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Econometric Evaluation of Crude Oil Price Effects on the Economy's Wellbeing: A Case of South Africa

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ABSTRACT

Changes in crude oil prices are seen as a significant contributor to macroeconomic uncertainties globally. Crude oil is a vital resource for most emerging economies and an energy source used to transport goods and to generate electricity. This points out that the economic wellbeing of crude oil importing countries rely significantly on imported oil, making the nations susceptible to crude oil price increases. The study evaluates crude oil price effects on the economy's wellbeing of South Africa. The evaluation used unemployment and economic growth as proxies of the economy's wellbeing of the country, with data spanning from 1994Q1 to 2023Q4 for unemployment model and from 1993Q1 to 2024Q1 for economic growth model. Both models have the same independent variables, which include crude oil prices, inflation, exchange rate, and interest rate. The study employed an EGARCH model and the Toda-Yamamoto causality test, and the results indicate that crude oil prices drive both unemployment and economic growth, which proves that the ongoing changes in crude oil prices on the world market has a substantial influence on the economy's wellbeing of South Africa, influencing both unemployment and the nation's economic growth. The study recommends that policymakers from oil-importing countries consider investment in renewable energy sources. By diversifying its energy portfolio, South Africa can improve energy security and mitigate the risks linked to supply interruptions or geopolitical conflicts.

Keywords: Crude Oil Prices, South African Economic Wellbeing, Unemployment, Economic Growth, EGARCH Model
JEL Classifications: Q43, E24, E31, C22, O55.

1. INTRODUCTION

Over the years, there has been an ongoing fluctuation in the price of crude oil, which has been negatively affecting the economy's wellbeing of crude oil-importing countries. According to Bashar et al., (2013), the association between crude oil prices and the economy's wellbeing at macroeconomic level is considered as one the most important, debatable, and unresolved issues in energy economics. Escalation of crude oil prices are seen as a significant contributor to uncertainties globally since the 1970s, and even more so until recently. Crude oil is a vital resource for most emerging economies and an energy source used to transport goods and to generate electricity (Weliswa, 2013). Crude oil contributes approximately 17% of South African main energy needs, and 70% of the country's liquid fuels comes from crude oil (Ziramba, 2010).

South Africa as oil importers rely on crude oil making the country vulnerable to changes crude oil prices. According to Wabiri and Amusa (2011), imports of crude oil provide 64% of South Africa's liquid fuel needs. The Middle East accounts for 85% of these imports, with the African region accounting for the majority of the remaining 15%. In the year 2023, South Africa imported a total of 13.2 billion liters of crude oil, a decline from a 11.2 billion liters imported in 2022. This proves that crude oil is an important commodity and one of the main imports into the country, increasing the country's susceptibility to factors beyond its control; oil import supply risks (especially with limited crude oil

reserves), and the oil price shocks. Most crude oil in South Africa is imported from countries such as Saudi Arabia and Nigeria, accounting for 29% (3.8 billion liters) and 24% (3.1 billion liters) of total imports in 2023, respectively, down from 47% (5.3 billion liters) and 36% (4.1 billion liters) in 2022. Following at 8% (1.0 billion liters) are the United States, 7% (935.5 million liters) are Angola, and 4% (473.5 million liters) is Algeria (Department of Mineral Resources and Energy, 2023).

Wabiri and Amusa (2011) argue that the main locally based energy multinationals, PetroSA and SASOL, as well as private entities involved in petroleum refining, storage, and marketing, import crude oil into South Africa. Changes in currency and elevated crude oil prices are some of the factors driving fuel prices up in South Africa. The more costly crude oil is on the global market or the weaker the domestic currency is, the more expensive petrol will be. This leads to higher production expenses for firms, especially those relying on energy-intensive operations or logistics, resulting in decreased profitability, reduced consumer spending power, and ultimately slower economic growth (Takentsi et al., 2022). Since the financial crisis in 2008, there have been major changes in exchange rate as well as prices of crude oil. For example, Brent crude oil increased from US$43.71 in January 2009 to US$125.38 in March 2012, and then it started to decline and reached a low of US$30.93 in January 2016 after a downward trend. Since then, there has been a decline in the price of Brent crude oil, falling to US$18.68 per barrel in April 2020 due to COVID-19, the lowest price of the twenty-first century. From there on, it increased to US$122.78 per barrel in June 2022 due to the war between Ukraine and Russia (South African Reserve Bank, 2024). These changes have caused economic instability as well as slow economic growth (Balcilar et al., 2017).

Using South Africa as an example, the study analyses how crude oil is linked with the economy's wellbeing. At macroeconomic level, the economy's wellbeing can be measured using several macroeconomic indicators. Since the economy's wellbeing is broad, the study uses unemployment and economic growth as proxies to measure economy's wellbeing. As a result, there are two models in this study. According to Rafiq et al., (2009), the significant changes of crude oil prices cause incidences of slow growth, high inflation and unemployment to occur in most crude oil-importing countries.

Economic growth is referred to as an improvement or an increase in the production of goods and services in a country. South Africa continues to face a number of economic difficulties even though it is one of the most industrialised and technologically advanced nations in Africa. For more than ten years, the country has experienced slow economic growth. Since 2012, the GDP has grown by an average of just 0.8% per year, which contributed to high rates of poverty and unemployment (National Treasury Budget Review, 2024). South Africa's economic growth relies heavily on crude oil that comes from other countries to meet its energy needs. The country's high reliance on crude oil from other nations makes it susceptible to rising crude oil prices on the world market. The question to ask is; how do crude oil prices influence the nation's growth? According to Saidi et al., (2019), changes in production costs can be caused by fluctuations in crude oil prices, raising inflation and causing slow economic growth. A nation's government will implement monetary policies by increasing interest rates in an effort to lower inflation, resulting in decreased investments, which would ultimately influence economic growth. Many researchers have investigated the escalation of oil prices and their impact on economic growth. Weliswa (2013), Akinlo and Apanisile (2015), and Maruping and Mongale (2017) all analysed the connection between crude oil prices and economic growth and obtained a positive correlation between them.

The other measure of the economy's wellbeing is unemployment. Over the years, there had been inconclusive results with regards to how crude oil prices affect the economy's wellbeing, particularly unemployment. With regards to the South African economy, the country is among the nations with the highest rates of unemployment worldwide. Statistics South Africa (2024) reported that unemployment was sitting at 31.9% in 2023Q3 and 32.1% in 2023Q4, a 0.2% increase between the two quarters. Comparing the two quarters, the number of people without jobs increased significantly by 46,000, proving that unemployment is a major issue, and the country continuously struggles to find a solution for it. The main goal of this research is to evaluate whether changes in crude oil prices contribute to unemployment and to suggest appropriate policies. Studies done by Senzangakhona and Choga (2015) and Ahmad (2013) examined the association between crude oil prices and unemployment and revealed a positive relationship between the two variables.

2. LITERATURE REVIEW

Economic wellbeing is broad and can be measured using several macroeconomic variables. Taher (2021) had economic wellbeing as a dependent variable proxied by GDP per capita. The study was done in Lebanon, where the researcher analysed oil price effects on the nation's economic wellbeing. Annual data from 1988 to 2018 was collected and regressors used are crude oil prices, labour force participation rate and gross fixed capital formation. The results obtained indicate that there is a significant positive correlation between oil price fluctuation and Lebanese economic wellbeing. The researcher recommended that Lebanese policy makers should prioritise green investments to mitigate oil cost effects on the country's economic wellbeing.

Using the VECM model, Weliswa (2013) examined the effect of oil price volatility on economic growth in South Africa. The data was in quarters spanning from 1994 to 2010, and the variables utilised are, GDP as the dependent variable, crude oil prices, gross fixed investment, real interest rate, and real exchange rate as the independent variables. The findings indicate that there is a positive association between oil prices and GDP in the long-term, but a negative association in the short run. The analysis also demonstrates how South Africa, an oil-importing nation, is susceptible to fluctuations in oil prices because its economic growth is dependent on oil that is imported. Weliswa (2013) recommended that monetary and fiscal policies be included in policy interventions. In this sense, it is crucial to encourage regional integration in order to minimise reliance on oil by

maximising the availability of electricity throughout the region. Due to economies of scale, this will increase efficiency and decrease generation costs.

Ahmed et al., (2023) analysed the relationship between inflation and macroeconomic variables such as GDP, trade balance and unemployment via oil prices in the UK. The study used monthly data from January 2010 to June 2022 and utilised a VAR technique. Initially, GDP, trade balance, unemployment rate, and price of crude oil all decline because of inflation. However, in contrast to other proxies, crude oil increase responds to rising inflation the fastest, positively linking with it in a month. In addition, the effect of inflation is greatest during the quarter one but decreases over time. Policymakers can utilise this knowledge to help them create measures that will reduce the short-term negative effects.

Using Toda Yamamoto causality test, Ahmad (2013) also did a study in Pakistan, where he evaluated the oil price effects on the country's unemployment. The study collected monthly data from January 1991 to December 2010 making it 238 observations for each variable. Oil prices, unemployment and real interest rate are the variables used in this study. The outcome indicated that there is a significant correlation between oil prices and unemployment, an insignificant link between real interest rate and unemployment, and a strong connection between oil prices and real interest rate.

South Africa continues to be one of the nations with the highest unemployment rate, particularly among the youth. Researchers are still debating whether or not crude of prices affects unemployment. The correlation between crude oil prices and unemployment in the country was investigated by Senzangakhona and Choga (2015). Using quarterly data from 1990 to 2010, the study employed a Johansen cointegration technique and VAR model. The results demonstrate a positive correlation between crude oil prices and unemployment in the long term, while there exist a negative relationship in the near term.

Najimi and Shorkar (2019) used the Autoregressive Distributed Lag method and Granger Causality technique to examine how oil prices affect unemployment in the Swedish economy. The research used quarterly data of oil prices and unemployment from the period 1983 to 2017. To determine if there exist a relationship, the study performs a linear regression analysis using recent changes in the variables, where unemployment is the independent variable and oil prices is the dependent variable. The outcome of the linear regression analysis on recent variations revealed a correlation between the price of oil and Sweden's unemployment rate. There was a positive correlation found in the linear regression pertaining to the recent changes in these variables. Both ARDL and Granger Causality techniques confirmed the association between the two variables.

Eltony and Al-Awadi (2001) analysed how oil prices influence the seven key macroeconomic variables for the Kuwaiti economy. The study collected quarterly data from 1984Q1 to 1998Q4 and employed VAR and VECM models. Eltony and Al-Awadi (2001) believe that the VECM is the model fit to analyse the relation compared to the VAR model. Furthermore, the outcomes that align with the VECM model are more in line with common sense. The estimated models, however, show that the main macroeconomic variables are highly correlated. The majority of the empirical data suggests that fluctuations in oil prices and the resulting income from oil have a strong effect on government spending, current and development. Nonetheless, there has been a comparatively greater influence on government development spending. Moreover, the findings clearly demonstrate the significance of both forms of government spending in clarifying the CPI's forecast errors variance. As an alternative, oil shocks can also satisfactorily describe the value of imports; however, they do so more closely when it comes to changes in government spending overall and in development-related spending in particular.

Most researchers agree that high inflation and the recession of the early 1970s were largely caused by the escalation of price of oil. Oil prices have been elevating recently, and the economic impact of this is a topic that is receiving more attention both internationally and specifically in South Africa. Niyimbanira (2013) analysed the influence of oil prices on inflation in South Africa. This research utilised the Johansen-Juselius Cointegration method to evaluate the long-term connection between oil prices and inflation, as well as the Augmented Dickey-Fuller methodology to assess unit root. The outcome demonstrated a co-integrating relationship between inflation and oil prices for data from South Africa. Granger causality was used at two and four lag periods in an additional attempt to verify the causal correlation between the two variables. At various lags, the same results were displayed. In the first test, which used lag two (2), unidirectional causality was observed between the price of oil and inflation. An additional test at lag four (4) was conducted, and the results only confirmed the first by showing a unidirectional causal relationship between inflation and prices of oil. According to the paper's findings, South Africa's monetary authorities should take the price of oil into account when attempting to control inflation.

Jawad (2013) utilised the linear regression analysis to analyse how the changes in oil cost influence Pakistan's economic growth. The research collected annual data spanning from 1975 to 2011, and it was found that all utilised variables are integrated at order one. A dampening impact was found when analysing the correlation between oil prices and Pakistan's economic growth. The study recommends that the nation's government should develop a suitable plan and process based on Pakistan's economic growth and needs. This will minimise oil costs impact on economic growth and help to maintain the balance between the supply and demand for oil.

3. RESEARCH METHODS

3.1. Data Sources

The study aims to analyse crude oil price effects on the economy's wellbeing of oil importing countries, a case of South Africa. The dependent variable of this study is the economy's wellbeing of South Africa proxied by unemployment and economic growth. The study has two models as a result of having two dependent variables. Unemployment is the dependent variable in model 1 economic growth is dependent variable in model 2. Both models have similar independent variables, which are crude oil prices, inflation, exchange rate, and interest rate.

3.1.1. Model 1: Unemployment

To analyse the influence of prices of crude oil on the economy's wellbeing, the study utilises quarterly data from 1994 quarter 1 to 2023 quarter 4, making it 120 observations. The SARB provided data of unemployment, crude oil prices, and exchange rate. Whereas, the data for inflation and interest rate was obtained from Federal Reserve Economic Data (FRED).

3.1.2. Model 2: Economic growth

Utilising South African quarterly data from 1993Q1 to 2024Q1, the study looks at the correlation between crude oil prices and the economy's wellbeing. The study's 125 observations are sufficient according to Niyimbanira (2013) recommendation of a minimum sample size of 30 in order to produce unadulterated results. The data for crude oil prices and exchange rate was obtained from SARB, while the data for economic growth, inflation, and interest rate was obtained from FRED.

The first model uses quarterly data from 1994Q1 to 2023Q4 because the available data for unemployment starts from 1994. The data for all the variables in the two models was collected from SARB and FRED because they are globally recognised institutions, they are reliable and have a long history of serving researchers. For the second model, the study employs quarterly data spanning from 1993 to 2024. Since the available data for economic growth begins in 1993 and there are no monthly data for the variable, the researcher chose to utilise quarterly data for the first model in order to have a large enough sample size.

3.2. Model Specification and Discussion of The Variables

To evaluate crude oil price effects on the economy's wellbeing of crude oil-importing country, the study employs a model used by Rostin *et al.* (2019) who investigated the influence of crude oil prices on inflation, interest rate, and economic growth in Indonesia. Rostin *et al.* (2019) study had three models, where they used inflation, economic growth, and interest rate as the dependent variables, and has only one independent variable in each model, which is crude oil prices. This study makes minor changes in the model above by having two models instead of three and by removing interest rate and inflation as the dependent variables and replace it with unemployment. The study will also include multiple independent variables in the model instead of one. The model the study used is specified as follows:

The functional form of the study is as follows:

$$\text{Model 1: } UNE_t = f(COP_t, INF_t, EXR_t, INR_t) \quad (1)$$

$$\text{Model 2: } GDP_t = f(COP_t, INF_t, EXR_t, INR_t) \quad (2)$$

The Econometric model of the study is specified as:

$$UNE_t = \beta_o + \beta_1 COP_t + \beta_2 INF_t + \beta_3 EXR_t + \beta_4 INR_t + \varepsilon_t \quad (3)$$

$$GDP_t = \beta_o + \beta_1 COP_t + \beta_2 INF_t + \beta_3 EXR_t + \beta_4 INR_t + \varepsilon_t \quad (4)$$

UNE: Denoted unemployment rate in South Africa
GDP: Denoted the economic growth of South African economy
COP: Represent Brent crude oil price in Rand,
INF: Denotes the inflation rate
INR: Denotes the interest rate,
EXR: Represents SA cents/US Dollar exchange rate

3.3. Expected Signs

Under Model 1, theoretically, crude oil price, exchange rate, and interest rate are expected to have a positive relationship with unemployment, while inflation is expected to be negatively related to unemployment. For Model 2, as presented in Table 1, all independent variables are expected to be negatively related to the economy's wellbeing, where economic growth is used as the proxy.

3.4. Research Techniques

3.4.1. Unit root

A unit root test is an economic measure that helps researcher check if a time series is stationary or not. Econometricians use these tests to examine economic data (Wallstreetmojo Team, 2024). As per the findings of Nkoro and Uko (2016), a time series is considered non-stationary if a unit root is present, and stationary if none is. The Augmented Dickey-Fuller and Phillips Peron unit root tests are utilised to perform a unit root test in order to determine whether the variables are integrated at order zero, order one, or both. The null hypothesis is that the series is non-stationary. Reject the null hypothesis if the probability value is <5% level of significant (Niyimbanira, 2013).

3.4.2. Choosing optimal lag length

Lag length is the amount of time intervals that are utilised to measure the connection between two variables by shifting one variable forward or backward (Linkedin, 2024). Selecting an appropriate lag length is an essential step in guaranteeing the reliability and precision of the findings. Choosing the incorrect optimal lag length can lead to misleading results including endogeneity, false correlation, and bias because of variables not included. The general-to-specific technique and the information criteria approach are the two primary methods for determining the lag length of an econometric model. The general-to-specific technique begins with a large number of lags and uses t-tests or F-tests to remove the ones that are not significant. While the information criteria approach utilises a set of criteria measuring the trade-off between the number of parameters and the model fit (Linkedin. 2023). This study uses the information criteria approach. The Akaike information criterion (AIC) and the Schwartz Criterion (SC) are criterions that can be used to compare different lag length and choose the one that best fits the model. It is essential to choose the criterion with a small value because the smaller the value the greater good the model.

3.4.3. GARCH model

This study employs the GARCH (Generalized Autoregressive Conditional Heteroscedasticity) model to evaluate the impact of crude oil prices on the economy's wellbeing of South Africa. The GARCH model, revised by Bollerslev (1986), is an extension of the ARCH model adopted by Engle (1982), aimed at overcoming the shortcomings of the ARCH model. The ARCH and GARCH models are regarded as essential tools in the analysis of time series data, particularly within financial contexts. These models are particularly advantageous for analysing and predicting volatility (Engle, 2001).

The GARCH model is used to analyse historical volatility and predict future volatility of marketable securities, such as stock prices, commodity prices, and oil prices (Haimes, 2011). The simplest but often very useful GARCH model is the GARCH (1, 1) model. According to Engle (2001), the notation (1, 1) indicates that the first number denotes ARCH terms included in the equation, while the number of GARCH terms is represented by the second number. The GARCH (1, 1) model's simplicity facilitates interpretation for policymakers. The GARCH models have a mean equation and a conditional variance equation (Haque and Shaik, 2021). The mean equation is specified as follows:

$$R_t = \pi + \varepsilon_t \quad (5)$$

Where R_t is denoted as the stock return at time, π represents the mean stock return, and ε_t is considered as the residual returns. The GARCH (1, 1) model equation is written as:

$$\sigma_t^2 = \omega + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 \sigma_{t-1}^2 \quad (6)$$

The necessary condition for the variance to be positive is:

$\omega > 0, \alpha_1 \geq 0, \beta_1 \geq 0$

σ_t^2 is the conditional variance,

α_t denotes residual returns

$\omega, \alpha_1, \beta_1$ represents the parameters.

While the GARCH (1, 1) model has demonstrated its efficacy in analysing the symmetric effect of volatility, it is hampered by a number of restrictions, including relatively non-negative constraints placed on the parameters that require estimation, not appropriate for modeling the frequently observed asymmetric effect and are ineffective in modeling asymmetries of the volatility due to the sign of the prior shock (Deebom & Essi, 2017). Therefore, this study utilises the Exponential General Autoregressive Conditional Heteroskedastic (EGARCH) model which is another form of the GARCH model.

The EGARCH model proposed by Nelson (1991) is frequently the appropriate model to use due to its ability to manage asymmetries, which is typical in commodity markets. The EGARCH (1, 1) model analyses market asymmetries, specifically investigating the leverage effect of returns and volatility. Asymmetric effects are typically more significant than symmetric ones when examining the volatility of oil prices. This is due to the fact that accurate modeling and prediction depend on the differences in how oil markets react to shocks, both positive and negative (Deebom and Essi, 2017). Taking into account the asymmetric influence on volatility from positive and negative shocks, the EGARCH model has the following conditional variance equation:

$$\ln\left(\sigma_t^2\right) = \omega + \beta_1 \ln\left(\sigma_{t-1}^2\right) + \delta_1 \frac{\varepsilon_{t-1}}{\sqrt{\sigma_{t-1}^2}} + \gamma_1 \left[\frac{\left|\varepsilon_{t-1}\right|}{\sqrt{\sigma_{t-1}^2}} - \frac{2}{\pi} \right] \quad (7)$$

Table 1: Definition of the variables and expected signs

Variable	Description	Source	Expected sign
Model 1			
UNE	Unemployment is referred as a number of individuals who are actively seeking for employment but have no luck in finding one. In this study, it is used as one of the proxies of the economic wellbeing of South Africa. It denotes unemployment rate over a certain period of time in percentage.	SARB	N/A
COP	Crude oil price is the main independent variable of the research. Changes in crude oil lead to higher production cost of production and transportation. Inflation may result from the rise in crude oil prices. A nation's government will implement monetary policy by increasing interest rates in an effort to lower inflation, resulting in decreased investments, which would ultimately affect economic growth (Saidi et al., 2019).	SARB	+
INF	According to McKinsey and Company (2022), inflation can be defined as a major increase in prices of products and services and decline in the purchasing power for consumers.	FRED	-
EXR	The exchange rate is the rate at which one country's currency may be exchanged into another country's currency (Chen, 2024). Exchange rate is utilised to determine the relative values of foreign currencies and also in figuring out the dynamics of trade and money flows.	SARB	+
INR	Interest rate is the fee required as an interest by the lender to the borrower for a loan given, often stated as an annual percentage of the principle. It is a vital tool that monetary authorities can utilised to boost economic activity and control inflation.	FRED	+
Model 2			
GDP	In this study, economic growth is used as one of the proxies of the economy's wellbeing of South Africa, and is the dependent variable of the second model. It is the rise in the market value of an economy's products and services over a given fiscal year.	FRED	N/A
COP	An escalation in oil prices can result in higher production, transportation, and other energy-related costs, which can then raise the cost of products and services throughout the economy (Jackson, 2024). In this study, crude oil prices denote Brent crude oil price in Rand.	SARB	-
INF	Philips Curve discusses the link between inflation and unemployment. He hypothesised that there is an inverse correlation between the two variables. In this study, it represents the inflation rate of the South Africa economy.	FRED	-
EXR	The relative cost of one currency compared with another nation's currency is known as an exchange rate. It represents the rand/US Dollar exchange rate in this study.	FRED	-
INR	Interest rate is an imperative tool utilised by central banks to regulate inflation and spending. When interest rates are reduced, borrowing money becomes more affordable, leading to increased investment, driving up economic growth. Reduced interest rate also encourages businesses to fund expansion, resulting in more hiring and low unemployment (Asgharpur et al., 2007).	FRED	-

Where $\ln\left(\sigma_t^2\right)$ denotes the log normal of conditional variance, δ_1 is the leverage effect among return and volatility, and the assumption is that $\gamma_1 < 0$. A positive and substantial coefficient of conditional volatility indicates a positive correlation between risk and return. A negative and significant coefficient of the asymmetric term indicates heightened volatility in response to negative market news, whereas a positive asymmetric term signifies reduced volatility in reaction to positive market news (Haque and Shaik, 2021).

4. RESULTS AND DISCUSSION

4.1. Unit Root

To evaluate crude oil price effects on South African economic wellbeing, the collected data is tested for unit root to find out whether a time series is stationary or not. To check for unit root, the study employs the ADF and PP tests, which are known as formal unit-root tests. Tables 2 and 3 below present the findings of the formal tests.

Tables 2 and 3 above present the ADF and the PP test results of both models. For GARCH model to be utilised, the variables chosen in this study are required to be stationary at level, first difference, or both. The null hypothesis suggests that there is a unit root. A probability value <0.05 indicate that the variable is stationary.

The ADF test outcome in Table 2 indicates that the dependent variables of the two models, which are unemployment and economic growth, are not stationary at level. Stationarity of these variables occurs at first difference. Crude oil prices, exchange rate, and interest rate appears to be also non-stationary at level in both models, and only becomes stationary at first difference. Only inflation is stationary at level in both models using 5% level of significance. Therefore, reject the null hypothesis, concluding that the series is stationary.

The Philips-Peron (PP) test results in Table 3 confirms that both unemployment and economic growth are non-stationary at level, which is in line with ADF test outcome. These variables become stationary at first difference. Similar outcome occurs with all the independent variables in both models except for one, rejecting the null hypothesis. However, the stationarity of inflation at first difference contradicts the results of the ADF test. According to Gujarati and Porter (2009), it is essential to employ a multi-test approach to reach firm conclusions regarding the series' stationarity properties. Since the stationarity of inflation gives conflicting results, the study employs the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) Test to check whether inflation is stationary at level or first difference. Table 4 below present the outcome of the KPSS test on inflation for at level both models.

Table 4 present the outcome of the KPSS test on inflation at level for the two models. The KPSS test is not the same as the ADF and PP tests. The null hypothesis in the ADF and PP tests assumes that there is a unit root, while the KPSS test assumes the opposite. If the KPSS Test Statistic exceeds the critical value at 5% level of significance, the study reject the null hypothesis, suggesting that the series is non-stationary. The opposite is true. The outcome of the test suggests that KPSS Test Statistic (0.250019 and 0.349227) in both models is less than the critical value (0.463000) at 5% level of significance. This proves that inflation is stationary at level and does not require differencing. The KPSS test results are in line with the ADF test outcome, therefore, the study can

Table 2: Augmented Dickey Fuller test result for both models

Variables	Level			1st difference	Decision
	None	Intercept	Trend and Intercept	None	
Model 1					
UNE	0.8661	0.5288	0.0992	0	I (1)
COP	0.8150	0.8091	0.0797	0	I (1)
INF	0.2102	0.0110	-	-	I (0)
EXR	0.9872	0.9562	0.4392	0	I (1)
INR	0.3300	0.2930	0.1227	0	I (1)
Model 2					
LNGDP	0.9938	0.0696	0.9975	0.0307	I (1)
COP	0.8111	0.8174	0.0733	0	I (1)
INF	0.2454	0.0278	-	-	I (0)
EXR	0.9889	0.9597	0.4276	0	I (1)
INR	0.3029	0.2632	0.1408	0	I (1)

Source: Estimated by current author

Table 3: Phillips Peron test results for both models

Variables	Level			1ST difference	Decision
	None	Intercept	Trend and intercept	None	
Model 1					
UNE	0.9013	0.4129	0.1708	0	I (1)
COP	0.8855	0.8738	0.4030	0	I (1)
INF	0.1736	0.0974	0.2749	0	I (1)
EXR	0.9791	0.9398	0.6158	0	I (1)
INR	0.3829	0.4493	0.3356	0	I (1)
Model 2					
LNGDP	1.0000	0.1840	0.4981	0	I (1)
COP	0.8744	0.8786	0.3649	0	I (1)
INF	0.1960	0.1229	0.3270	0	I (1)
EXR	0.9814	0.9447	0.6018	0	I (1)
INR	0.3224	0.3712	0.4007	0	I (1)

Source: Estimated by current author

Table 4: Kwiatkowski-phillips-schmidt-shin (KPSS) test on inflation

Model 1	
KPSS test statistic	0.250019
Significance	**Critical value**
1% level	0.739000
5% level	0.463000
10% level	0.347000
Model 2	
KPSS test statistic	0.349227
Significance	**Critical value**
1% level	0.739000
5% level	0.463000
10% level	0.347000

Source: Estimated by current author

conclude that inflation is stationary at level not at first difference as the PP test assumed.

4.2. GARCH Estimation Analysis

To evaluate crude oil price effects on the economy's wellbeing of South Africa, the study employs the GARCH model. The model, revised by Bollerslev (1986), extend the ARCH model proposed by Engle (1982), aimed at overcoming the shortcomings of the ARCH model. The study employs the EGARCH model which is another form of the GARCH model.

The EGARCH model proposed by Nelson (1991) is frequently the appropriate model to use due to its ability to manage asymmetries, which is typical in commodity markets. This model is suitable for capturing time-varying volatility in time series data. The study employs this model because it aims to analyse how the volatility of crude oil prices impacts the economy's wellbeing of South Africa. The simplest and commonly used version of the EGARCH model is EGARCH (1, 1).

4.2.1. ARCH LM (lagrange multiplier) test

When employing the EGARCH model, it is essential to check the ARCH effects using the ARCH-LM test before estimating the model. If the ARCH effects are detected, therefore, the EGARCH model can be utilised. However, if the ARCH effects are not detected, there is no need to estimate the EGARCH model. The null hypothesis assumes that there are no ARCH effects. If the probability value is <0.05, reject the null hypothesis and conclude that ARCH effects are present. The other way around is true. Table 5 below present the outcomes of ARCH-LM test.

The ARCH-LM test outcome above show that the probability value is 0 in both models, which is <0.05. Therefore, the null hypothesis of no ARCH effects present is rejected meaning that there is ARCH effects present in the residuals. The presence of ARCH effects confirms that the EGARCH (1, 1) can be utilised. The next section is the results and discussion of the EGARCH model.

4.2.2. Estimation of the EGARCH model

The EGARCH (1, 1) model was utilised to evaluate how crude oil price volatility impact the economy's wellbeing of South Africa. Both models' results are presented in Table 6, where model 1 has unemployment as the dependent variable and model 2 has economic growth as the dependent variable. The models have the same independent variables. The study first gives interpretation of the variance equation (C6, C7, C8, and C9). In the first model, the asymmetric effect (C6) is not statistically significant, implying a lack of evidence to support a substantial asymmetric influence of crude oil prices on unemployment. The ARCH term (C7), which measure the influence of past shocks, is positive and significant at 1% level of significance. This indicate that past shocks in crude oil prices significantly increase the volatility of unemployment in South Africa, which will hinder the economy's wellbeing of South Africa.

C(8) is the GARCH term, which reflects how persistent past volatility is in predicting current volatility. The GARCH term is positive but not statistically significant with a probability value of 0.2446, indicating no strong evidence that unemployment volatility persists over time independently of new crude oil prices shocks. Crude oil price volatility (C9), which measures volatility of crude oil price effects on unemployment volatility, is positive and statistically significant with a P-value below 0.01. This indicates that higher crude oil price volatility results in greater volatility in unemployment, thereby reducing economic stability and well-being in South Africa.

In the second model, the asymmetric effect (C6) is significant and has a negative coefficient, indicating that a decline in crude oil prices significantly reduce the volatility of South Africa's economic growth, while oil price increases may increase it. This can happen as a result of increased exports revenue in South Africa. The ARCH term (C7), which measures past shock, is positive and statistically significant, suggesting that past shocks in crude oil prices are positively connected with current economic growth in South Africa. The GARCH term (C8), is statistically insignificant, meaning there no evidence that past economic growth volatility persists over time beyond the influence of new shocks. C9 represents crude oil price volatility, which is positive and significant. This implies that the volatility of crude oil prices is positively linked with South African economic growth. Increased export earnings and a better trade balance could be indirect advantages of increased oil prices for South Africa.

Table 6 outcome shows that crude oil prices are statistically significant at 1% level of significance in both models, with a probability value of 0.0006 in model 1 and 0.0000 in model 2. The coefficient of crude oil prices in each model has a positive

Table 5: Heteroskedasticity test: ARCH

Model 1			
Heteroskedasticity Test: ARCH			
F-statistic	21.42146	Pro. F(1, 117)	0.0000
Obs*R-square	18.41589	Prob. Chi-Square(1)	0.0000
Model 2			
Heteroskedasticity Test: ARCH			
F-statistic	101.0705	Pro. F(1, 122)	0.0000
Obs*R-square	56.18286	Prob. Chi-Square(1)	0.0000

Table 6: Results of the EGARCH model

Variable	Dependent variable: UNE Sample: 1994Q1-2023Q4 Observations: 120		Dependent variable: LNGDP Sample: 1993Q1-2024Q1 Observations: 125	
	Model 1		Model 2	
Variable	Coefficient	Prob.	Coefficient	Prob
COP	0.002442	0.0006	0.000328	0.0000
INF	−0.478517	0.0000	−0.002126	0.4227
EXR	0.004799	0.0000	0.000118	0.0000
INR	0.216910	0.0032	−0.016668	0.0000
C	19.58718	0.0000	13.58098	0.0000
Variance equation				
C (6)	−0.518485	0.1100	−2.457771	0.0147
C (7)	1.212256	0.0007	1.167145	0.0024
C (8)	0.260607	0.2446	−0.056060	0.7569
C (9)	0.544709	0.0025	0.727426	0.0000

Source: Estimated by current author

sign, which implies that the variable is positively correlated to both the study's dependent variables. As a result, a one percent increase in crude oil prices will result in approximately 0.24% rise in unemployment and also lead to approximately 0.033% rise in economic growth, ceteris paribus. The positive sign of the coefficient in the first model is in line with the expected sign from the hypothesis of the study drafted. However, the positive sign obtained in the second model is different from the expected sign.

Model 1: The positive correlation between prices of crude oil and unemployment suggests that if crude oil prices increase, unemployment will increase as well. According to Kilian (2010), in most crude oil-importing countries, rising oil prices elevate energy and transportation costs for firms, diminishing profit margins and perhaps prompting cost-reduction strategies, including layoffs. Higher unemployment may result due to businesses finding it difficult to continue operating under the rising costs. This corresponds with the findings of this study, which show that unemployment will rise when crude oil prices rise. Several previous research obtained similar findings, this includes a study done by Senzangakhona and Choga (2015) where they investigated the link between crude oil prices and unemployment in South Africa. Their findings indicate that there is a significant positive correlation between crude oil prices and unemployment in South Africa.

The study's findings are also in line with Ahmad (2013) who analysed oil price impacts on unemployment in Pakistan, and reported a positive connection between the two variables. Ahmed et al., (2023) also obtained that crude oil prices are positively linked with unemployment in United State of America. One study that contradict these findings was done by Raifu et al., (2020), who evaluated the connection between Nigerian unemployment and oil prices. Their findings show that there is an insignificant negative relationship between the two variables. This could be because of Nigeria being an oil-exporting country. The positive correlation between crude oil prices and unemployment suggests that if crude oil prices increase, unemployment will increase as well, which will hinder the wellbeing of the South African economy. South Africa relies heavily on imported crude oil, and is an essential input for various sectors, such as manufacturing, transportation, and agriculture. Elevated oil prices lead to high costs of production, which can reduce profit margins for businesses. To maintain profitability, firms may reduce their workforce, leading to higher unemployment. Therefore, using unemployment as a proxy for South African economic wellbeing, an increase in crude oil prices negatively impacts the wellbeing of the South African economy.

Model 2: Table 7 indicate that prices of crude oil are positively correlated to economic growth. The outcome is similar with Chisadza et al., (2016) and Matekenya (2013) who obtained a positive relationship between crude oil prices and economic growth and they are also significant. Takentsi et al. (2022) also used economic growth as a proxy for South African economic performance, and discovered a favorable correlation between crude oil prices and South African economic growth in both the long and short term. The positive correlation obtained between is not in line with the expected sign hypothesised and contradicts Balcilar et al., (2017) who obtained a negative relationship.

The robust monetary policy of South Africa may be the reason for the positive correlation between crude oil prices and economic growth. Although elevated oil prices exacerbate inflationary pressures, South Africa's central bank may implement a balanced monetary policy should economic prospects enhance due to increased export revenues. According to the Department of Mineral Resources and Energy (2024), coal accounts for 82% of South Africa's energy supply, indicating that crude oil is not the primary source of energy; it only contributes 9%. Overall, the current study's findings of a positive relationship between prices of oil and economic growth, indicate that high oil prices positively impact the economy's wellbeing of South Africa.

Inflation presents a negative relationship with both unemployment and economic growth. Table 8 shows that inflation has a negative coefficient and is statistically significant in model 1. However, the variable is insignificant in model 2. In model 1, the coefficient for inflation is −0.478517, indicating that a 1% rise in inflation leads to an approximate drop of 0.48 units in unemployment. The negative sign is in line with the expected sign of this study. These findings prove the Philips Curve theory, which state that there is an inverse correlation between unemployment and inflation, which simply means the higher the unemployment rate the faster the inflation rate will decrease. Idenyi et al., (2017) discovered a negative substantial relationship between inflation and Nigeria's unemployment. Korkmaz and Abdullazade (2020) found similar outcomes. When unemployment is low, people have more money to spend, resulting in a rise in demand for products and services causing prices to elevate. Conversely, when unemployment is high,

Table 7: Lag order selection criteria of Model 1

Model 1						
Lag	**LogL**	**LR**	**FPE**	**AIC**	**SC**	**HQ**
0	-2361.520	NA	1.55e+12	42.25928	42.38064	42.30852
1	-1772.610	1114.723	65698494	32.18946	32.91763*	32.48490
2	-1722.966	89.53660	42421976	31.74939	33.08436	32.29103*
3	-1707.190	27.04316	50352996	31.91412	33.85590	32.70196
4	-1681.563	41.64482	50423660	31.90291	34.45150	32.93695
5	-1641.194	61.99521*	39121407*	31.62846*	34.78386	32.90871
6	-1617.449	34.34499	41268646	31.65088	35.41309	33.17733
7	-1600.876	22.49283	50127111	31.80135	36.17036	33.57400
8	-1575.311	32.41271	52690783	31.79126	3.76708	33.81011

there is less money to spend, resulting in a decrease in inflation (Picardo, 2024).

The same negative relationship is present in model 2 between inflation and economic growth. However, the variable is insignificant. The negative link corresponds with the expected sign and confirms Philips Curve. These results are in line with Benazić and Rami (2016) and Akinsola and Odhiambo (2017) who evaluated monetary policy effects on unemployment. They also found negative and insignificant connection between inflation and unemployment.

Exchange rate on the other hand is positively linked with both unemployment and economic growth, and is also significant in both models. In model 1, exchange rate's coefficient is 0.004799, which suggest that a 1% rise in exchange rate result to approximately 0.48% increase in unemployment. The positive correlation corresponds with the sign drafted in the hypothesis, and the P-value of the variable is 0.0000, which is less than the 1% level of significance. These results similar with Benazić and Rami (2016) and Ani et al., (2019) established positive and significant connection between exchange rate and unemployment.

The positive relationship obtained is also in line with Nyahokwe and Ncwadi (2013), who analysed exchange rate volatility effects on unemployment in South Africa. The study also employed the GARCH method and found a positive link between exchange rate and unemployment, and significance. The positive relationship obtained converse the expected sign on the hypothesis drafted and contradict Senzangakhona and Choga (2015) who found that exchange rate negatively impacts unemployment in long and short run. The positive link suggests that as the South African Rand depreciates, unemployment increases, and vice versa is true. According to Benazić and Rami (2016), currency depreciation raises the cost of imported goods, leading to higher inflation. This lowers consumer spending and aggregate demand for products and services. Less demand can lead to reduced output and job cuts, increasing unemployment.

In model 2, exchange rate's coefficient is 0.000118, which implies that a 1% escalation in exchange rate, results in 0.0118% rise in unemployment. The probability value of exchange rate is <1% level of significance, indicating statistical significance for the variable. These results are almost similar Weliswa (2013) and Rapetti et al., (2012) obtained positive correlation between exchange rate and a nation's economic growth. Korkmaz (2013) also got similar outcome, as exchange rate depreciate, economic growth increases, or conversely, as exchange rate appreciate, economic growth decreases. The positive connection found between exchange rate and economic growth is in line with the expected sign in the hypothesis drafted. A stronger currency lowers prices of imported goods and services. Cheaper imports can alleviate inflationary pressures, improving consumers' real purchasing power and allowing them to spend more on goods and services, so stimulating domestic economic growth (Weliswa, 2013).

Table 8 further show that interest rate is positively correlated with unemployment in model 1 and negatively linked with economic growth in the second model. Interest rate is statistically significant in both models, with its P < 1% level of significance. In the first model, interest rate has a coefficient of 0.216910, which shows that a one percent rise in interest rate results in approximately 0.217 unit rise in unemployment. These results correspond with Senzangakhona and Choga (2015) who found that interest rates have a positive impact on unemployment in the long run, and a negative impact on unemployment in the short run. Nyahokwe and Ncwadi (2013) also employed the GARCH method and obtained interest rate is positively linked with unemployment. Doğrul and Soytas (2010) and Hashim et al., (2021) also found that the variables are positively connected. The positive link corresponds with the sign that was expected. When the SARB raise interest rates, borrowing costs increase for both businesses and consumers. Higher financing costs may cause businesses to limit their investment in capital projects, expansion, or hiring. Reduced investment slows economic growth and creates fewer job possibilities, which increases unemployment.

In model 2, interest rate is negatively correlated with economic growth and is significant with P < 0.01. The coefficient of the rate of interest in Table 6 suggests that a 1% rise in interest rate will result in approximately 0.0167 unit decline in economic growth. Weliswa (2013), Khazaleh (2024), Mohsen et al., (2022), and Al-Ajlouni and Sanajleh (2023) also reported a negative relationship between real interest and economic growth. Bağci and Ergüven (2016) found positive correlation between interest rate and a country's growth, contradicting the negative relationship obtained in this study. The negative correlation found corresponds with the expected sign. A rise in the rate of interest is expected to make borrowing expensive for businesses and individuals, which lowers investment resulting in slow production growth and economic expansion.

Table 8: Lag order selection criteria of model 1

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-2078.776	NA	2.03e+09	35.62010	35.73814	35.66803
1	-1405.956	1276.633	31486.74	24.54626	25.25451*	24.83380
2	-1348.467	104.1684	18111.21	23.99089	25.28934	24.51804*
3	-1330.180	31.57281	20432.28	24.10563	25.99430	24.87241
4	-1280.456	81.59841	13538.22	23.68300	26.16188	24.68939
5	-1238.063	65.94376*	10239.56*	23.38570*	26.45478*	24.63171
6	-1219.688	27.01351	11781.69	23.49894	27.15823	24.98456
7	-1210.223	13.10436	15964.76	23.76450	28.01400	25.48975
8	-1185.174	32.54328	16802.83	23.76365	28.60336	25.72851

Source: Estimated by current author

4.3. Toda-Yamamoto Causality Test

The research further employs the Toda-Yamamoto causality test, which is a method for assessing Granger causality between time series variables without necessitating pre-tests for stationarity or cointegration. This test is an updated form of the Granger causality test that can be utilised even when the series are integrated at different orders or when cointegration relationships are present between them. According to Ahmad (2013), the Toda-Yamamoto causality technique has four steps. The first step involves employing unit root tests to find the greatest order of integration (expressed by d_{max}) among the variables. The study has completed the unit root test earlier in the chapter, and the outcome indicated that inflation is stationary at level, whereas, the rest of the variables are integrated of order one.

The second step involves determining the lag length in the VAR model, by utilising information criteria such as the Akaike information criterion (AIC). Table 7 below presents the outcome of the optimal lag length of the first model, and Table 10 displays the results of model 2.

Tables 7 and 8 present optimal lag length outcome. The study uses the AIC for determination of optimal lag because it has the smallest value compared to the other criterions. The chosen lag length is indicated by an asterisk sign (*), which is 5 in both models based on the results. After selecting the optimal lag length, the final step involves estimating a VAR model by using the obtained optimal lag of 5 on the lag interval for endogenous and increase the optimal lag to 7 on the exogenous variables, followed by a Wald test for Granger causality. Granger causality demonstrates the direction of causation between variables, while the Toda Yamamoto technique is employed to analyse long-term Granger causality. Table 9 below display the outcome of the Toda-Yamamoto method for model 1 and Table 10 presents the results of model 2.

Table 9 above present the outcome of the Toda-Yamamoto technique for model 1. The findings indicate that there are only six significant relationships. The first relation shows that crude oil prices granger causes unemployment in the long term, as crude oil prices are significant. This corresponds with the EGARCH model results obtained. Elevated oil prices lead to increased production expenses, which can reduce profit margins for businesses, resulting in reduced workforce. This answers the main question of the study, positive crude oil price shocks increase unemployment, which hinders the economy's wellbeing of South Africa. The second significant relationship is from exchange rate to unemployment. This suggests that as

Table 9: Toda-Yamamoto causality test for model 1

Excluded	Chi-square	Degree of freedom	Prob.
Dependent variable: UNE			
COP	9.856004	5	0.0794
INF	7.836338	5	0.1655
EXR	15.40774	5	0.0088
INR	8.270068	5	0.1420
All	39.47322	20	0.0058
Dependent variable: COP			
UNE	3.692289	5	0.5949
INF	2.365865	5	0.7965
EXR	1.407178	5	0.9235
INR	1.736838	5	0.8842
All	14.74243	20	0.7910
Dependent variable: INF			
UNE	3.717249	5	0.5908
COP	14.52509	5	0.0126
EXR	21.71394	5	0.0006
INR	9.850280	5	0.0796
All	48.62810	20	0.0003
Dependent variable: EXR			
UNE	3.785365	5	0.5807
COP	10.03748	5	0.0742
INF	3.901701	5	0.5637
INR	6.576524	5	0.2541
All	22.71616	20	0.3029
Dependent variable: INR			
UNE	6.418931	5	0.2676
COP	4.121179	5	0.5321
INF	4.730033	5	0.4497
EXR	5.703817	5	0.3361
All	21.48274	20	0.3692

Source: Authors' computation using Eviews 12

Table 10: Toda-Yamamoto causality test for model 2

Excluded	Chi-square	Degree of freedom	Prob.
Dependent variable: LNGDP			
COP	17.98643	5	0.0030
INF	5.309520	5	0.3793
EXR	5.140939	5	0.3989
INR	2.016729	5	0.8468
All	45.50478	20	0.0009
Dependent variable: COP			
LNGDP	5.939977	5	0.3121
INF	1.794563	5	0.8768
EXR	2.465424	5	0.7817
INR	1.806912	5	0.8754
All	14.57098	20	0.8004
Dependent variable: INF			
LNGDP	3.216482	5	0.6667
COP	12.57547	5	0.0277
EXR	17.27993	5	0.0040
INR	7.577574	5	0.1811
All	39.50853	20	0.0058
Dependent variable: EXR			
LNGDP	3.597601	5	0.6087
COP	9.021779	5	0.1082
INF	1.548382	5	0.9074
INR	3.369867	5	0.6432
All	19.17511	20	0.5105
Dependent variable: INR			
LNGDP	1.961711	5	0.8544
COP	2.575301	5	0.7651
INF	4.252502	5	0.5137
EXR	2.429975	5	0.7870
All	15.09364	20	0.7710

Source: Estimated by current author

Table 11: Multicollinearity results

Variable	Model 1	Model 2
	Centered VIF	Centered VIF
COP	3.718068	3.835632
INF	1.705264	1.629143
EXR	2.548552	2.783030
INF	3.239681	2.975528

Source: Authors' computation using Eviews 12

Table 12: Diagnostic tests results

Diagnostic	Tests	Null hypothesis	Acceptance region	Probability	Conclusion
Model 1					
Autocorrelation	Serial Correlation LM test	No Autocorrelation	P >0.05	0.0000	Reject H_0
Fixed Autocorrelation	Serial Correlation LM test	No Autocorrelation	P >0.05	0.0516	Accept H_0
Normality	Jarque-Bera	Residuals are normally distributed	P >0.05	0.258769	Accept H_0
Model 2					
Autocorrelation	Serial Correlation LM test	No Autocorrelation	P >0.05	0.0000	Reject H_0
Fixed Autocorrelation	Serial Correlation LM test	No Autocorrelation	P >0.05	0.2534	Accept H_0
Normality	Jarque-Bera	Residuals are normally distributed	P >0.05	0.079580	Accept H_0

the Rand depreciates, unemployment increases as well in the long run, and the opposite is true. The outcome in Table 9 also reveals that crude oil prices granger cause inflation. Several industries rely heavily on imported crude oil, so a hike in crude oil price forces them to elevate the pricing of products and services.

Another significant relationship occurs from exchange rate to inflation. This implies that when the South African Rand depreciates, it causes imported goods and services to be more expensive, resulting in increased domestic prices. There also exist causality from interest rate to inflation. When the South African Reserve Bank lowers interest rate, it becomes affordable for companies and individuals to borrow money, leading to high purchasing power for businesses and consumers, which will increase aggregate demand, resulting in increased prices of goods. The last significant causality occurs from crude oil prices to exchange rate. Prices of crude oil are often expressed in US Dollars, an escalation in crude oil prices increases the cost of imports, creating high demand of US Dollars to pay for imports, resulting in depreciation of local currency. Table 10 below shows model 2 outcome.

Table 10 shows the Toda-Yamamoto outcome of model 2. The results presented shows three significant relationships. The first one show that crude oil prices Granger cause economic growth in the long run. High crude oil prices escalate production expenses for various industries especially those reliant on energy intensive-products, resulting in reduced profit and output. Low output hinders the economy's wellbeing of the country that import crude oil, particularly South Africa. This answers the main question of the study, indicating thet elevated crude oil prices negatively affect the economy's wellbeing of South Africa, utilising economic growth as a proxy.

Another significant relationship is from crude oil prices to inflation. This implies that crude oil prices have a substantial influence on inflation in the long run. Crude oil price shocks raises production expenses, reducing the business's profit margin and resulting in increased prices of goods and services. The last causality is from exchange rate to inflation. This implies that when the South African Rand depreciates, it causes imported goods and services to be more expensive, resulting in increased domestic prices.

4.4. Diagnostic Tests

4.4.1. Multicollinearity

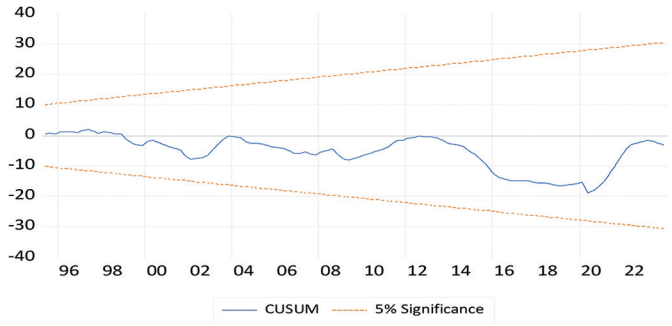
Multicollinearity occurs when 2 or more independent variables are associated. The current research employs the Variance Inflation Factor (VIF) to assess multicollinearity. Centered VIF values lying between 1 and 5, indicate that there is no severe multicollinearity, whereas, centered VIF values >5 shows evidence of multicollinearity existing in the model. Table 11 shows the outcome of multicollinearity for both models, and indicate that there is no severe multicollinearity existing in both model as the centered VIF values of all the independent variables are lying between 1 and 5.

4.4.2. Autocorrelation and normality

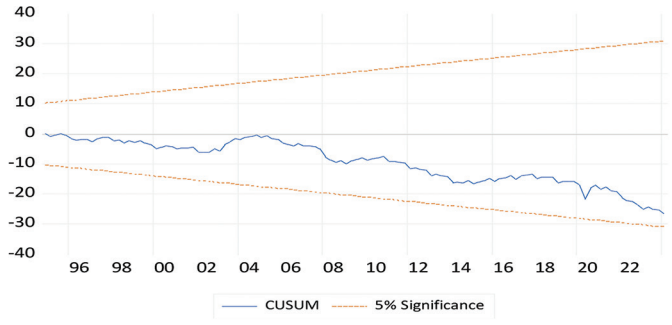
Table 12 present the outcome of the diagnostic tests. The study employed the serial correlation LM-test to test for autocorrelation and the Jaque-Bera test for normality. The P-values displayed show that there is no autocorrelation, and the residuals are normally distributed in both models.

4.4.3. Stability test

Model 1



Model 2



The study utilised the CUSUM test to test for the stability of the two models. The cumulative sum plot should be inside the 5% critical lines, which proves that residual variance is stable. If the cumulative sum plot is outside the 5% critical lines, then the model

is not stable. Based on the results shown below, the cumulative sum plot (blue line) lies within the 5% critical lines (red lines) which indicate that both models are stable.

5. CONCLUSION AND RECOMMENDATION

The current study used unemployment and economic growth as proxies of the economy's wellbeing of the country, with data spanning from 1994Q1 to 2023Q4 for unemployment model and from 1993Q1 to 2024Q1 for economic growth model. Following this was the unit-root test. A unit root test was performed to check whether the variables are stationary or non-stationary. The study utilised the ADF, PP, and KPSS tests to assess stationarity of the variables. Unit root results indicate that only inflation is stationary at level, and the other variables are stationary at first difference.

An EGARCH model was employed to evaluate crude oil price volatility on the economy's wellbeing of South Africa. The EGARCH model results indicated that there is a positive and substantial link between crude oil prices and unemployment. The significant relationship between the variables suggests that if crude oil prices elevate, unemployment will go up as well, which will hinder the wellbeing of the nation's economy. The findings further revealed that crude oil price shocks do not necessarily lower South African economic growth. Overall, crude oil price shocks negatively affect the economic wellbeing of the South Africa when using unemployment as a proxy but does not have sever effect through economic growth.

The study further employed the Toda-Yamamoto causality test to test the long run impact of one variable to the other. The lag selection was done using the AIC before that. The Toda-Yamamoto causality test indicated that crude oil prices granger causes both unemployment and economic growth, which proves that crude oil price shocks negatively affect the economy's wellbeing of South Africa.

5.1. Recommendations

The main objective of the study was to evaluate crude oil price effects on the economy's wellbeing of South Africa. The study has two models, with unemployment and economic growth used as proxies of the economy's wellbeing. An EGARCH method and the Toda-Yamamoto causality tests were employed to evaluate the association between crude oil prices and the economy's wellbeing of South Africa. Based on the findings of the study, the following policies are recommended:

The country has shown high dependence on oil that is imported, which makes it susceptible to oil hikes. The study recommends that policymakers from oil-importing countries consider making investments in renewable energy sources. Renewable energy can mitigate dependency on imported oil, stabilise energy costs, and improve economic resilience in an economy as South Africa, which is significantly influenced by crude oil price escalation. By diversifying its energy portfolio, South Africa can improve energy security and mitigate the risks linked to supply interruptions or geopolitical conflicts. By investing in clean energy technology and incorporating them into the national energy infrastructure, South Africa can reduce its susceptibility to oil price hikes while fostering growth and lower unemployment.

In most emerging nations that import oil, an escalation in production expenses arise as a result of crude oil price increase, leading to a rise in inflation. Monetary and fiscal policies can address how oil prices influence inflation. Monetary authorities face the task of addressing cost-push inflation caused by rising prices. The SARB uses inflation targeting to maintain inflation between 3% and 6%. The strategy can mitigate inflation caused by rising crude oil prices through interest rate adjustments. Another recommendation is to consider policies that would help stabilise exchange rate to prevent vulnerability during unexpected increases in crude oil prices.

REFERENCES

Ahmad, F. (2013), The effect of oil prices on unemployment: Evidence from Pakistan. Business and Economics Research Journal, 4(1), 43-57.

Ahmed, M.I., Farah, Q.F., Kishan, R.P. (2023), Oil price uncertainty and unemployment dynamics: Nonlinearities matter. Energy Economics, 125, 106806.

Ahmed, R., Chen, X.H., Kumpamool, C., Nguyen, D.T. (2023), Inflation, oil prices, and economic activity in recent crisis: Evidence from the UK. Energy Economics, 126, 106918.

Akinlo, T., Apanisile, O.T. (2015), The impact of volatility of oil price on the economic growth in Sub-Saharan Africa. British Journal of Economics, Management and Trade, 5(3), 338-349.

Akinsola, F.A., Odhiambo, N.M. (2017), Inflation and Economic Growth: A Review of the International Literature. Sciendo, 20(3), 41-56.

Al-Ajlouni, S.A., Sanajleh, B.M. (2023), The effect of real interest rate on real economic growth in Jordan. Jordan Journal of Economic Sciences, 10(2), 184-192.

Ani, E.C., Joel, E., Baajon, M.A. (2019), Exchange rate and unemployment in Nigeria: An analysis. International Journal of Family Business and Management, 3(2), 1-7.

Asgharpur, H., Kohnehshahri, L.A., Karami, A. (2007), The Relationships between Interest Rates and Inflation Changes: An Analysis of Long-Term Interest Rate Dynamics in Developing Countries. Available from: https://repo.uum.edu.my/id/eprint/2416

Bağci, E., Ergüven, E. (2016), Relations between interest rate, inflation, growth, and investment in Turkey, 2002-2015. ISOR Journal of Economics and Finance, 7(5), 43-49.

Balcilar, M., Eyden, R., Uwilingive, L., Gupta, R. (2017), The impact of oil price on South African GDP growth: A Bayesian markov switching-VAR analysis. African Development Review, 29(2), 319-336.

Bashar, O.H., Wadud, I.M., Ahmed, H.J.A. (2013), Oil price uncertainty, monetary policy and the macro-economy: The Canadian perspective. Economic Modelling, 35, 249-259.

Benazić, M., Rami, J. (2016), Monetary policy and unemployment in Croatia. Economic research-Ekonomska Istraživanja, 29(1), 1038-1049.

Bollerslev, T. (1986), Generalized autoregressive conditional heteroskedasticity. Journal of Econometrics, 31(3), 307-327.

Chen, J. (2024), Exchange Rates: What they are, how they Work, and why they Fluctuate. Available from: https://www.investopedia.com/terms/e/exchangerate.asp [Last accessed on 2024 Aug 31].

Chisadza, C., Dlamini, J., Gupta, R., Modise, M.P. (2016), The impact of oil shocks on the South African economy. Energy Sources, Part B: Economics, Planning, and Policy, 11(8), 739-745.

Deebom, Z.D., Essi, I.D. (2017), Modeling price volatility of Nigerian crude oil markets using Garch model: 1987-2017. International Journal of Applied Science and Mathematical Theory, 4(3), 23-49.

Department of Mineral Resources and Energy. (2023), South African Energy Trade Report 2023. Available from: https://www.dmre.gov.za/Portals/0/resources/publications/reports/energy%20sector%20reports/sa%20energy%20trade%20report/2023-south-african-energy-trade-report.pdf [Last accessed on 2024 Aug 19].

Department of Mineral Resources and Energy. (2024), The South African Energy Sector Report 2024. DMRE, Pretoria.

Doğrul, H.G., Soytas, U. (2010), Relationship between oil prices, interest rate, and unemployment: Evidence from an emerging market. Energy Economics, 32(6), 1523-1528.

Eltony, M.N., Al□Awadi, M. (2001), Oil price fluctuations and their impact on the macroeconomic variables of Kuwait: A case study using a VAR model. International Journal of Energy Research, 25(11), 939-959.

Engle, R. (2001), GARCH 101: The use of ARCH/GARCH models in applied econometrics. Journal of Economic Perspectives, 15(4), 157-168.

Engle, R.F. (1982), Autoregressive conditional heteroscedasticity with estimates of the variance of United Kingdom inflation. Econometrica: Journal of the Econometric Society, 50, 987-1007.

Gujarati, D.N., Porter, D.C. (2009), Basic Econometrics. 5th ed. United States of America: McGraw Hill Companies.

Haimes, Y.Y. (2011), Risk Modeling, Assessment, and Management. New Jersey: John Wiley & Sons.

Haque, M.I., Shaik, A.R. (2021), Predicting Crude Oil Prices During a Pandemic: A Comparison of Arima and Garch Models. Montenegrin Journal of Economics, 17(1), 197-207.

Hashim, A., Rambeli, N., Jalil, N.A., Hashim, E. (2021), The dynamic relationship between unemployment, inflation, interest rate and economic growth. International Journal of Innovation, Creativity and Change, 8(7), 89-94.

Idenyi, O., Favour, E.O., Johnson, N., Thomas, O. (2017), Understanding the relationship between unemployment and inflation in Nigeria. Advances in Research, 9(2), 1-12.

Jackson, E.A. (2024), Economic Theory of Inflation. Available from: https://www.econstor.eu/bitstream/10419/280999/1/economic-theory-of-inflation.pdf [Last accessed on 2024 Apr 14].

Jawad, M. (2013), Oil price volatility and its impact on economic growth in Pakistan. Journal of Finance and Economics, 1(4), 62-68.

Khazaleh, M. (2024), The relationship between crude oil prices and the gross domestic product, inflation, and unemployment: Evidence from Jordan. Business Series, 3(2), 283-299.

Kilian, L. (2010), Explaining fluctuations in us gasoline prices: A joint model of the global crude oil market and the US retail gasoline market. Energy Journal, 31(2), 87-112.

Korkmaz, S. (2013), The Effect of Exchange Rate on Economic Growth. Conference Paper.

Korkmaz, S., Abdullazade, M. (2020), The causal relationship between unemployment and inflation in G6 countries. Advances in Economics and Business, 8(5), 303-309.

Linkedin. (2023), How can you Choose the Best Lag Length for a Macroeconometric Model? Available from: https://www.linkedin.com/advice/1/how-can-you-choose-best-lag-length-macroeconometric-model#:~:text=The%20optimal%20lag%20length%20is,on%20the%20same%20lag%20length [Last accessed on 2024 Sep 15].

Linkedin. (2024), How do you Choose the Appropriate Lag Length and Frequency for Nonstationary Data? Available from: https://www.linkedin.com/advice/0/how-do-you-choose-appropriate-lag-length-frequency#:~:text=Lag%20length%20and%20frequency%20are,its%20relationship%20with%20another%20variable [Last accessed on 2024 Sep 15].

Maruping, H.P., Mongale, I.P. (2017), The real influences of oil prices changes on the growth of real GDP: The case of South Africa. Centre of Excellence for Scientific and Research Journalism, 5(1), 44-55.

Matekenya, W. (2013), The Impact of Oil Price Volatility on Economic Growth in South Africa: A Cointegration Approach. Masters Dissertation. Alice: University of Fort Hare.

McKinsey and Company. (2022), What is Inflation? Available from: https://www.mckinsey.com/featured-insights/mckinsey-explainers/what-is-inflation [Last accessed on 2024 Aug 02].

Mohsen, A.S., Hoang, F.A., Tariq, A.F. (2022), Effect of interest rates on economic growth in Bangladesh. Journal of Economics, 6(1), 36-44.

Najimi, E., Shorkar, M.A.N. (2019), Oil prices and unemployment relationship in Swedish economy. Asian Journal of Management Sciences and Education, 8(4), 113-125.

National Treasury Budget Review. (2024), 2024 Budget Review Economic Outlook. Available from: https://www.treasury.gov.za/documents/national%20budget/2024/review/chapter%202.pdf [Last accessed on 2024 Jun 04].

Nelson, D.B. (1991), Conditional heteroskedasticity in asset returns: A new approach Econometrica: Journal of the Econometric Society, 59, 347-370.

Niyimbanira, F. (2013), An investigation of the relationship between oil prices and inflation in South Africa. Mediterranean Journal of Social Sciences, 4(6), 105-111.

Nkoro, E., Uko, A.K. (2016), Autoregressive distributed lag (ARDL) cointegration technique: Application and interpretation. Journal of Statistical and Econometric Methods, 5(4), 63-91.

Nyahokwe, O., Ncwadi, R. (2013), The Impact of the Exchange Rate Volatility on Unemployment in South Africa (Doctoral Dissertation, University of Fort Hare).

Picardo, E. (2024), How Inflation and Unemployment are Related. Available from: https://www.investopedia.com/articles/markets/081515/how-inflation-and-unemployment-are-related.asp [Last accessed on 2024 Nov 28].

Rafiq, S., Salim, R., Bloch, H. (2009), Impact of crude oil price volatility on economic activities: An empirical investigation in the Thai economy. Resources Policy, 34, 121-132.

Raifu, I.A., Aminu, A., Folawewo, A.O. (2020), Investigating the relationship between changes in oil prices and unemployment rate in Nigeria: Linear and nonlinear autoregressive distributed lag approaches. Future Business Journal, 6, 1-18.

Rapetti, M., Skott, P., Razmi, A. (2012), The real exchange rate and economic growth: Are developing countries different? International Review of Applied Economics, 26(6), 735-753.

Rostin, R., Muthalib, A.A., Adam, P., Nur, M., Saenong, Z., Suriadi, L.O., Baso, J.N. (2019), The effect of crude oil prices on inflation, interest rates and economic growth in Indonesia. International Journal of Energy Economics and Policy, 9(5), 14-19.

Saidi, L.O., Adam, P., Rahim, M. (2019), The effect of crude oil prices on economic growth in South East Sulawesi, Indonesia: An application of autoregressive distributed lag model. International Journal of Energy Economics and Policy, 9(2), 194-198.

Senzangakhona, P., Choga, I. (2015), Crude oil prices and unemployment in South Africa: 1990-2010. Mediterranean Journal of Social Sciences, 6(2), 407-414.

South African Reserve Bank (SARB). (2024), Online Statistical Query. Available from: https://www.resbank.co.za/en/home/what-we-do/statistics/releases/online-statistical-query [Last accessed on 2024 Apr 09].

South African Reserve Bank. (2002), Statement of the Monetary Policy Committee. Available from: https://www.resbank.co.za/en/home/publications/publication-detail-pages/statements/monetary-policy-statements/2002/4321#:~:text=inflationary%20pressures%20increased%20sharply%20in,rising%20expectations%20of%20price%20increases [Last accessed on 2024 Aug 25].

Statistics South Africa. (2024), Quarterly Labour Force Survey (QLFS) – Q4. Available from: https://www.statssa.gov.za/publications/P0211/

Media%20release%20QLFS%20Q4%202023.pdf [Last accessed on 2024 Apr 15].

Taher, H. (2021), Oil price fluctuations impact on the Lebanese economic wellbeing. BAU Journal-Health and Wellbeing, 4(1), 10.

Takentsi, S., Sibanda, K., Hosu, Y.S. (2022), Energy prices and economic performance in South Africa: An ARDL bounds testing approach. Cogent Economics and Finance, 10(1), 2069905.

Wabiri, N., Amusa, H. (2011), South African Crude Oil Import Portfolio Risks: Which Way Out? Available from: https://hsrc.ac.za/uploads/pagecontent/3328/2011febsouth%20african%20crude%20oil%20import%20portfolio%20risks.pdf [Last accessed on 2024 Apr 15].

Wallstreetmojo Team. (2024), Unit Root Tests. Available from: https://www.wallstreetmojo.com/unit-root-tests [Last accessed on 2024 Apr 15].

Weliswa, M. (2013), The Impact of Oil Price Volatility on Economic Growth in South Africa: A Cointegration Approach. Unpublished Master's Thesis, University of Fort Hare, South Africa.

Ziramba, E. (2010), Price and income elasticities of crude oil import demand in South Africa: A cointegration analysis. Energy Policy, 38(12), 7844-7849.