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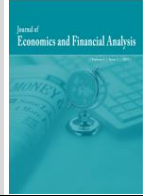
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The Dynamic Linkages among Gold Prices, Stock Prices, the Exchange Rate and Interest Rate in South Africa

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Abstract

The fundamental aim of this study is to examine the intricate interplay among gold prices, interest rates, exchange rates, and stock price indices within the context of South Africa. To achieve this, both a conventional Vector Autoregression Model and a Bayesian Vector Autoregression Model were applied to monthly data spanning from June 1995 to December 2022. The findings indicate that a positive shock in stock prices triggers positive reactions in exchange rates, gold prices, and interest rates. Conversely, a positive shock in interest rates induces negative reactions in both gold prices and stock prices. Moreover, a positive shock in gold prices elicits negative responses in both interest rates and stock prices. Additionally, a positive shock in exchange rates prompts positive reactions in gold prices and interest rates, while simultaneously resulting in a negative response in stock prices.

Keywords: Exchange Rate; Interest Rate; Gold Market; Stock Market; Bayesian Analysis; Vector Autoregression.

JEL Classification: C11, E3, F31, G11, Q30.

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1. Introduction

The primary aim of this paper is to assess the dynamic relationship among the price of gold, interest rates, the exchange rate and the stock price indices in South Africa. Historically, gold was considered the foundation of monetary systems across the world in which monetary authorities held gold reserves in order to convert money into a specified quantity of gold demand. In modern times, nations across the world are implementing a floating exchange rate system whereby currencies are fiat money and the money supply is infinitely expandable while the gold price is determined by factors of demand and supply.

Accordingly, the demand for gold is driven by a number of factors that are impacted by the macroeconomic conditions of a particular country as well as globally. Gold is believed to be an important asset class and has been used as a safe haven and counter-cyclical investment tool. To this end, investors have considered gold as a hedge against stock movements. Moreover, Ghosh et al. (2004) find that gold is also a safe haven against other forms of uncertainty such as exchange rate fluctuations.

As a result of the above, it becomes important to study the dynamic relationship among the prices of gold, stock price indices and the exchange rate as these can have an impact on investor expectations in a developing country such as South Africa. In addition, this article assessed the dynamic relationship between the price of gold and interest rates. Interest rates are a common monetary policy tool used by monetary authorities in order to respond to inflation fluctuations and stabilize the economy. Monetary authorities employ interest rates as a monetary policy tool whilst considering inflation, the investment level as well as fluctuations in the exchange rate, all which have links to the price of gold.

Given the above, this article employed both standard Vector Autoregression modelling as well as Bayesian Vector Autoregression modelling which is considered to be more superior than standard Vector Autoregression model as it typically addresses the issue of over fitting by incorporating prior information about parameters along with sample information.

To this end, priors act as restrictions on the coefficients which leads to the shrinking and sharpening of the estimates. Bayesian Vector Autoregressions are thus believed to result in more accurate estimates when compared to standard Autoregression models (Litterman, 1986).

The rest of this study is organized as follows: Section 1 provided the introduction to the study and objective. Section 2 outlines the existing literature.

Section 3 details the empirical strategy chosen. Section 4 discusses the empirical findings. Lastly, section 5 concludes the study.

2. Literature Review

Existing literature contains a number of studies that assess the relationships between a number of macroeconomic and financial variables, which include gold prices, stock prices, the exchange rate and interest rates for various countries. Wang & Chueh (2013) aimed at showing that in the short-term, both gold and crude oil prices, positively influenced each other. To achieve this, Wang & Chueh (2013) explored the short-term and long-term interactions between interest rates, US Dollars, the price of oil and the price of gold using the threshold cointegration technique on daily data from 2 January 1989 to 20 December 2007. The empirical findings revealed that interest rates have a negative influence on future gold prices and a positive influence on future crude oil prices (Wang & Chueh, 2013).

Sinton (2014) assessed the cointegration relationship and the causality relationship between the price of gold, exchange rate changes and the Jakarta Composite Index using daily data for the period 2 January 2004 to 30 December 2013. Sinton (2014) employed cointegration and granger causality tests and found that the price of gold was affected by various factors including the exchange rate and the Jakarta Composite Index.

Batten et al. (2014) examined the long-term dynamic relationship between inflation and the price of gold using monthly data for the period January 1985 to June 2012. Using three sets of cointegration tests, Batten et al (2014) found that there is no cointegration between the price of gold and the inflation rate once the volatile period of the 1980s was excluded from the data.

Moreira et al. (2015) examined how Brazil's monetary policy's credibility is dynamically related to its macroeconomic performance. Using monthly data from the period January 2005 to July 2012, Moreira et al. (2015) employed a Bayesian Vector Autoregressive model with Litterman/Minnesota priors. Moreira et al. (2015) found results that suggest that Brazil's monetary policy's credibility gains (and losses) are affected by inflation rate shocks, while the higher the credibility, the easier the control of inflation expectations.

Abdullah & Bakar (2015) aimed to determine a forecasting model of the price of gold in relation to the rate of interest from 1971 to 2013 that would aim to benefit wealth managers in the forward interpretation of capital market expectations. In doing so, Abdullah & Bakar (2015) modelled a full population of

the price of gold with the rate of interest for purposes of assessing the impact of a change in the interest rate on the change in the price of gold and vice versa. Abdullah & Bakar (2015) found that the price of gold and real interest rates were inversely related.

Aleemi et. (2016) examined the short and long-run dynamics of gold prices, interest rates and exchange rates in Pakistan. Using annual time series data for the period 1975 to 2013, Aleemi et. (2016) employed the Johansen Cointegration and Vector Error Correction specifications. The empirical results suggested that the price of gold and the interest rate was significantly positively related with inflation in the long run. In addition, the results revealed that the exchange rate was insignificant to impact inflation over the length of the study.

Jain & Biswal (2016) assessed the relationship between the global prices of gold, crude oil, the Us Dollar-Indian Rupee exchange rate, and the stock market in India. Using daily data from the period 2006 to 2015, Jain & Biswal (2016) employed a Dynamic Conditional Correction GARCH model and found that the fall in gold prices and crude oil prices leads to the decline in the value of the Indian Rupee and the benchmark stock index.

Balcilar et al. (2017) employed nonparametric causality in quantities test in order to assess the predictability of mean and variance changes in gold prices based on inflation for G7 countries. Using monthly data from December 1979 to August 2016, Balcilar et. (2017) found support that suggests that gold serves as a hedge against inflation, but only in mid-quantile ranges. In addition, Balcilar et al. (2017) found that gold does not serve as a hedge against inflation during periods when gold market prices changes are very low and/or very high which are respectively quiet and volatile periods.

Zhu et al. (2018) assessed the gold price dynamics under various inflation regimes and stock market conditions using United Kingdom and United States of America index linked treasury bond data. To do so, Zhu et al. (2018) modelled the price of gold against data for inflation expectations, exchange rates and stock market returns. Zhu et. (2018) found that gold lost its role as an inflation hedge after May 1997 in the United Kingdom and after 2003 gold did not act as an inflation hedge in the United States of America which supports the view that gold is an inflation hedge only in periods of high inflation and inflation expectations.

Akbar et al. (2019) investigated the dynamic linkages among the price of gold, stock prices, the exchange rate and the interest rate using monthly data from the Pakistan economy. Using monthly data from January 2001 to December 2014, Akbar et. (2019) compared the performance of the classical Vector

Autoregressive Model and the Bayesian Autoregressive Model under four different priors. Akbar et al. (2019) found that stock prices and the value of the Rupee move downward during periods of recessions, however, gold becomes more attractive to hold. In addition, the empirical results suggested that the direct relationship between nominal interest rates and the exchange rate in Pakistan conform to the International Fisher effect theory.

Singhal et al. (2019) examined the relationship between oil prices, international gold prices, the exchange rate and the stock market index in Mexico. Singhal et al. (2019) employed an Autoregressive Distributed Lag (ARDL) bound testing cointegration methodology on daily data from the period January 2006 to April 2018. The empirical findings indicated that international gold prices positively affect the stock price in Mexico whereas the price of oil impacts the stock price negatively. In addition, the price of oil negatively impacts the exchange rate in the long run.

Ansari & Sensaram (2019) investigated the effect of US monetary policy, prices of oil and the price of gold on stock indices of BRICS countries. Using a Vector Autoregression model to study the indices of BRICS countries over the period of 1996 to 2018, Ansari & Sensaram (2019) found that the Bombay Sensex responds positively to the Federal Funds rate, the FTSE JSE of Johannesburg South Africa responds negatively to shocks in oil prices while the stock indices of Russia and Brazil respond positively to gold price changes.

Kumar et al. (2021) examined the relationship among the price of natural gas, the price of crude oil, the price of gold, the exchange rate and the stock market index in India using the Nonlinear Autoregressive Distributed Lag (NARDL) model on weekly data for the period January 1997 to June 2019. The empirical results revealed that the price of gold, the price of natural gas and the stock market have an asymmetrical effect on the price of crude oil in the long run as well as the price of crude oil having an impact on the price of natural gas in the short run. Further, the empirical results revealed that the exchange rate has no impact on the prices of natural gas and crude oil in both the short and long run (Kumar et., 2021).

Yildirim et al. (2021) assessed the causal relationship between the interest rate and the price of gold in Turkey. Using the standard Granger causality methodology over the period 1 June 2000 to 1 July 2017, Yildirim et al. (2021) found that the price of gold depends on daily announcements, demand, and supply whereas the interest rate depends on factors such as monetary policy, the inflation rate and different macroeconomic parameters. Further, Yildirim et al. (2021) found that the price of gold and the interest rate in Turkey have a significant causality.

Cepri et al. (2021) examined the impact of uncertainty shocks on Real Estate Investment Trusts (“REITs”) returns over a monthly period from January 1971 to December 2015, and sub-samples January 1972 to June 2009 and July 2009 to December 2015. Using a proxy Structural Vector Autoregressive model, Cepri et al. (2021) find that uncertainty shocks generate a larger negative impact on REITs returns over the post-global financial crisis period.

Cepri & Gupta (2021) assessed how monetary policy shocks affected the stock market in the United States of America. Using monthly data from the period November 1978 to September 2017, Cepri & Gupta (2021) employed a Vector Autoregressive model and found that compared to the low investor sentiment regime, the negative reaction of stock returns to contractionary monetary policy shocks tended to be stronger in States associated with higher investor sentiment.

Shaikh & Priyanka (2022) assessed the effects of the Reserve Bank of India’s Monetary Policy Committee on the Indian gold market considering scheduled Monetary Policy Committee meetings. Shaikh & Priyanka (2022) considered 98 Monetary Policy Committee meetings and essential government gold policies and regulations for the period 2005 to 2020. The empirical findings revealed that a decrease in the price of gold surrounding the meetings implied the tightening of monetary policy from a neutral state. In addition, Shaikh & Priyanka (2022) found that the Indian Rupee/US Dollar exchange rate plays a key role in the price of gold.

3. Methodology

3.1. Data

The main purpose of this study is to examine the dynamic linkages between the price of gold (G), the foreign exchange rate (E), the stock prices (S), and interest rates (I). To this end, this study employed data in the form of the London price of gold in South Africa Rands (ZAR), the foreign exchange rate in terms of US Dollar (\$) to South African ZAR, the FTSE JSE All Share Index and the South African Reserve Bank rediscount rate.

Monthly data for the period June 1995 to December 2022 is extracted from different sources. Data on the price of gold, the exchange rate and the rediscount rate are extracted from the South African Reserve Bank, whereas data on the JSE All Share Index is extracted from Marketwatch.com. The summary and descriptive statistics of these variables is found in Table 4 and Table 5 in the appendix.

Figure 1 below shows the pattern of the time series variables employed in this study. Important to note is that stationary testing is required for time series analysis. Given this, this study employed three-unit root tests, that being, the Augmented Dicky Fuller (ADF) test, the Phillips Perron (PP) test and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test. The results of these tests are found in Table 1 below.

In addition, this study employed a cointegration test to determine whether they were any long-run relationships among the variables. To do so, this study used the Johansen & Juselius (JJ) (1990) Cointegration test. The results of the JJ Cointegration test are found in Table 2 below.

3.2. Model Specification

The purpose of this study is to examine the dynamic relationship between the price of gold, exchange rate, interest rate and stock prices. To do so, the study employed a standard VAR model for the price of gold, stock prices, the exchange rate and interest rates. This model is specified as follows:

$$y_t = \beta_0 + \sum_{j=1}^p \beta_j Y_{t-j} + U_t \tag{1}$$

Where Y_t represents a 4 x 1 vector of endogenous variables, β_0 represents a 4 x 1 vector of intercepts, $\beta_j, j = 1, 2, 3, \dots, p$ represents 4 x 4 matrices of coefficients and U_t represents a 4 x 1 vector of disturbance terms whereby $U_t \sim N_4(0, \Sigma)$. The four equations for the Standard VAR model can be written as follows:

$$S_t = \beta_{01} + \beta_{11}S_{t-1} + \theta_{11}G_{t-1} + \delta_{11}E_{t-1} + \varphi_{11}I_{t-1} + \mu_{1t} \tag{2}$$

$$I_t = \beta_{02} + \beta_{21}S_{t-1} + \theta_{21}G_{t-1} + \delta_{21}E_{t-1} + \varphi_{21}I_{t-1} + \mu_{2t} \tag{3}$$

$$G_t = \beta_{03} + \beta_{31}S_{t-1} + \theta_{31}G_{t-1} + \delta_{31}E_{t-1} + \varphi_{31}I_{t-1} + \mu_{3t} \tag{4}$$

$$E_t = \beta_{04} + \beta_{41}S_{t-1} + \theta_{41}G_{t-1} + \delta_{41}E_{t-1} + \varphi_{41}I_{t-1} + \mu_{4t} \tag{5}$$

In addition, this study employed a Bayesian hierarchical modelling approach to Vector Autoregression (VAR) models. This particular subsection introduces the estimation model as well as details the prior specification and the hierarchical prior selection procedure which was developed by Giannone et al. (2015). This study considered the following Bayesian VAR model:

$$y_t = a_0 + A_1 y_{t-1} + \dots + A_p y_{t-p} + \epsilon_t, \text{ with } \epsilon_t \sim \mathcal{N}(0, \Sigma) \tag{6}$$

Where y_t represents an $M \times 1$ vector of endogenous variables, a_0 represents an $M \times 1$ intercept vector, A_j ($j = 1, \dots, p$) represents $M \times M$ coefficient matrices, whereas ϵ_t represents an $M \times 1$ vector of Gaussian exogenous shocks with zero mean and variance-covariance (VCOV) matrix Σ as suggested by Kuschnig & Vashold (2019). $M + M^2p$ are the number of coefficients which are to be estimated, these rise quadratically with the number of added variables and are linearly in lag order. According to Kuschnig & Vashold (2019), this dense parameterization will often lead to inaccuracies with regard to out-of-sample forecasting and structural inference, more so, for high-dimensional models. This occurrence is often referred to as the curse of dimensionality.

In order to address this limitation, the Bayesian approach to estimating VAR models is employed which imposes additional structure to the model. This approach allows for adoption of informative conjugate priors which are believed to be effective in addressing the curse of dimensionality (Doan et., 1984).

In addition, the Bayesian approach will aid in moving the model parameters towards a parsimonious benchmark which reduces estimation errors and improves out-of-sample prediction accuracies (Koop, 2013). The Bayesian approach is suitable for a range of economic issues and involves prior information. Further, the Bayesian framework accounts for layers of uncertainty by incorporating hierarchical modelling (Gelman et al., 2021).

3.3. Prior Selection and Specification

In regard to prior selection and specification, this study followed the work of Giannone et al. (2015) which indicated that prior parameters should be set in a data-based fashion by treating them as addition parameters to be estimated. Indeed, prior parameters are then assigned their own hyperpriors with their own hyperparameters. The uncertainty which surrounds the choice of parameters is addressed by being acknowledged explicitly by Bayes' law as follows:

$$p(\gamma|y) \propto p(y|\theta, \gamma)p(\theta|\gamma)p(\gamma), \tag{7}$$

$$p(y|\gamma) = \int p(y|\theta, \gamma)p(\theta|\gamma)d\theta, \tag{8}$$

Where $y = (y_{p+1}, \dots, y_T)^T$ represents the autoregressive and variance parameters of the VAR model and is denoted by θ and has set hyperparameters γ . Equation 7 above is said to be marginalized with respect to the parameters in Equation 8 which yields a density of the data as a function of the hyperparameters $p(y|\gamma)$, often referred to as the marginal likelihood (ML) (Kuschnig & Vashold, 2019).

According to Giannone et al. (2015) the quantity tends to be marginal with respect to the parameters θ and yet conditional on the hyperparameters γ . Further, the ML is often used as a decision criterion for the hyperparameter choice. Indeed, by adopting the Bayesian hierarchical approach, the ML can be utilised to explore the full posterior hyperparameter space while also acknowledging the uncertainty which surrounds it (Kuschnig & Vashold, 2019). This according to Giannone et al. (2015) results in robust inference which is theoretically grounded and is implemented in an efficient manner.

Given the above, this particular study adopted the conjugate prior distributions proposed by Giannone et al. (2015), which are referred to as the Normal-inverse-Wishart (NIW) family. As a result, this study took Equation 8 above and $A = [a_0, A_1, \dots, A_p]'$ and $\beta = \text{vec}(A)$ in order to derive the following conjugate prior setup:

$$\begin{aligned} \beta | \Sigma &\sim (b, \Sigma \otimes \Omega), \\ \Sigma &\sim IW(\psi, d), \end{aligned} \tag{9}$$

Where b , Ω , ψ and d are representations of functions of a lower-dimensional vector of hyperparameters γ . Specifically, this study adopted the Minnesota prior, which is advocated by Litterman (1980). The Minnesota prior hypothesizes that individual variables follow random walk processes. Furthermore, according to Kilian & Lutkepohl (2017), this parsimonious specification tends to perform well in forecasts of macroeconomic time series data. The Minnesota prior can be derived as follows:

$$\begin{aligned} \mathbb{E}[(A_s)_{ij} | \Sigma] &= \begin{cases} 1 & \text{if } i = j \text{ and } s = 1, \\ 0 & \text{otherwise} \end{cases} \\ \text{cov}[(A_s)_{ij}, (A_r)_{kl} | \Sigma] &= \begin{cases} \lambda^2 \frac{1}{s^\alpha} \frac{\Sigma_{ik}}{\psi_j / (d - M - 1)} & \text{if } l = j \text{ and } r = s, \\ 0 & \text{otherwise.} \end{cases} \end{aligned} \tag{10}$$

Parameter θ is believed to control the overall tightness, i.e., meaning it weights the relative importance of the prior and the data (Kuschnig & Vashold, 2019). Indeed, if $\lambda \rightarrow 0$, it is believed that the prior outweighs any information in the data and the posterior approaches the prior. Conversely, if $\lambda \rightarrow \infty$, it is believed that the posterior distribution mirrors the sample information. More so, it is seen that α controls the degree of shrinkage for more distant observations whereas ψ_j controls the prior's standard deviation on lags of variables which are not the dependent variables (Kuschnig & Vashold, 2019).

4. Results

4.1. Stationarity Tests

Figure 1 below shows the trends and patterns of all the time series data used in this study. Stock prices appear to have an increasing trend. The price of gold and the exchange rate also appears to have an increasing trend whereas interest rates seem to be declining over the period.

Figure 1 offers a visual inspection of the time series variables employed in this study. However, simply visually inspecting the data is not sufficient to conclude on the nature of the data. Stationarity tests are conducted in the form of the Augmented Dicker Fuller test, the Philip-Perron test and the Kwiatkowski-Phillips-Schmidt-Shin test. The results of the three stationarity tests are found in Table 1 below. As reflected, all of the four variables used in this study are non-stationary at level and stationary at first difference. As a result of this, cointegration testing was conducted to determine the long run relationships among the variables.

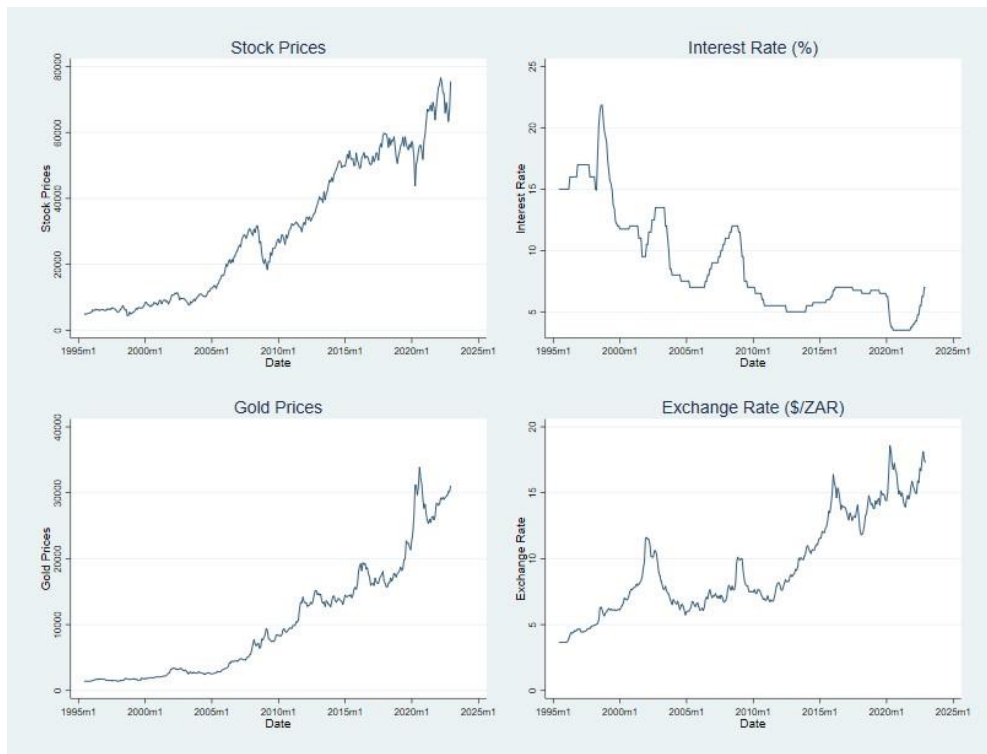


Figure 1. Graphical Representation of the Variables

Table 1. Results of Unit Root Tests

Variables	Augmented Dicky Fuller		Phillips-Perron		Kwaitkowski-Phillips-Schmidt-Shin	
	Level	1 st Difference	Level	1 st Difference	Level	1 st Difference
Price of gold (G)	-2.214 [0.4822]	-15.662 [0.0000]	-2.518 [0.3188]	-15.655 [0.0000]	2.37 [0.01]	0.0701 [0.01]
Exchange Rate (E)	-2.064 [0.5661]	-13.260 [0.0000]	-2.434 [0.3615]	-13.081 [0.0000]	2.11 [0.01]	0.101 [0.01]
Interest Rate(I)	-0.879 [0.9584]	-13.970 [0.0000]	-2.057 [0.5701]	-14.877 [0.0000]	1.61 [0.01]	0.129 [0.01]
Stock Market (S)	-2.324 [0.4208]	-18.374 [0.0000]	-2.326 [0.4194]	-18.383 [0.0000]	3.85 [0.01]	0.0356 [0.01]

4.2. Cointegration Tests

The results of the JJ Cointegration test are found in Table 2 below. There appears to be no evidence of cointegration among the variables. The JJ Cointegration test does not consider structural breaks that could be found in long time series as a result, this study employed the Gregory-Hansen Cointegration Structural Break test.

Table 2. Results of JJ Cointegration Test

Hypothesized No. of CE	λ_{Trace}	P-Value	$\lambda_{Max.Eigen}$	P-Value
r=0	53.5410	0.08058	27.6393	0.08058
r=1	25.9016*	0.05752	19.4895	0.05752
r=2	6.4121	0.01766	5.8636	0.01766
r=3	0.5485	0.00167	0.5485	0.00167

Table 3 below reflects the results of the Gregory-Hansen Cointegration test. As reflected, the results appear to suggest that there is no cointegration in the breaking points for all three models employed.

Table 3. Results of Threshold Cointegration Test

	Test Statistic	Breakpoint	Date	Asymptotic Critical Values		
				1%	5%	10%
Model: Change in Level						
ADF	-4.49	113	2004m10	-5.77	-5.28	-5.02
Zt	-5.15	118	2005m3	-5.77	-5.28	-5.02
Za	-42.60	118	2005m3	-63.64	-53.58	-48.65
Model: Change in Level and Trend						
ADF	-4.74	125	2005m10	-6.05	-5.57	-5.33
Zt	-4.77	125	2005m10	-6.05	-5.57	-5.33
Za	-42.28	125	2005m10	-70.27	-59.76	-54.94
Model: Change in Regime						
ADF	-4.77	125	2005m10	-6.51	-6.00	-5.75
Zt	-5.45	124	2005m9	-6.51	-6.00	-5.75
Za	-47.04	124	2005m9	-80.15	-68.94	-63.42

4.3. Impulse Response Functions

The impulse response function results from the standard VAR model are found in Figure 2 below. These include impulse responses of stock prices, interest rates, gold prices and exchange rates.

A one-unit positive shock in stock prices leads to positive responses in the exchange rate, the price of gold and the interest rate. A one-unit positive shock in the interest rate leads to a negative response in the price of gold and stock prices. A one-unit positive shock in the prices of gold results in an initial positive response in exchange rates which are followed by a decline over the subsequent periods.

A one-unit positive shock in the gold price leads to negative responses on both interest rates and stock prices. A one-unit positive shock in the exchange rate leads to positive responses in the price of gold and the interest rate. Whereas a one-unit positive shock in the exchange rate leads to negative responses to stock prices.

The impulse response function results from the Bayesian VAR are found in Figure 3 below. These include impulse responses for stock prices, interest rates, gold prices and the exchange rate. A one-unit positive shock in stock prices leads to a positive response in exchange rates, gold prices and the interest rates. A one-

unit positive shock in the interest rate leads to negative responses in both the gold price and the stock prices.

A one-unit positive shock in gold prices leads to an initial positive response in the exchange rate which is followed by a decline over the period. A one-unit positive shock in gold prices leads to negative responses to both the interest rate and stock price. A one-unit positive shock in the exchange rate leads to positive responses to gold prices and interest rates. A one-unit positive shock in the exchange rate leads to a negative response on stock prices.

The above results suggest that when the stock price increases it leads to the depreciation of the South African rand against the US dollar. Moreover, the results reveal that when the stock price increases, there will be subsequent increases in both the price of gold and the interest rate. An increase in the interest rate by monetary authorities appears to have a negative effect on the stock price and the price of gold. This seems to suggest that an increase in the interest rate will adversely affect investments and/or investors. This could imply that in the event of increases in interest rates, investors shift their investments to other economies as reflected in the downward trend in stock prices and gold prices.

An increase in the price of gold leads to the initial depreciation of the South African rand towards the US dollar which is followed by an appreciation of the South African rand against the US dollar. The rise in the price of gold leads to the devaluation of the South African rand due to increases in the demand of gold as compared to the South African rand. In contrast, the appreciation of the South African rand against the US dollar will lead to a decline in the demand of gold.

An increase in the price of gold and the demand of gold adversely impacts the stock price. This could suggest that when the demand of gold increases, investors switch their investments from the stock market to a commodity such as gold. This implies that in South Africa, investors consider the stock market and the gold market as substitutes to one another. The results also reveal that the increase in the price of gold leads to a decline in interest rates.

The depreciation of the South African rand against the US dollar leads to the decline in the stock market whereas an appreciation of the South African rand against the US dollar leads to an improvement in the stock market. The depreciation of the South African rand could imply higher inflation in the future which results in scepticism in the minds of investors regarding the future performance of South African firms which leads to the decline of stock prices.

The depreciation of the South African rand against the US dollar leads to the decline in the price of gold over time. In contrast, the appreciation of the South African rand against the US dollar will lead to the increase in the price of gold. This could be as a result of investors, when faced with the devaluation of the US dollar that have foreign assets will tend to move their investments to the gold and stock market. In contrast, when faced with the depreciation of the South African rand against the US dollar, investors that have investments in the gold and stock markets will shift their investments to the US dollar which leads to a decline in the price of gold and stock prices.

4.4. Variable Forecasting

Figure 4 below reveals the standard VAR's forecasting results for stock prices, interest rates, the gold prices and exchange rates. These forecasting results predict that stock prices decline over the next subsequent period. Interest rates are predicted to sharply decline over the subsequent periods. The results also seem to predict that the prices of gold and the exchange rate are expected to decline in the subsequent periods.

Figure 5 below shows the Bayesian VAR, forecasting results for stock prices, the interest rate, gold prices and the exchange rate. The Bayesian forecasting results predict that stock prices will decline over the next subsequent periods. Interest rates are predicted to increase in the initial subsequent periods but will decline over time. The forecasting results predict that the prices of gold and the exchange rate are expected to decline over the period.

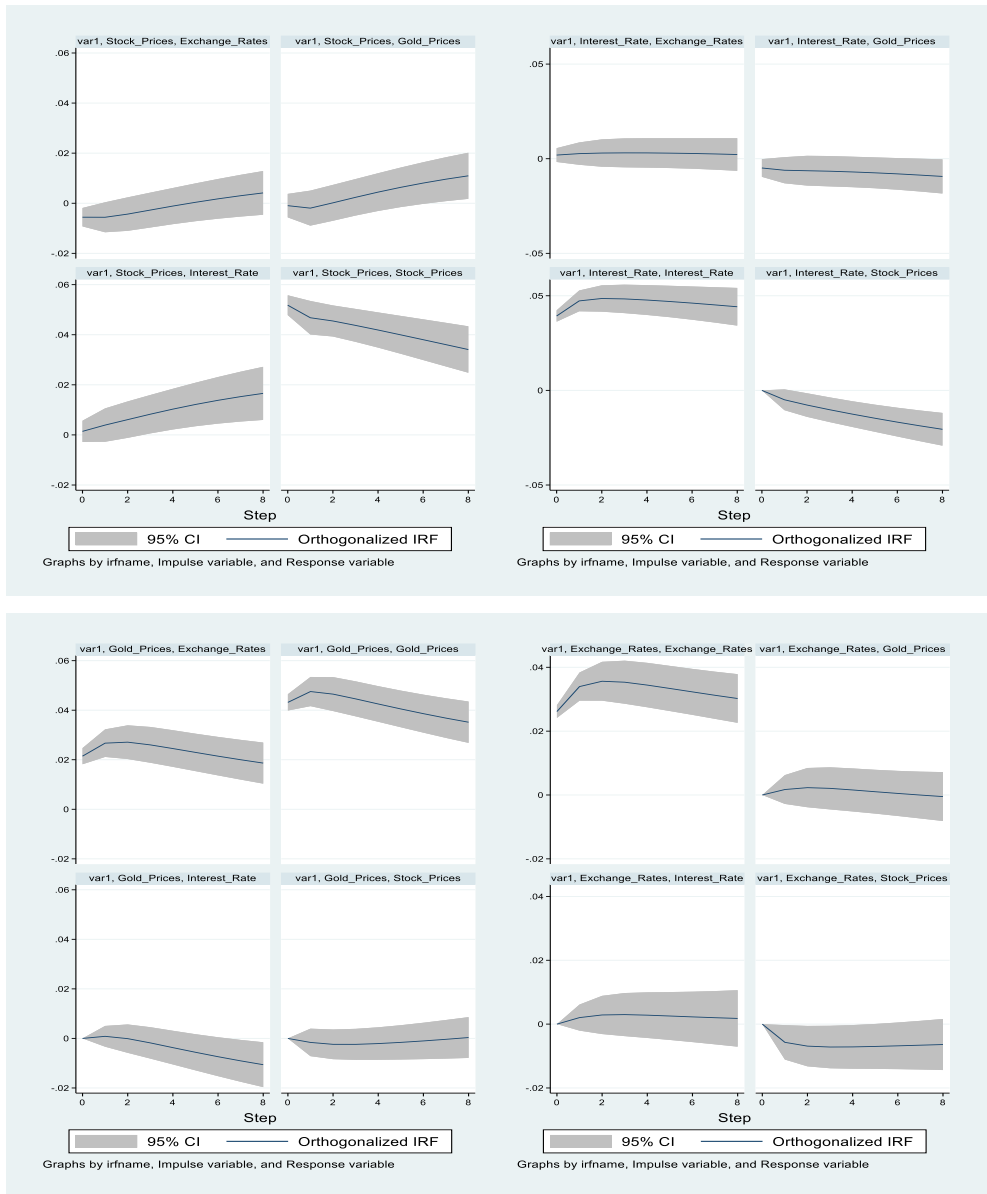


Figure 2. Impulse Response Function

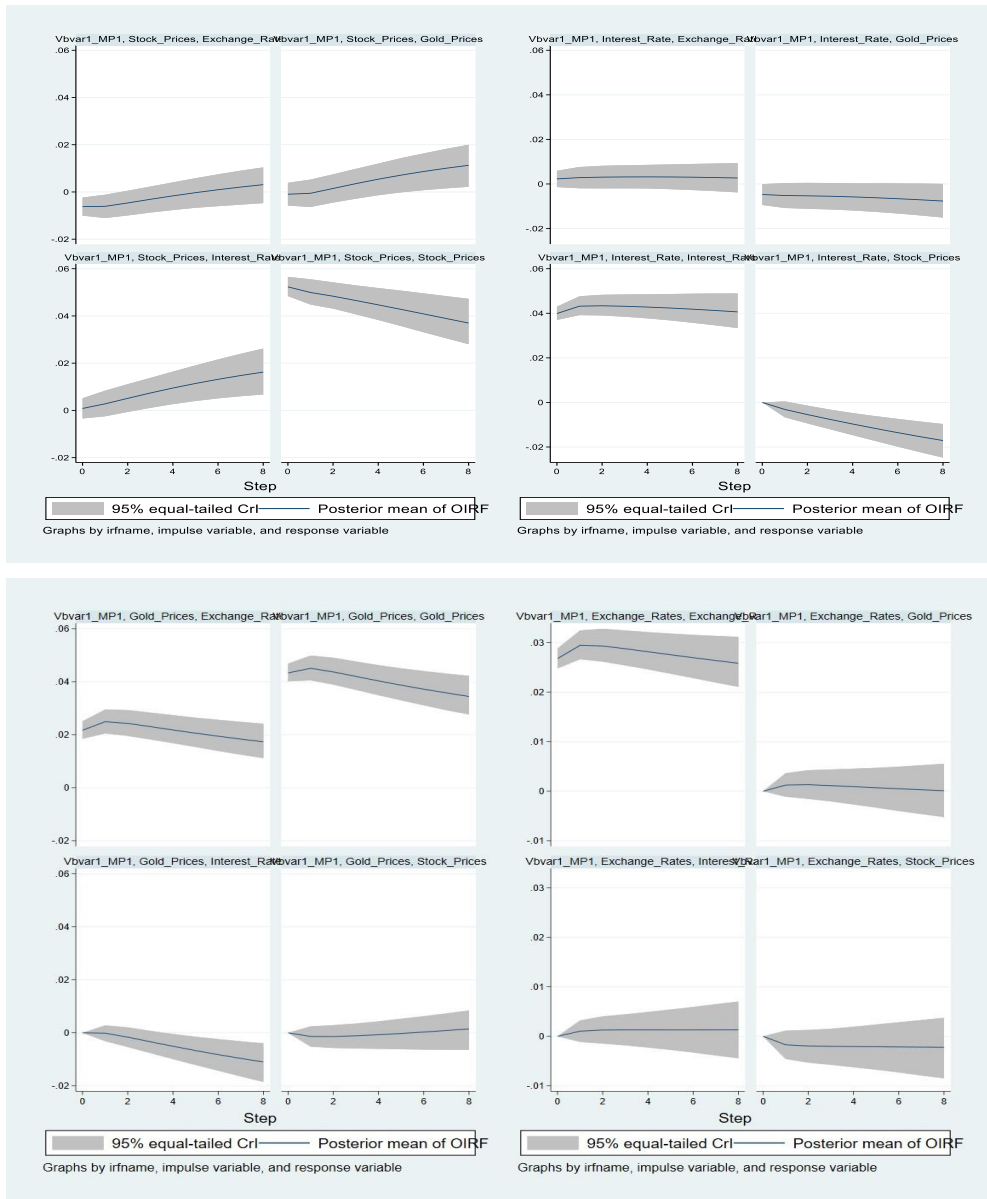


Figure 3. Bayesian Impulse Responses Function

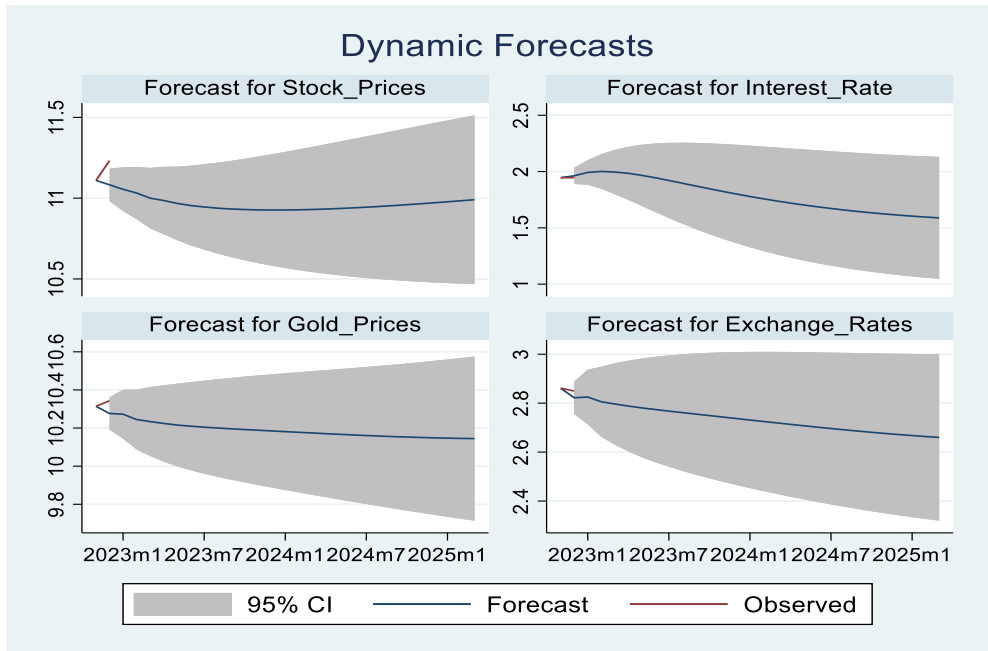


Figure 4. Variable Forecasts

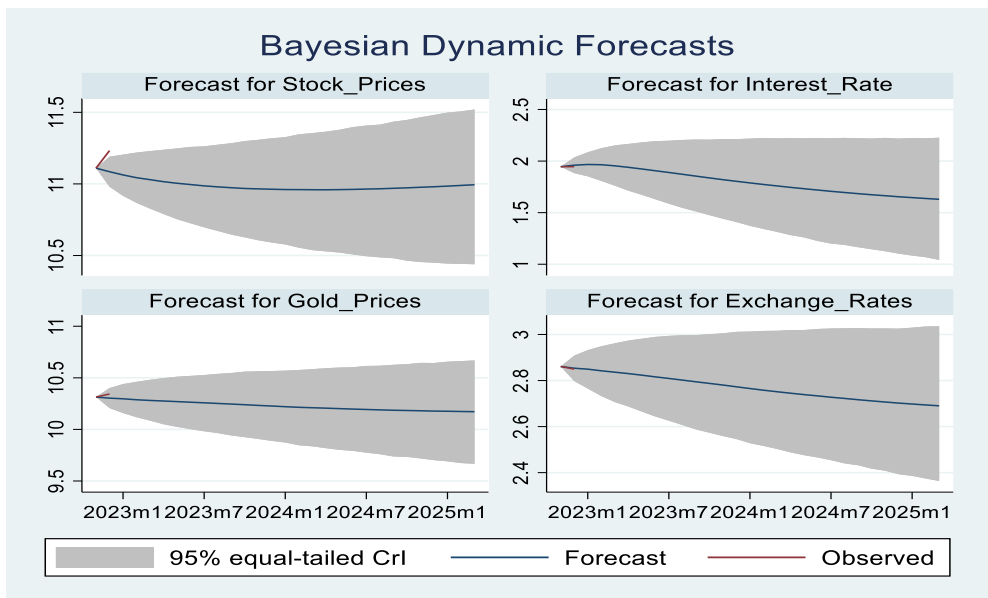


Figure 5. Bayesian Variable Forecasts

5. Conclusion

This study assessed the dynamic relationship among the price of gold, interest rates, exchange rates and the stock price indices in South Africa. This study employed both a standard Vector Autoregression Model and a Bayesian Vector Autoregression Model on monthly data for the period June 1995 to December 2022.

Three unit root tests were used, that being, the Augmented Dicker Fuller test, the Phillip-Perron test and the Kwiatkowski-Phillips Schmidt-Shin test. These tests revealed that all four variables used in this study were nonstationary at level and stationary at first difference. In addition, the JJ cointegration test revealed that there was no cointegration among the variables. Further, the Gregory-Hansen cointegration test revealed that there is no cointegration at the breaking points for all the models tested.

In regard to the impulse response functions, a positive shock in the stock price resulted in positive responses in the exchange rate, the price of gold and the interest rate. A positive shock in the interest rate results in a negative response in the price of gold and stock prices. A positive shock in the price of gold leads to negative response in both the interest rate and stock price. A positive shock in the exchange rate leads to a positive response in the price of gold and interest rates while also leading to a negative response in stock prices.

This article is significant to both South African investors and policy makers as it is believed that both the stock market and the foreign exchange market are less stable than the gold market as a result of the interdependence of global markets and global financial integration. To this score, investors have a keen interest regarding the risk of equity investing given the unexpected fluctuations of the stock and foreign exchange markets. The gold market can be seen as a safe haven to investors for purposes of hedging during periods of financial market instability and can truly be considered as a viable alternative investment option.

Therefore, it is clear that understanding the dynamic relationship between the foreign exchange market, the gold market and the stock market is significant in the eyes of investors and portfolio managers in South Africa. In addition, this article could prove significant to policymakers who have a keen interest in the relationship between interest rates, the gold market, the foreign exchange market and the stock market. Understanding these dynamic interrelationships can assist in the implementation of effective monetary policy.

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APPENDICES

Table 4. Data Description

Variable	Description	Data Code	Frequency	Data Source
Price of Gold	London gold price in rand	KBP5356M	Monthly	South Africa Reserve Bank (SARB)
Foreign Exchange Rate	Foreign exchange rate : SA cent per USA dollar Middle rates (R1 = 100 cents)	KBP5339M	Monthly	South Africa Reserve Bank (SARB)
Interest Rates	Bankrate (lowest rediscount rate at SARB)	KBP1401M	Monthly	South Africa Reserve Bank (SARB)
Stock Prices	FTSE JSE All Share Index	N/A	Monthly	https://www.marketwatch.com/investing/index/alsj/download-data?startDate=1/3/2000&endDate=08/21/2023&countryCode=za

Table 5. Descriptive Statistics

Variable	Observations	Mean	Std. Dev.	Min	Max
Price of Gold	331	10170.92	8729.74	1396.56	33859.76
Foreign Exchange Rate	331	9.387884	3.739629	3.6407	18.576
Interest Rates	331	8.951994	4.17437	3.5	21.85
Stock Prices	331	30273.02	21102.91	4400.29	76600.13