

# AN EMPIRICAL INVESTIGATION INTO THE CORRELATION BETWEEN RAND CURRENCY INDICES AND CHANGING GOLD PRICES

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## Abstract

This study sets out to investigate the relationship between two South African Rand currency indices, ZARX and RAIN, in relation to the gold prices. The ZARX is computed with the formula used to determine the USD currency index (USDX) with the latter being developed by the JSE. Albeit sets of variables have been investigated to determine if any long term relationships exist using the theory of co-integration. The findings suggest that there is no co-integrating relationship between the South African Rand currency indices and the gold price changes over the research period.

**Keywords:** ZARX, Correlation, Gold Price, Unit-Root Test, Co-integration, Granger Causality

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## INTRODUCTION

After the successful introduction of the United States Dollar Currency Index (USDX) in 1973, various authors proposed the implementation of currency indices that are tradable on their regional exchanges. One such suggestion was made by Liu and Han (2010:1) who demonstrated a similar approach which could be used to create a Chinese Yuan index (CHYX) with possible benefits for investors. One benefit of the USDX mentioned by Krull and Rai (1992) is that it brings diversification benefits that investors would receive from including a currency index in a portfolio of foreign currencies. Another diversification advantage from the use of the USDX is the negative correlation with the gold price during periods of market uncertainty (Liu and Han, 2010:3). The most fundamental benefit of using an index is that it helps the investor determine the movement of a market from one day to the next.

Over the past decade, financial markets have been adversely affected by two major black swan events. The first was in 2001 with the "9/11" event and the second in 2008 with the sub-prime crisis. These two events have resulted in investors moving from risky asset classes and choosing more risk adverse asset classes. Foreign currencies and gold can be regarded as two sides of the same coin. Foreign currencies are extremely volatile with their value changing every few seconds in contrast to gold which is regarded as a safe haven asset during times of market turbulence. The USD is one of the foreign currencies that can be regarded as one of the most significant variables causing the gold price to change. By including the USD and other macroeconomic

effects into the ZARX and RAIN, an analysis can be done to determine the price of gold over time.

On 08 November 2010 the Johannesburg Stock Exchange decided to introduce the Rand currency index (RAIN) in the South African currency derivatives market. The RAIN is calculated as an inverse arithmetic trade-weighted currency index which accounts for the trade-weights of South Africa's five major trading partners. Other advantages of these South African Rand currency indices is that they provide investors with a more accurate measure of the foreign currency exposure of, for instance, South Africa in relation to its major trading partners. This provides an estimate of foreign currency exposure that may be a more reliable measure of volatility than only looking at the USD/ZAR exchange rate. This can be done by analysing and predicting the trend of these currency indices. As gold prices also describe trends, it may, from a business perspective be important to determine if these trends in gold prices are in any way related to the trends in the Rand currency indices. A better understanding of future volatility may help businesses better hedge exchange rate volatility.

## OBJECTIVE OF THE RESEARCH

The main objective of this research is to determine the relationship between the RAIN index introduced by the JSE and the gold price and a rand index (ZARX), calculated in similar fashion to the USD index (USDX). The ZARX is compiled for the sake of this research as an alternative index to the RAIN. This is done to overcome a disadvantage in the way the RAIN is determined. This allows more accurate comparisons to be made with the USDX in the South

African currency market. Indices are used extensively in financial markets as indicators of financial price changes from one day to the next. It therefore makes sense to compare the gold price and these indices.

As the gold price can be seen as an indicator of the sentiment of investors globally about the state of the dollar as an important currency in the international business environment, it is important to understand how it would correlate with a South African currency index based on the dollar. This information may be helpful in setting up a currency hedging strategy. As the dollar is an important currency influencing the sentiment and trends of all other currencies, it speaks for itself that such a comparison could prove meaningful. The analysis for SA can also be compared with previous research which may confirm or contradict results of international studies.

### **BRIEF OVERVIEW OF THE RELATIONSHIP BETWEEN THE USDX AND THE GOLD PRICE**

A large variety of literature exists examining the relationship between the USD and the gold price. However, it seems only a limited number of studies have focused on the long run relationship between the changes in the gold price and the USDX.

Huang and Wang (2010:724) cited studies by Chen (2006); Shuguang and Hu (2008) that found that a negative correlation existed between the USD, USDX and the gold price. Ismail, Yahya and Shabri (2009:1509) on the other hand used the USDX to forecast the price of gold with other economic variables included using multiple linear regression models. It was found that the forecast power of the USDX was only obtained when combining it with other economic variables, which makes sense. This presented another limitation when analyzing the relationship between the USDX and changes in the gold price. In contrast to the above findings, Huang and Wang (2010:724) analyzed the relationship between the USDX and the gold price. They found that there was no co-integration in the long-term and were able to conclude that the gold price was influenced by many market factors. All these limitations and mixed results reinforced the need for studies to be conducted on the topic with significant implications for the South African market.

Min and Yanbin (2010) conducted a study on the effect that the behavior of the USDX relative to changing oil prices. They drew three conclusions from the study. Firstly, it was found that negative long run correlations exist between the two. Secondly, using error correction, the long run equilibrium of USDX did not reflect in the short term spot oil prices changes. Thirdly, using variance decomposition they identified numerous other variables that had an effect on the spot oil prices. For these reasons the changing

oil price instead of changing gold price has been considered for further research.

### **RESEARCH METHODOLOGY**

Mainly two comparisons were done for this research. The ZARX was compared to the gold price and secondly the RAIN was also compared to the gold price. Since the ZARX calculation was based on monthly data, monthly gold price data were obtained from the IMF (2010). The second set of variables used was the RAIN with the gold price. The JSE calculates the RAIN on a daily basis from the base year which is 1 January 2006. In order to make comparison possible, daily gold price data were obtained from 3 January 2006 to 7 December 2010 from the BFA McGregor database.

In the South African market, gold prices are quoted in terms of the US dollar. The gold prices in US dollars terms have been converted to ZAR units using US dollar/ZAR exchange rates. These monthly and daily cross rates were obtained from the Quantec (2011) database from 01 January 1980 and the BFA McGregor (2005) database from 3 January 2006.

Co-integration theory was used in this study to determine if the causal effect of changes in the South African currency indices relative to the changes in gold prices (ZAR). These co-integration tests were complemented with Pairwise Granger causality tests to determine the direction of causality amongst the pairs of variables.

This section provides a brief overview of the USDX and the use of its pricing convention to create a ZARX.

Redfield (1986:625) provides an inverse geometric trade-weighted formula to determine the USDX at time  $t$ . The USDX is quoted in indirect terms or inversely so that the index is not correlated with the underlying foreign currencies. This allows investors to hedge any adverse effects of the USD, but to still enter into positions and make profits from the underlying foreign currencies. Another characteristic of the USDX is that it is trade-weighted by ten major trading partners. Since the inception of the USDX, the trade-weights were adjusted only once. This adjustment occurred when the euro replaced the EMU member countries.

The ZARX is calculated for the sake of this study as an inverse geometrically trade-weighted value with the formula proposed by Redfield (1986:625). These trade-weights are obtained for the six major trading partners with the weights not being adjusted in a similar fashion to the USDX to obtain longitudinal comparisons (Economy Watch, N.D). The method used to calculate the normalized trade-weights from South Africa's six trading partners is shown in the table below:

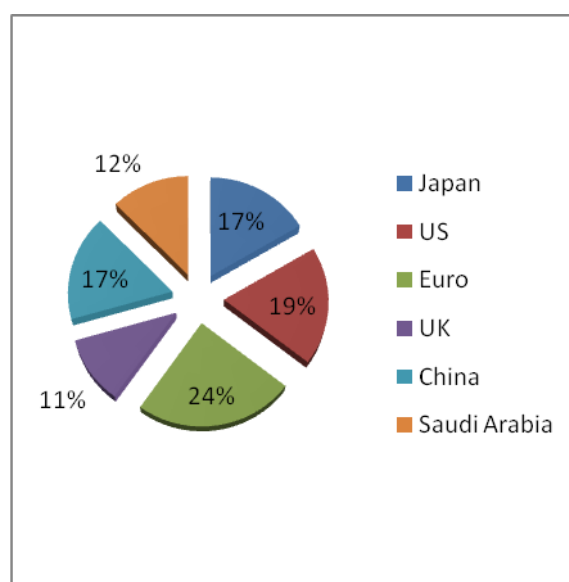
**Table 1.** Normalised Trade-Weights of South Africa's Main Trading Partners (2009)

Trading Partners	Export (%)	Import (%)	Average Trade	Normalised Trade
Japan	11.10	5.50	8.30	0.17
USA	11.10	7.90	9.50	0.19
Euro	13.20	11.20	12.20	0.24
UK	6.80	4.00	5.40	0.11
China	6.00	11.10	8.55	0.17
Saudi Arabia	-	6.20	6.20	0.12
Other	51.80	54.10	49.85	
<b>Total</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>	<b>1.00</b>
Total without other	48.20	45.90	50.15	

Source: Economy Watch (N.D.)

Recent import and export data for 2009 was used. The rationale behind this is that South Africa can be seen as a developing or emerging economy. This

allows for a better representation of the foreign economic climate using recent trade data.

**Figure 1.** Normalized Weights Presented Graphically (2009)

Source: Own Compilation

The RAIN is calculated by the JSE is an inverse arithmetic trade weighted currency index. RAIN is trade-weighted based on the six major trading partners. The trade-weights are updated annually with data provided by the South African Revenue Service. The RAIN computation takes into account the contract sizes of each of the five underlying trading partners' foreign currencies. Secondly the index is calculated at time  $t$  from the rebalancing date of the trade-weights at time  $T$  (JSE, 2010a, b and c). To obtain an equal comparison of ZARX and RAIN, both currency indices were initiated on 01/01/2006 using an index base value of 10 000.

## RESEARCH FINDINGS

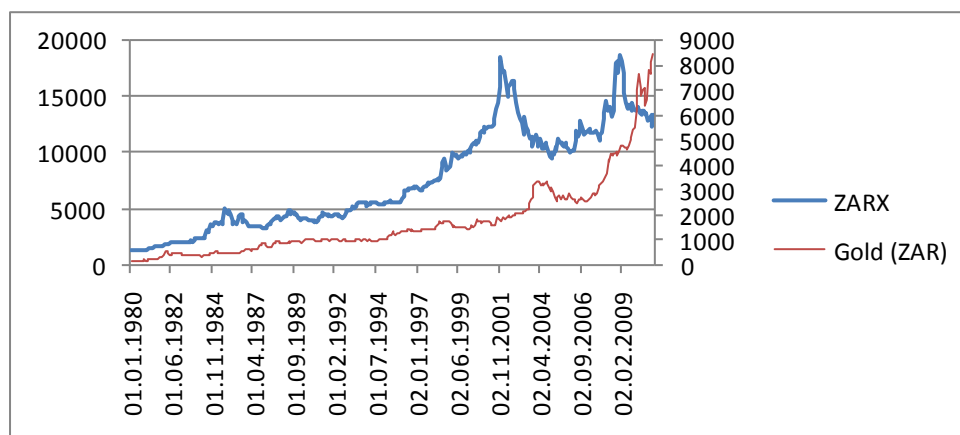
A graphical representation of the ZARX and RAIN with a brief discussion thereof follows. Unit root tests, granger causality as well as co-integration regressions were conducted in E-views to determine if co-integrating relationships exists amongst these currency indices. This is also presented and briefly discussed.

Figure 1 exhibits a strong positive lagged correlation between ZARX and the gold price during two periods of market uncertainty. In 2001, ZARX shows a large upward trend with an increase in the gold price only occurring towards the end of 2004. The gold price shows a lagged change relative to the

ZARX. This may signify a flight of investors possibly to the gold commodity market due to the inherent dollar weakness after increased volatility and uncertainty. In 2008, a similar scenario existed when ZARX showed an increase. Gold prices once again lagged this ZARX change, with an eventual spike in the gold price only occurring in 2010 again due to a possible flight to gold. From a South African investor's perspective, during periods of financial uncertainty, the foreign currencies of the trading

partners (which are developed markets) making up the rand currency index, appreciated resulting in a weakening of the USD/ZAR exchange rate. This ultimately caused gold prices quoted in US dollars terms to increase and become more expensive in rand terms due to the weaker rand. This may be one possible explanation for the strong positive lagged correlation between the South African rand currency index and the gold price changes.

**Figure 2.** Movement of ZARX in relation to the Changing Gold Price

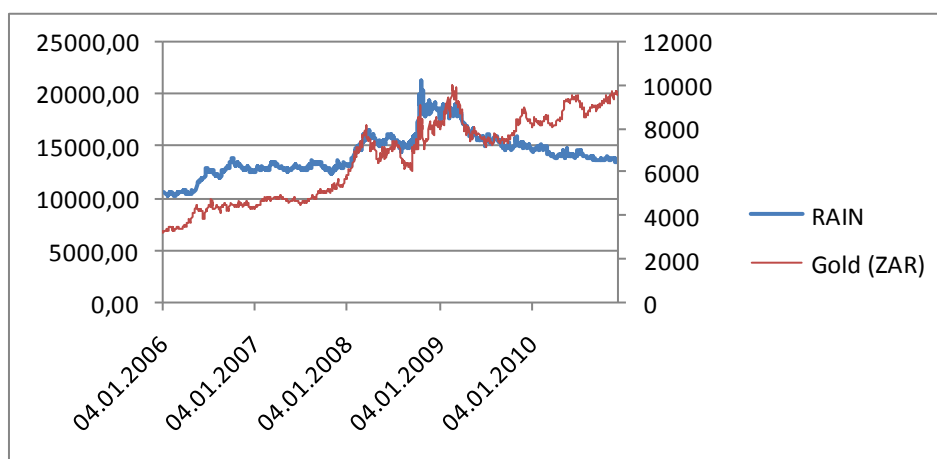


Source: IMF and Quantec database

The RAIN calculated by the JSE in Figure 2 removes this lagged effect with increases coinciding during 2008/2009 period which may be due to the annual resetting of the trade weights. The RAIN

calculated in Figure 2 takes a closer look at the second period of market uncertainty shown by the second spike/ upward trend of ZARX in Figure 1.

**Figure 3.** Movement of RAIN in relation to the Changing Gold Price



Sources: IMF and JSE (2010a, b, c)

From Figures 1 and 2 above, it may be concluded that investors may be indifferent of the increased gold prices during periods of market uncertainty due to the safe haven benefits that they receive from holding this commodity. The increased

demand puts pressure on spot gold prices in the market which will amplify the upward trend. After a period of greater market uncertainty, the majority of foreign trading partner's currencies depreciated relative to the South African rand causing the rand to

strengthen and gold prices to decline. This decline in the gold price created a greater demand for gold in the periods after this decline. This again gave rise to a renewed upward trend.

Another important variable that needs to be considered is the level of interest rates. Investors use the risk-free interest rate as an opportunity cost measure to price instruments enabling them to decide how to seek alternative investment classes that may yield more than the risk-free interest rate. At present, the level of risk-free interest rates was lowered by the central bank after the last period of greater market uncertainty and high levels of credit, to stimulate consumer spending and to help increase economic activity. As a result of the low risk-free interest rates, investors started looking for alternative risk-free securities which may offer higher returns at a lower risk. In this case they turned to gold as one of the safer higher yielding assets and currently also to bonds.

To summarize, in Figure 1, the gold price trend lagged ZARX's trend. RAIN calculated in Figure 2 by the JSE removed this lag with an identical spike of gold prices and RAIN occurring during 2008/2009. The removal of this lag meant that when RAIN is in a downward trend, gold prices should follow. In Figure 2 this was also the case when gold prices declined between 2009 and 2010, with an upward trend thereafter. This upward trend could be the outcome of the above mentioned factors.

A unit root test was conducted on the monthly and daily gold price data in rand terms (GOLDZAR) to test whether the data is stationary. The p-values in Table 1 and Table 2 suggest that the null hypothesis of GOLDZAR should be rejected, implying that the price of gold in rand terms displays a tendency in the long term. This implies therefore that difference operator should rather be used as only stationary time-series can be compared to determine if there is co-integration.

**Table 2.** Unit Root Test on Monthly Gold Prices

Null Hypothesis: GOLDZAR has a unit root  
 Exogenous: **Constant**  
 Lag Length: 6 (Automatic - based on SIC, maxlag=16)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	5.445534	1.0000
Test critical values: 1% level	-3.448012	
5% level	-2.869219	
10% level	-2.570928	

\*MacKinnon (1996) one-sided p-values.

Source: Own Compilation

**Table 3:** Unit Root Test on Daily Gold Prices

Null Hypothesis: GOLDZAR has a unit root  
 Exogenous: **Constant**  
 Lag Length: 0 (Automatic - based on SIC, maxlag=22)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-1.001703	0.7545
Test critical values: 1% level	-3.435554	
5% level	-2.863726	
10% level	-2.567984	

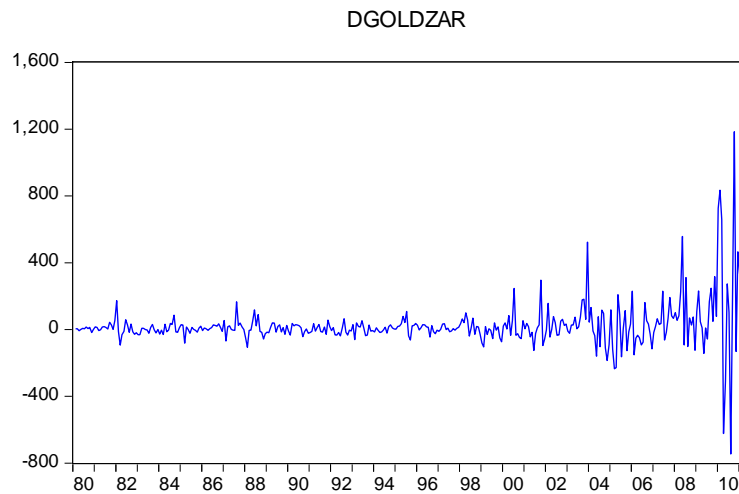
\*MacKinnon (1996) one-sided p-values.

Source: Own Compilation

To obtain stationary time series required the differencing of the monthly and daily gold price data.

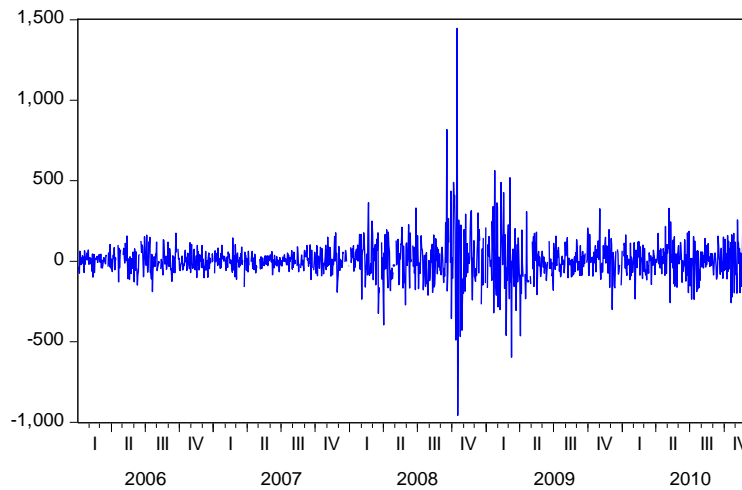
The differenced monthly and daily gold prices are shown in Figures 3 and 4 below.

**Figure 4.** Monthly Differenced Gold Prices



Source: Own Compilation

**Figure 5.** Daily Differenced Gold Prices  
D(GOLDZAR)



Source: Own Compilation

Once the differenced data have been obtained, unit root tests were performed to determine if a stationary time-series exists. Using Augmented Dickey-Fuller test statistics, the p-values from

tables 3 and 4 indicate that the null hypothesis must not be rejected as the gold prices contain a unit root. This proves that the gold price data is now stationary which is shown in Tables 3 and 4.

**Table 4.** Unit Root test on Differenced Monthly Gold Prices

Null Hypothesis: DGOLDZAR has a unit root  
Exogenous: **None**  
Lag Length: 10 (Automatic - based on SIC, maxlag=16)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-2.564507	0.0102
Test critical values:		
1% level	-2.571383	
5% level	-1.941704	
10% level	-1.616111	

\*MacKinnon (1996) one-sided p-values.

Source: Own Compilation

**Table 5.** Unit Root test on Differenced Daily Gold Prices

Null Hypothesis: D(GOLDZAR) has a unit root  
 Exogenous: None  
 Lag Length: 0 (Automatic – based on SIC, maxlag=22)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-36.83058	0.0000
Test critical values: 1% level	-2.566937	
5% level	-1.941094	
10% level	-1.616518	

\*MacKinnon (1996) one-sided p-values.

Source: Own Compilation

This approach mentioned above has been repeated for the ZARX and RAIN in tables 5 and 6 and shown graphically in Figures 5 and 6.

**Table 6.** Unit Root Test on ZARX

Null Hypothesis: ZARX has a unit root  
 Exogenous: Constant  
 Lag Length: 0 (Automatic - based on SIC, maxlag=16)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-0.995677	0.7558
Test critical values: 1% level	-3.447722	
5% level	-2.869092	
10% level	-2.570860	

\*MacKinnon (1996) one-sided p-values.

Source: Own Compilation

**Table 7.** Unit Root Test on RAIN

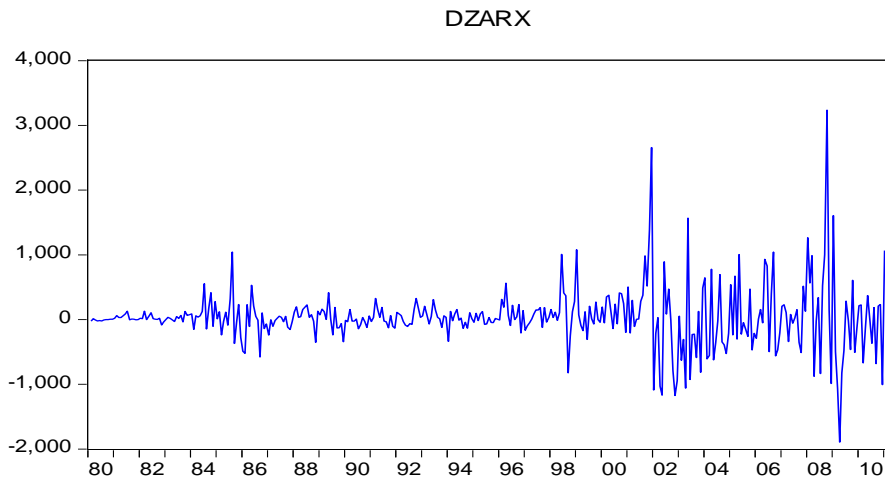
Null Hypothesis: D(RAIN) has a unit root  
 Exogenous: None  
 Lag Length: 1 (Automatic - based on SIC, maxlag=22)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-27.20250	0.0000
Test critical values: 1% level	-2.566994	
5% level	-1.941101	
10% level	-1.616512	

\*MacKinnon (1996) one-sided p-values.

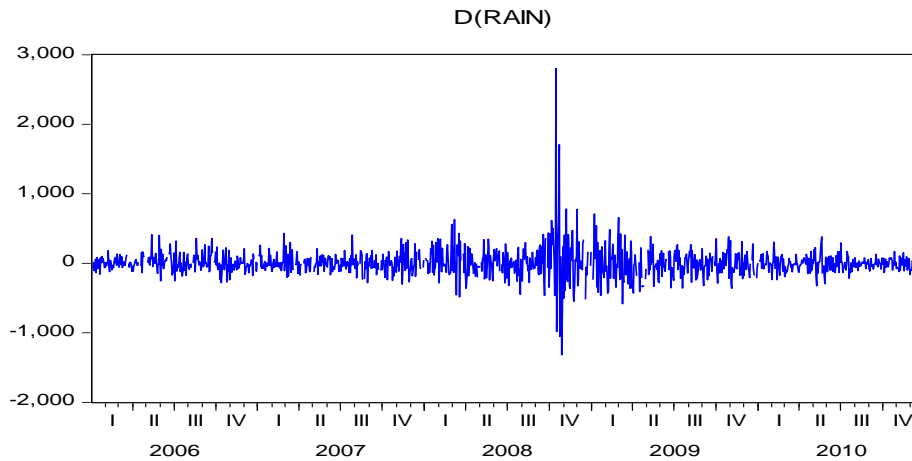
Source: Own Compilation

**Figure 6. Monthly Differenced ZARX**



Source: Own Compilation

**Figure 7. Daily Differenced RAIN**



Source: Own Compilation

**Granger Causality Tests on ZARX and RAIN**

Pairwise Granger Causality Tests were conducted on the ZARX, RAIN and gold prices to determine the causality of the gold price and the ZARX and vice versa. From tables 7 and 8 it is evident that both null hypotheses should not be rejected. This suggests that

there is no directional causality amongst any of the variables. The lower p-value of 0.6647 in Table 7 suggests that the gold price has greater causal effect compared to ZARX than ZARX compared to the gold price. The opposite is true in Table 8 with the causal effect of RAIN having the lower p-value.



**Table 8.** Pairwise Granger Causality Tests: ZARX and Monthly Gold Price

Pair wise Granger Causality Tests

Date: 04/20/11 Time: 09:51

Sample: 1980M01 2011M01

Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
GOLDZAR does not Granger Cause ZARX	371	0.40894	0.6647
ZARX does not Granger Cause GOLDZAR		0.05411	0.9473

Source: Own Compilation

**Table 9:** Pairwise Granger Causality: Rain and Daily Gold Prices

Pairwise Granger Causality Tests

Date: 04/21/11 Time: 17:32

Sample: 1/03/2006 12/07/2010

Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
GOLDZAR does not Granger Cause RAIN	1172	0.65417	0.5201
RAIN does not Granger Cause GOLDZAR		1.16530	0.3122

Source: Own Compilation

**Co-Integration Tests: ZARX and RAIN**

Both the ZARX and the monthly gold price data contain unit roots when the data is differenced into stationary time series. These stationary time series can now be compared with each other to determine if any

long run co-integrating relationships exists. This co-integrated relationship has been performed by regressing the gold price and a constant on the ZARX. From the regression output below, both the constant and gold price are statistically significant.

**Table 10.** Co-integration Regression: ZARX and Gold Prices

Dependent Variable: ZARX

Method: Least Squares

Date: 04/20/11 Time: 09:31

Sample: 1980M01 2011M01

Included observations: 373

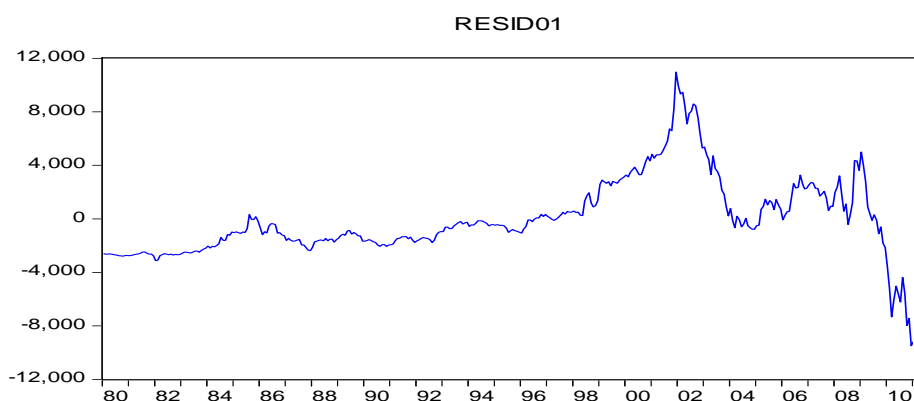
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3635.326	223.5502	16.26179	0.0000
GOLDZAR	2.229691	0.097175	22.94509	0.0000
R-squared	0.586619	Mean dependent var		7445.070
Adjusted R-squared	0.585505	S.D. dependent var		4490.343
S.E. of regression	2890.941	Akaike info criterion		18.78190
Sum squared resid	3.10E+09	Schwarz criterion		18.80293
Log likelihood	-3500.824	Hannan-Quinn criter.		18.79025
F-statistic	526.4773	<b>Durbin-Watson stat</b>		<b>0.036264</b>
Prob(F-statistic)	0.000000			

Source: Own Compilation

To determine if a ZARX co-integrating relationship exists relative to the gold price, unit root tests were conducted on the residuals from the regression in Table 8. This is shown graphically in

Figure 7 and reported in table 10. This was also done for RAIN and the daily gold price data in Tables 11 and 12 with the error terms from the regression shown in Figure 8.

**Figure 8.** Residuals from Co-integration Regression: ZARX and Gold Price



Source: Own Compilation

**Table 11.** Unit Root Test on Residuals from ZARX and Gold Price Regression

Null Hypothesis: RESID01 has a unit root  
 Exogenous: Constant  
 Lag Length: 9 (Automatic - based on SIC, maxlag=16)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-1.817461	0.3718
Test critical values:		
1% level	-3.448161	
5% level	-2.869285	
10% level	-2.570963	

\*MacKinnon (1996) one-sided p-values.

Source: Own Compilation

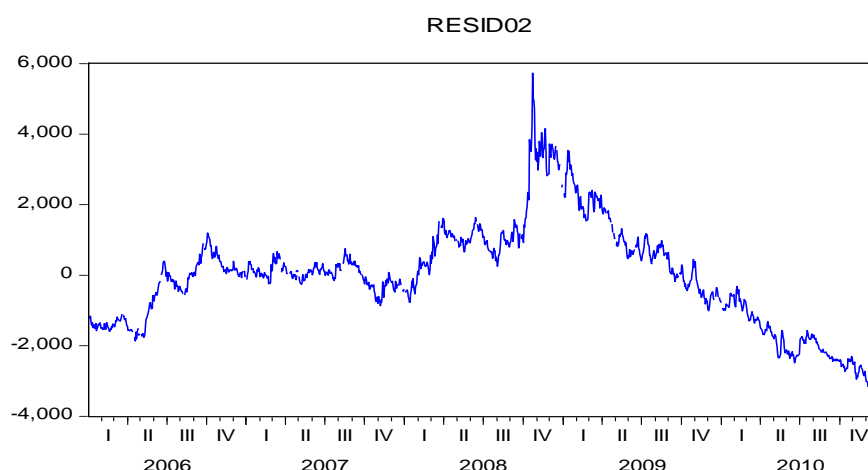
From Table 9, the p-value using the Augmented Dickey-Fuller test statistic indicates that the null hypothesis of the residuals containing a unit root must be rejected. This can also be seen in Figure 7 with the residuals not being a stationary time series. Thus, no co-integrating relationship exists between the ZARX and the gold price in rand terms. A possible reason for the differences in the two R squared figures shown in

tables 9 and 11 could be because the trade-weights of the foreign currencies comprising of RAIN being updated annually which may give rise to a material change especially if major changes took place over the period of a year. Another possible reason could be due to the contract sizes factored into the terminal value of the RAIN at the rebalancing date of the index.

**Table 12.** Co-integration Regression: RAIN and Gold Prices

Dependent Variable: RAIN  
 Method: Least Squares  
 Date: 04/20/11 Time: 19:51  
 Sample: 1/03/2006 12/07/2010  
 Included observations: 1244

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	9270.839	145.4235	63.75062	0.0000
GOLDZAR	0.752301	0.021106	35.64343	0.0000
R-squared	0.505663	Mean dependent var		14249.06
Adjusted R-squared	0.505265	S.D. dependent var		2031.354
S.E. of regression	1428.802	Akaike info criterion		17.36867
Sum squared resid	2.54E+09	Schwarz criterion		17.37691
Log likelihood	-10801.31	Hannan-Quinn criter.		17.37177
F-statistic	1270.454	<b>Durbin-Watson stat</b>		<b>0.012272</b>
Prob(F-statistic)	0.000000			

**Figure 9.** Residuals from Co-integration Regression: RAIN and Gold Price

Source: Own Compilation

**Table 13.** Unit Root Test on Residuals from RAIN and Gold Price Regression

Null Hypothesis: RESID02 has a unit root  
 Exogenous: None  
 Lag Length: 0 (Automatic – based on SIC, maxlag=22)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-1.017440	0.2781
Test critical values:		
1% level	-2.566879	
5% level	-1.941086	
10% level	-1.616523	

\*MacKinnon (1996) one-sided p-values.

Source: Own Compilation

The unit root test conducted on the residuals from the RAIN and gold price regression resulted in a p-value of 0.2781. As the p-value is greater than the 5 % level of significance, the null hypothesis that the residuals contain a unit root must be rejected. Accordingly, no co-integrating relationship exists amongst the RAIN and the changing gold price.

## SUMMARY AND CONCLUSIONS AND RECOMMENDATIONS

When the majority of foreign currencies comprising of the rand currency index appreciate relative to the South African rand, it results in an increase in the rand currency index and vice versa. During periods of extreme market uncertainty, the rand currency indices experience relatively large increases. An example is shown in Figure 1 when ZARX had large increases in 2001 and 2008. Another example is RAIN in Figure 2 with a sharp increase over the 2008 period. The reason for this increase in rand currency indices during periods of market uncertainty is due to the inverse quotation of the foreign currencies underlying this index. This inverse quotation allows investors to

more accurately manage foreign currency exposure in primarily two ways.

Firstly, investors could enter into derivative positions on the Rand currency indices. By entering into these positions investors can remove exposure to the rand whilst still entering into exposure positions on the underlying foreign currencies making up the index.

Secondly, investors in the foreign exchange market could use RAIN to determine when there is a lot of uncertainty in the market and whether to choose to move to commodity markets. If a decline in the RAIN is expected, then the gold price should change in the opposite direction meaning investors will move to gold. Alternatively, investors should then plan to hedge against the currency volatility. One type of commodity market is the gold market which provides a natural hedge against adverse movements in currencies which investors regard as a safe haven.

Assuming investors move from the foreign exchange market to the gold market during periods of extreme market uncertainty, there should be a positive correlation amongst changes in the rand currency indices and the changing gold price.

The main findings of this study underline the following:

- Both currency indices and gold prices contain upward trends which have to be differenced to obtain stationary time series, which can be compared using co-integration theory.
- ZARX has been calculated as an inverse geometric average in comparison to RAIN which has been calculated as an inverse arithmetic average of the South African Rand. The former contains dynamic hedging characteristics, while the latter contains static currency hedging characteristics.
- A positive, lagged correlation exists between the changing gold prices and ZARX and RAIN currency indices. The RAIN may help to determine when to move to gold.
- Analyzing the stationary trend of the error terms using unit root tests indicated that no co-integration exists between changing gold prices and the ZARX and RAIN currency indices.
- The creation of a portfolio of currencies into a single currency index does not correlate with changing gold prices.

When looking at tables 9 and 11, it becomes apparent that investors should not base decisions solely on the positive correlation relationship between changes in rand currency indices and the gold price. A correlation measure in these tables is represented by the R squared. As no co-integrating relationship exists for either of the South African Rand currency indices in relation to the changing gold prices, the R squared measure could be a function of spurious correlations. This can give rise to unreliable forecasting and wrong decision making if only the macroeconomic environment of South Africa's trading partners are considered.

Some recommendations for further research include:

- The use of the Absa NewRand Index opposed to South African Rand Index.
- The use of the Absa NewGold Index, gold share prices instead of the gold price per bullion.
- Use co-integration tests to analyze which sectors of the ALSI have an effect on ZARX and RAIN in the long term.
- Test the co-integration of other types of changing commodity prices such as oil.

- Use oil price data which is the average of U.K., Brent, Dubai and West Texas Intermediate.
- Include foreign direct investment (FDI) as a weight in the calculation of the ZARX and compare with RAIN.
- Include a double export weight in the calculation of ZARX trade weights to account for any third market effects. The trade weights in this study only account for the international position of the Rand in relation to its trading partners.

## References

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