expected inflation**	**Unexpected inflation**
Gold	1.00				
Krugerrand	0.99	1.00			
Actual Inflation	0.97	0.98			
Expected inflation	-0.67	-0.68	-0.73	1.00	
Unexpected inflation	0.87	0.88	0.91	-0.94	1.00

ISBN 978-0-9925622-1-2

Interestingly, it can be seen that both Gold and the Krugerrand display a very high positive correlation with actual inflation, a result which is echoed with unexpected inflation. However, the correlation coefficient between gold and the expected inflation variable is negative. This may provide evidence that gold provides a hedge against actual and unexpected inflation, but not expected inflation.

The other preliminary method of analysis necessary is that of ADF tests on each of the variables. The results of these tests are shown in table 2 below:

TABLE 2: ADF TEST STATISTICS AND RESULTS

Variable	Level t-statistic	First difference t statistic	Order of integration
CPI	-0.1279	-8.7082***	I (1)
Gold	-0.5651	-14.3889***	I (1)
Krugerrands	-0.5426	-12.6434***	I (1)
Expected inflation	-1.2296	-8.7735***	I (1)
Unexpected inflation	-0.5629	-9.0248***	I (1)

*, ** and *** denote statistical significance at the 10%, 5% and 1% levels respectively

Since all the variables used in the study were found to be I(1), this meant that utilising them in their level form in the regression analysis would lead to a spurious regression. Each variable was therefore differenced once to induce stationarity, after which the short run test was conducted.

ISBN 978-0-9925622-1-2

Short Run Analysis

The results of the OLS regressions are displayed in the table below:

TABLE 3: OLS REGRESSION OF GOLD AND KRUGERRANDS AGAINST EXPECTED AND UNEXPECTED UNFLATION

Model: $Rg_t = \alpha + \gamma[CPI_t] + \epsilon_t$		
Gold		
	Coefficient	T-statistic
γ **(Actual Inflation)**	-1.27	-1.30
Krugerrand		
γ **(Actual Inflation)**	-1.689	-1.99**

Model: $Rg_t = \alpha + \beta_1[EI_t] + \beta_2[UEI_t] + \epsilon_t$		
Gold		
	Coefficient	T-statistic
β_1 **(Expected Inflation)**	-0.141	-1.058
β_2 **(Unexpected inflation)**	-0.311	-2.237**
Krugerrand		
β_1 **(Expected Inflation)**	-0.096	-0.82
β_2 **(Unexpected inflation)**	-0.209	-1.714*
Model: $Rg_t = \alpha + \gamma[CPI_t] + \epsilon_t$		
Gold		
	Coefficient	T-statistic
γ	-1.27	-1.30
Krugerrand		
γ	-1.689	-1.99**

*, ** and *** denote statistical significance at the 10%, 5% and 1% levels respectively

The results in table 3 show that whilst gold is not a hedge against actual inflation in the short run, the krugerrand is, however this coefficient has a negative value. We also find that the beta coefficient of expected inflation in both the gold and krugerrand equations is statistically insignificant, which indicates that gold is not a hedge in the short run against expected inflation. This result coincides with that produced in the correlation table. However, it can also be seen that whilst the coefficient of unexpected inflation is statistically significant at the 5% level in the gold equation, and significant on the 10% level in the krugerrand equation, the sign of both coefficients is negative. This suggests that in the short run, when actual/unexpected inflation increases, this results in the decrease in the price of gold/krugerrands, which indicates that gold does not provide a hedge against this factor in the short run.

Long run analysis

The results of the preliminary analysis showed that each of the variables used are integrated of order 1, which means that all these variables can be included in the cointegration analysis. The trace and max eigenvalue tests were used to determine whether cointegration was present. The results of both tests is contained in Table 4.

ISBN 978-0-9925622-1-2

TABLE 4: RESULTS OF JOHANSEN COINTEGRATION ANALYSIS

	Hypothesis	Trace Statistic	5% Critical Value	Maximum-Eigen Statistic	5% Critical Value
Gold and Actual Inflation	*None*	44.89*	12.32	42.69*	11.22
	At Most 1	2.20	4.13	2.20	4.13
Gold and Expected Inflation	*None*	10.62	12.32	8.62	11.22
	At Most 1	0.01	4.13	2.01	4.13
Gold and Unexpected Inflation	*None*	14.8*	12.32	11.49*	11.22
	At Most 1	3.31	4.13	3.31	4.13
Krugerrand and Actual Inflation	*None*	44.49*	12.32	42.25*	11.22
	At Most 1	2.24	4.13	2.24	4.13
Krugerrand and Expected Inflation	*None*	10.77	12.32	8.79	11.22
	At Most 1	1.97	4.13	1.97	4.13
Krugerrand and Unexpected Inflation	*None*	14.81*	12.32	11.22*	11.22
	At Most 1	3.32	4.13	4.13	4.13

*, ** and *** denote statistical significance at the 10%, 5% and 1% levels respectively

The results in Table 4 shows evidence of cointegration between gold/krugerrand and actual inflation, as well as unexpected inflation. Therefore, similar to the results of the short run test, we find evidence that there is some relationship between gold and actual as well as unexpected inflation. However, the nature of this relationship, ie. whether it is a positive or negative one, is not known as yet. The full extent of this conclusion can therefore only be reached after analysing the appropriate VECM models, which will provide us with more details.

ISBN 978-0-9925622-1-2

TABLE 5: COEFFICIENTS PRODUCED IN THE VECM EQUATIONS OF THE COINTEGRATING RELATIONSHIPS

Cointegration: Gold and Actual Inflation		
	Beta coefficient	T-statistic
Actual Inflation (CPI)	1.095	12.38***
Adjustment Parameter: Gold	0.0069	3.13
Adjustment Parameter: CPI	0.001	6.02***
Cointegration: Gold and Unexpected Inflation		
Actual Inflation (UEX)	5.21	4.88
Adjustment Parameter: Gold	-0.0007	-2.76
Adjustment Parameter: UEX	-0.0002	-1.56

Cointegration: Krugerrand and Actual Inflation		
Unexpected Inflation (CPI)	0.80	6.02
Adjustment Parameter: Krugerrand	0.0045	3.42
Adjustment Parameter: CPI	0.0006	5.62
Cointegration: Krugerrand and Unexpected Inflation		
Unexpected Inflation (UEX)	2.658	8.36
Adjustment Parameter: Krugerrand	-0.0022	-2.88
Adjustment Parameter: UEX	-0.0007	-1.49

*, ** and *** denote statistical significance at the 10%, 5% and 1% levels respectively

The coefficients of the inflation variables are found to positive in all the cointegrating relationships, which indicates that gold and the krugerrand do provide hedges against these types of inflation. It should be noted that the statistical significance of each of these variables should be interpreted with caution, since the variables used in the analysis are all I(1). In the case of actual inflation, the coefficient in the gold equation is 1.095 which indicates that gold is a more than complete hedge against actual inflation. The associated value in the Krugerrand equation is 0.80, which shows that whilst the Krugerrand is a hedge against inflation, it is only a partial one – albeit the value is very close to 1.

The coefficients of unexpected inflation are extremely high in both equations – 5.21 in the gold equation, and 2.658 in the krugerrand equation. This again provides evidence that both gold and the krugerrand are more than complete hedges against unexpected inflation.

The adjustment coefficients of each variable in each cointegrating relationship are very small – which indicates that when there is a deviation from the long term relationship, the adjustment back to equilibrium occurs very slowly.

ISBN 978-0-9925622-1-2

CONCLUSION

The study made use of various methods of analysis to determine if gold and the krugerrand are able to hedge against inflation in both the short and long run. In this case, inflation was divided into three categories: actual inflation, expected inflation and unexpected inflation. The evidence from the Short run analysis found that whilst there is a statistically significant relationship between gold and inflation, the direction of the relationship indicates that neither gold nor the krugerrand serve has hedges in the short run. The long run analysis however, found that both gold and the krugerrand are able to hedge against actual and unexpected inflation, with gold being the superior hedging mechanism.

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[i] An ingot is a common term for a bar of gold

[ii] It should be noted that the variables used in the OLS regression will need to be differenced first until they become I(0), since they all will currently be I(1)

[iii] Vandeloise and Wael (1990), Miller and Chin (1996), Ghosh et al. (2004), Worthington and Pahlavani (2006), Beckmann and Cudaj (2012) and Wang et al. (2013)

[iv] According to Mitchell-Innes (2006) there are three ways in which consumer price index can be measured in South Africa: the first being your headline consumer price index (CPI), the second is core consumer index and finally the overall index (CPIX) which does not include the interest rates on mortgage bonds. CPI headline index would be the most important variable here as it is based on metropolitan and other major areas as well as it being the preferred choice by the South African Reserve Bank (SARB) when carrying out inflation targeting