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Oil Price Fluctuations and Their Impact on Macroeconomic Variables: The Case of South Africa

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ABSTRACT

Oil price volatility has a significant impact on macroeconomic performance, presenting challenges for policymakers in both oil-exporting and oil-importing countries. This study examines the impact of oil price fluctuations on economic growth, inflation, and unemployment in South Africa over the period January 2000-December 2021, capturing more than two decades of economic and oil market dynamics, including major shocks such as the 2008 global financial crisis, the 2014 oil price collapse, and the COVID-19 pandemic. We explore short- and long-term relationships among these variables using the Johansen cointegration approach and a vector error correction model (VECM). Unit root tests indicate all series, except inflation, are stationary in first differences, and Granger causality tests reveal non-statistically significant short-run causality. Variance decomposition shows crude oil prices, inflation, and GDP account for a substantial share of unemployment variation over time. The analysis reveals a negative long-term relationship between oil prices and key macroeconomic indicators, suggesting that rising oil prices have an adverse impact on South Africa's economy. Diagnostic tests confirm model adequacy, with no evidence of heteroscedasticity and normally distributed residuals. These findings underscore the importance of incorporating oil price volatility into macroeconomic planning and the need for continued research on these dynamic relationships.

Keywords: Macroeconomic Variables, Vector Error Correction Model, Oil Price Fluctuations, South Africa
JEL Classifications: E31, Q43, C321

1. INTRODUCTION

The impacts of oil price variations are frequently discussed in public and academic discourse, yet their full implications for the broader economy are often poorly understood. Typically, increases in oil prices are expected to lead to higher gasoline and commodity prices, with adverse effects on economic performance. To better understand this process and its broader macroeconomic consequences, it is essential to investigate the effects of oil price fluctuations. Oil is a vital source of energy, widely used across nearly all sectors of the global economy, hence, its price movements influence not only energy markets but also broader economic performance. In this sense, oil is a key economic driver with the potential to shape macroeconomic conditions.

Oil is a critical global commodity that influences nearly every industry and plays a pivotal role in shaping economic outcomes. Oil price fluctuations impact energy markets and broader macroeconomic indicators, including inflation, economic growth, and employment. Numerous studies have highlighted the direct and indirect channels through which oil price shocks impact national economies (Yıldız et al., 2024; Khobai et al., 2024). This is particularly significant for countries like South Africa, where oil is largely imported, leaving the economy vulnerable to global oil price volatility. Recent analyses have highlighted the contribution of rising oil prices to inflationary pressures and macroeconomic instability in South Africa (South African Reserve Bank, 2024; Retail Motor Industry Organization [RMI], 2024). Given oil's central role, understanding the dynamics of its price movements is essential for policymakers, aiming to maintain macroeconomic stability (Balcilar et al., 2017).

The impact of oil price shocks on the global economy has been extensively documented, particularly following the crises of the 1970s, which culminated in negative issues like, high inflation, unemployment, and economic stagnation in many countries (Balcilar et al., 2017; International Monetary Fund [IMF], 2000). More recently, price fluctuations, such as the sharp increase in oil prices from 2001, followed by the dramatic decline in 2008, have reignited global interest in the macroeconomic effects of oil volatility (Nyangarika et al., 2019; Blanchard and Galí, 2007). These shocks highlighted the close relationship between oil prices and the economic health of nations; for instance, the 2008 financial crisis led to a steep decline in oil prices from $133.11 in July 2008 to under $42.01 by December 2008 due to a collapse in global demand (Balcilar et al., 2017; Investopedia, 2015; IMF, 2015a). These oil prices began to rebound shortly thereafter, however, this volatility reflects the persistent instability of global oil markets and the need for constant studies (Nyangarika et al., 2019; IMF, 2015b). Improvements in energy efficiency and policy responses have made some economies more resilient to oil price hikes (Blanchard and Galí, 2007), although supply-driven shocks continue to pose risks (IMF, 2015b; Federal Reserve Bank of St. Louis, 2022). Recent studies, further emphasize the effects of oil price uncertainty on macroeconomic activity, particularly in industrial production in the United States (Abiad & Qureshi, 2023). Geopolitical disruptions, such as ongoing conflicts in the Middle East, for instance, have triggered oil price spikes that have the potential to fuel global inflation and dampen economic growth (World Bank, 2023).

In South Africa, the effects of oil price fluctuations are particularly pronounced due to the country's dependence on oil imports since global price movements have a direct impact on domestic production costs, inflation dynamics, and overall economic performance. As oil is a critical input in the production of goods and services, volatility in its price can influence the economy through both direct and indirect channels (Sedick, 2016).

This study examines the relationship between oil price fluctuations and key macroeconomic indicators in South Africa over the period 2000-2021, capturing more than two decades of economic and oil market dynamics. This period encompasses major global and domestic shocks, including the 2008 financial crisis, the 2014 oil price collapse, and the COVID-19 pandemic, while also coinciding with the implementation of South Africa's modern monetary policy frameworks, such as inflation targeting. By focusing on this timeframe, the study provides a robust foundation for analyzing both the short- and long-term effects of oil price volatility on the economy, and although the data ends in 2022, the findings remain relevant for contemporary policy discussions due to ongoing global energy transitions and geopolitical risks that continue to affect oil markets.

There are well-documented global impacts of oil prices on macroeconomic indicators, despite this, a significant gap remains in the literature addressing the South African context. Many studies have examined oil price shocks in developed economies, however, relatively few have focused on emerging markets such as South Africa (Aaron and Sherzod, 2009). This study addresses this gap by empirically examining the relationship between oil price fluctuations and key macroeconomic indicators, specifically inflation, GDP, and unemployment, in South Africa. By generating context-specific insights, this research aims to inform more effective and responsive policy strategies for managing oil price volatility (Bayraktar et al., 2016).

Recent economic developments underscore the relevance of this analysis. The South African Reserve Bank (SARB) has repeatedly identified oil price volatility as a risk to achieving its anti-inflation targets (Sedick, 2016). In its latest monetary policy review, the SARB cautioned that elevated oil prices pose an upside risk to inflation, potentially obstructing progress toward the 4.5% inflation target by the end of 2025 (Reuters, 2024). Additionally, higher fuel prices have contributed to rising producer price inflation, particularly in the petroleum and chemical industries, thereby intensifying cost pressures on production (South African Reserve Bank, 2023). The Retail Motor Industry Organization (2024) has noted that a weakening rand, combined with global oil price increases, has exacerbated fuel price inflation, negatively affecting business operations and household expenses.

These dynamics highlight the need for a more nuanced understanding of oil price transmission mechanisms within the South African economy and the development of evidence-based, resilient policy frameworks to mitigate their adverse effects. To address these issues, the remainder of this paper is structured as follows: Section 2 reviews relevant literature on oil price volatility and its macroeconomic effects. Section 3 outlines the data sources and methodological approach used in the study. Section 4 reports and discusses the empirical findings from this study; finally, Section 5 concludes with key insights and policy recommendations based on these results.

2. LITERATURE REVIEW

2.1. Theoretical Framework

The macroeconomic effects of oil price fluctuations can be understood through several key theoretical perspectives. The Classical model, which assumes flexible prices and wages, posits that oil price increases, temporarily raise production costs and unemployment but leave long-term output unaffected due to market self-correction (Chen and Zhu, 2019; Weliswa, 2013). The Transmission Mechanism framework distinguishes between oil-exporting and importing countries, with exporters benefiting from higher revenues and demand, while importers face increased production costs, inflation, and potential recessions driven by reduced consumption and income (Gershon et al., 2019; Aaron and Sherzod, 2009; Weliswa, 2013). Complementing these, the Keynesian theory emphasizes demand-side constraints and the urgency of active policy responses, highlighting how oil price shocks can suppress consumption and investment, leading to underutilized resources and slower growth, thus necessitating fiscal and monetary interventions to stabilize inflation and output (Clarke, 2022; Oberholzer, 2017). Together, these frameworks provide a comprehensive foundation for analyzing the diverse macroeconomic impacts of oil price volatility.

2.2. Empirical Literature

Numerous empirical studies have examined the macroeconomic effects of oil price shocks, with findings varying significantly, depending on countries' oil trade status, economic structure, and policy responses. In oil-exporting economies, such as Nigeria, Bawa et al. (2020) used a nonlinear autoregressive distributed lag (NARDL) model to discover that rising global oil prices significantly increased headline, core, and food inflation. Awujola et al. (2020) similarly concluded that oil price volatility prompts policy actions, including financial sector reforms and anti-corruption measures, to mitigate inflationary effects. In contrast, in their study, Yakubu and Akanegbu (2019) reported that oil price volatility negatively affects Nigeria's economic growth, thereby, recommending diversification away from oil-dependency activities. Chukwuigwe et al. (2019) noted that, although oil prices have a positive correlation with short-term growth in Nigeria, the long-term relationship is more complex, suggesting the need for structural economic reforms.

Beyond Nigeria, other oil-exporting countries also experience diverse outcomes. In Azerbaijan, Mukhatarov (2020) observed that oil prices have a positive impact on growth and exports, but simultaneously exert downward pressure on the exchange rate, revealing a nuanced relationship between oil revenues and macroeconomic stability. In Qatar and Venezuela, Hajebi and Mohammadi (2022) found, using a global vector autoregressive (GVAR) model, that oil booms lead to increased fiscal spending and liquidity, however, in countries such as Nigeria and Iran, poor management of foreign exchange revenues has adverse effects on real GDP, underscoring the necessity for institutional quality.

In oil-importing countries, the adverse effects of oil price shocks tend to be more pronounced. Nitami et al. (2021) demonstrated that in Indonesia, oil price hikes contribute to long-term inflation and currency depreciation, although they provide a slight boost to economic growth. Usman (2020), using GJR-GARCH and VAR models for Pakistan, maintained that oil price volatility reduces both economic growth and employment, thereby advocating for energy reforms and reduced reliance on imported oil. In Liberia and Sierra Leone, Gershon et al. (2019) reported positive impacts on GDP per capita during periods of rising oil prices; however, inflationary pressures often offset these benefits. South Africa, a highly oil-dependent and well-studied economy, consistently shows strong macroeconomic responses to oil shocks. Studies by Nkomo (2006) and Weliswa (2013) highlight that rising oil prices contribute to inflation and economic strain, as the country is heavily dependent on oil imports. Maheu et al. (2020) and Sibanda et al. (2015) further confirmed the link between oil prices, inflation, and inflation expectations. SVAR-based analyses by Dlamini (2015) and Yildiz et al. (2021) illustrate significant impacts on exchange rates and inflation, although the short-term effects on GDP were minimal.

The broader socioeconomic consequences in South Africa are also well-documented. Chiweza and Aye (2018) demonstrated that oil price uncertainty affects both output and inflation, while Hassan et al. (2020) linked gasoline price increases to long-term reductions in economic growth. Sibanda et al. (2015) revealed that oil price volatility has adverse employment effects, particularly in the private sector. Chitiga et al. (2009) and Essama-Nssah et al. (2007) also demonstrated that petroleum price shocks lead to reductions in GDP and employment, with a disproportionate impact on low-income households due to higher transport costs. Maluleke and Leshoro (2020) added that, although wage pressures may rise in response to fuel price hikes, these are often offset by increased inflation and a decline in overall economic well-being.

The asymmetric and nonlinear nature of oil price impacts has been focused upon in more recent research. Wakeford (2006) argued that while oil shocks in the 1970s were highly disruptive, their modern-day effects have been moderated due to structural adjustments and the evolution of oil markets. Studies, such as those by Saidu et al. (2020) and Naseem et al. (2022) discovered that oil price increases for oil-importing countries lead to sharper economic contractions than how oil-price decrease stimulates recovery. Pamba (2024) employed a Markov Switching Intercepts VAR (MSI-VAR) model to analyze South African data from 2000 to 2023, identifying two distinct regimes: economic growth and recession. The study found that oil shocks reduce real GDP growth during expansions but increase it during recessions. Inflation declined across both regimes, while exchange and interest rates rose in growth periods and declined during recessions. The current account balance worsened in both regimes, underscoring persistent external vulnerabilities. These results highlight the need of accounting for regime-dependent responses, when formulating policy.

Additional country-specific evidence reinforces the asymmetric effects of oil shocks. In Kuwait, Alawadhi and Longe (2024) employed a VAR framework to find that positive oil price changes have a more significant and favorable impact on macroeconomic indicators than negative ones. The authors stressed the need for stronger policy frameworks to capitalize on oil booms and mitigate downturns through hedging mechanisms and fiscal buffers. At a broader level, Candemir (2013) found that macroeconomic responses to oil price fluctuations in OECD countries vary with the degree of oil import dependence. Similarly, Köse and Unal (2021) reported that both oil price levels and volatility significantly influence inflation in Turkey, suggesting the need for close monitoring of global oil markets and the implementation of inflation-targeting policies.

The empirical literature reveals that oil price shocks have significant and multidimensional effects on key macroeconomic indicators, including inflation, output, exchange rates, and the current account. These effects, however, can be mediated by trade status, institutional quality, and monetary policy flexibility. Oil-exporting countries may benefit in the short term from rising prices, however, long-term volatility often undermines economic stability due to fiscal mismanagement or Dutch Disease effects. Oil-importing countries, by contrast, are particularly vulnerable to inflationary pressures, currency depreciation, and reduced employment.

There is some depth in existing research; however, several gaps remain. First, much of the literature employs linear or symmetric models, potentially overlooking the true nature of oil price dynamics. Second, relatively few studies adopt a regime-switching or nonlinear framework that can account for differences in economic conditions. Third, limited attention is given to economies such as South Africa, which exhibit structural dualities, high dependence on imported oil, and diversified industrial bases. This study fills these gaps by applying a nonlinear, regime-dependent VAR model to examine the asymmetric impacts of oil price shocks on key macroeconomic variables in South Africa, thereby providing policymakers with more nuanced insights into these effects.

3. METHODOLOGY AND DATA

3.1. Methodology

This study employed a quantitative time series approach to examine the impact of oil price fluctuations on key macroeconomic indicators in South Africa, following a structured analysis procedure. First, the stationarity of each variable was tested using the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests. If the variables are integrated of the same order, the Johansen cointegration test is applied to determine the existence of long-run relationships. However, where cointegration is confirmed, a vector error correction model (VECM) is estimated to capture both short- and long-run dynamics. Granger causality tests are conducted to assess the direction of relationships, followed by impulse response functions and variance decomposition to evaluate the effects and contribution of oil price shocks over time. Diagnostic checks ensured the robustness of the model.

3.2. Data

The study utilized annual data from 2000 to 2021, sourced from the World Bank and the South African Reserve Bank. Variables include oil prices (WTI average), GDP (in current USD), unemployment, and inflation rates (in percentages), all adjusted to real terms. Data were processed in Excel and analyzed using EViews 12.

3.3. Model Specifications

Examining the theoretical and empirical literature allowed for the specification of the model. The models developed by Nitami and Hayati (2021) to analyze the relationship between crude oil price variations and macroeconomic indicators in Indonesia were adopted and modified for this study. As a result, the VAR model was described as follows:

$$\mathrm{COP_t} = \beta_{01} + \sum_{i=1}^{n} \beta i COP_{t-i} + \sum_{i=1}^{n} xiGDP_{t-i} + \sum_{i=1}^{n} \vartheta i INF_{t-i} + \sum_{i=1}^{n} \partial i OER_{t-i} + \varepsilon_{1t} \quad (3.1)$$

$$\mathrm{GDP_t} = \beta_{02} + \sum_{i=1}^{n} \beta i COP_{t-i} + \sum_{i=1}^{n} xiGDP_{t-i} + \sum_{i=1}^{n} \vartheta i INF_{t-i} + \sum_{i=1}^{n} \partial i OER_{t-i} + \varepsilon_{2t} \quad (3.2)$$

$$\mathrm{INFL_t} = \beta_{03} + \sum_{i=1}^{n} \beta i COP_{t-i} + \sum_{i=1}^{n} xiGDP_{t-i} + \sum_{i=1}^{n} \vartheta i INF_{t-i} + \sum_{i=1}^{n} \partial i OER_{t-i} + \varepsilon_{3t} \quad (3.3)$$

$$\mathrm{CER_t} = \beta_{04} + \sum_{i=1}^{n} \beta i COP_{t-i} + \sum_{i=1}^{n} xiGDP_{t-i} + \sum_{i=1}^{n} \vartheta i INF_{t-i} + \sum_{i=1}^{n} \partial i OER_{t-i} + \varepsilon_{4t} \quad (3.4)$$

$\mathrm{INFL_t}$ represents inflation at time, $\mathrm{GDP_t}$ represents Economic growth at time, $\mathrm{COP_t}$ represents crude oil prices at time, and $\mathrm{OER_t}$ represents the exchange rate at time.

This study updated the VAR model to explore how oil price changes impact the variables; hence, the exchange rate is excluded from the modified models. Below are the four models:

$$\mathrm{COP_t} = \delta_1 + \sum_{k=1}^{n} \delta i COP_{t-k} + \sum_{k=1}^{n} ykGDP_{t-k} + \sum_{k=1}^{n} \beta k INF_{t-k} + \sum_{k=1}^{n} \partial i UN_{t-k} + \mu_{1t} \quad (3.5)$$

$$\mathrm{GDP_t} = \delta_2 + \sum_{k=1}^{n} \delta i COP_{t-k} + \sum_{k=1}^{n} ykGDP_{t-k} + \sum_{k=1}^{n} \beta k INF_{t-k} + \sum_{k=1}^{n} \partial i UN_{t-k} + \mu_{2t} \quad (3.6)$$

$$\mathrm{INFL_t} = \delta_3 + \sum_{k=1}^{n} \delta i COP_{t-k} + \sum_{k=1}^{n} ykGDP_{t-k} + \sum_{k=1}^{n} \beta k INF_{t-k} + \sum_{k=1}^{n} \partial i UN_{t-k} + \mu_{3t} \quad (3.7)$$

$$\mathrm{UN_t} = \delta_4 + \sum_{k=1}^{n} \delta i COP_{t-k} + \sum_{k=1}^{n} ykGDP_{t-k} + \sum_{k=1}^{n} \beta k INF_{t-k} + \sum_{k=1}^{n} \partial i UN_{t-k} + \mu_{4t} \quad (3.8)$$

Whereby:

GDP = Gross domestic product/economic growth

COP = Crude oil price,

INF = Inflation,

UN = Unemployment

δ = Constant

k = Lag length

ε = Shock.

4. EMPIRICAL RESULTS AND DISCUSSION

This section presents the empirical results and their implications for the study's objectives. The stationarity of the variables was tested using standard unit root tests. Except for inflation, all variables were non-stationary at levels but became stationary after first differencing, indicating integration of order one, I(1). Consequently, cointegration tests were applied to examine long-run relationships. Upon confirming cointegration, a vector error correction model was estimated to capture short- and long-term dynamics. Additional analyses, including Granger causality tests, impulse response functions, and variance decomposition, were performed to assess the direction and magnitude of interactions.

Results are discussed in the context of economic theory and prior studies, shedding light on the macroeconomic impacts of oil price fluctuations in South Africa.

4.1. Unit Root Tests

Stationarity was assessed using the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests to ensure that the time series variables were free from spurious regression. The null hypothesis of a unit root was tested at the 5% significance level, where a $P \leq 0.05$ indicates stationarity, and a $P > 0.05$ suggests non-stationarity. The results in (Tables 1a and b) indicate that all variables except inflation are non-stationary at the level, however, after first differencing, all variables became stationary in the ADF and PP tests, confirming they were integrated of order one, I(1). This justified the use of the Johansen cointegration test to assess long-run relationships.

4.2. Lag Order Selection

Before proceeding with the Johansen cointegration test, it is essential to determine the optimal lag length for the VAR system. The lag order was selected based on multiple information criteria, including the Log-likelihood (LogL), Likelihood Ratio (LR), final prediction error (FPE), Akaike Information Criterion (AIC), Schwarz Criterion (SC), and Hannan-Quinn Criterion (HQ). As shown in Table 2, most of the criteria (LR, FPE, AIC, and SC) suggest that the optimal lag length is three. This lag order is thus retained for the cointegration analysis.

4.3. Johansen Cointegration Test

With all variables confirmed to be integrated of order one, I(1), the Johansen cointegration test was applied to examine the existence of long-run relationships among oil prices, GDP, inflation, and unemployment, using both the Trace and Maximum Eigenvalue test statistics. As presented in (Tables 3a and b), the Trace test indicates the presence of three cointegrating equations, with test statistics of 86.29, 42.73, and 16.31 for "None," "At most 1," and "At most 2," all exceeding their respective 5% critical values of 47.86, 29.80, and 15.49, and corresponding P = 0.0000, 0.0010, and 0.0376. The Maximum Eigenvalue test supports at least two cointegrating vectors, with values of 43.56 and 26.42 at "None" and "At most 1" exceeding the critical thresholds of 27.58 and 21.13, and P = 0.0002 and 0.0082, respectively. The result at "At most 2" (14.26; P = 0.0502) although marginal, it aligns with the Trace test outcome. These findings confirm a strong long-run equilibrium relationship among the variables, supporting the use of a vector error correction model (VECM) in subsequent analysis to explore both long- and short-term dynamics.

4.4. Vector Error Correction Model (VECM)

After confirming cointegration, the vector error correction model (VECM) analyzes long-run relationships and short-run dynamics among oil prices, GDP, inflation, and unemployment. Table 4 shows the estimated long-run cointegration coefficients and short-run adjustment parameters, highlighting how these variables interact over time. The long-run cointegration equation shows that

Table 1a: Augmented Dickey-Fuller (ADF) Stationarity test results

Variable	ADF	Level	Conclusion	1st difference	Conclusion
Oil	C	0.2214	Not stationary	0.0034	Stationary
	T and C	0.5277	Not stationary	0.0168	Stationary
GDP	C	0.2573	Not stationary	0.0071	Stationarity
	T and C	0.9533	Not stationary	0.0032	Stationary
Inflation	C	0.0101	Stationary	0.0000	Stationary
	T and C	0.7993	Not stationary	0.0001	Stationary
Unemployment	C	0.96	Not stationary	0.0060	Stationary
	T and C	0.1007	Not stationary	0.0289	Stationary

Source: Authors' computation using EViews 12

Table 1b: Phillips- Perron (PP) stationarity test results

Variable	Phillips Perron	Level	Conclusion	1st difference	Conclusion
Oil	C	0.1910	Not stationary	0.0034	Stationary
	T and C	0.4754	Not stationary	0.0168	Stationary
GDP	C	0.1157	Not stationary	0.0071	Stationary
	T and C	0.9791	Not stationary	0.0014	Stationary
Inflation	C	0.0982	Stationary	0.0001	Stationary
	T and C	0.2894	Not stationary	0.0007	Stationary
Unemployment	C	0.9662	Not stationary	0.0059	Stationary
	T and C	0.4462	Not stationary	0.0253	Stationary

Source: Authors' computation using EViews 12

Table 2: Lag order selection criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	−590.5926	NA	1.79e+22	62.58869	62.58869	62.62234
1	−536.4542	79.78282*	3.39e+20	58.57413	59.56828	58.74238
2	−522.3760	14.81914	5.49e+20	58.77643	60.56589	59.07927
3	−481.4638	25.83930	9.73e+19*	56.15409*	58.73887*	56.59153*

Source: Authors' computation using EViews 12. *Indicates the lag order selected by the criterion, LR: Sequential modified LR test statistic (each test at 5% level)

Table 3a: Unrestricted cointegration rank test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace statistic	0.05 critical value	Prob.**
None*	0.898995	86.28752	47.85613	0.0000
At most 1*	0.751028	42.72831	29.79707	0.0010
At most 2*	0.527758	16.31042	15.49471	0.0376
At most 3	0.102533	2.055395	3.841465	0.1517

Source: Authors' computation using EViews 12. The trace test indicates three cointegrating equations at the 0.05 level. *Denotes rejection of the hypothesis at the 0.05 level. **MacKinnon-Haug-Michells (1999) P values

Table 3b: Unrestricted cointegration rank test (maximum eigenvalue)

Hypothesized No. of CE (s)	Eigenvalue	Max-Eigen statistic	0.05 critical value	Prob.**
None*	0.898995	43.55920	27.58434	0.0002
At most 1*	0.751028	26.41789	21.13162	0.0082
At most 2	0.527758	14.25503	14.26460	0.0502
At most 3	0.102533	2.055395	3.841465	0.1517

Source: Authors' computation using EViews 12. Max-Eigenvalue test indicates 2 cointegrating eqn (s) at the 0.05 level. *Denotes rejection of the hypothesis at the 0.05 level. **MacKinnon-Haug-Michells (1999) P values difficult to reject the null hypothesis

Table 4: Results from the long-run and short-run co-integration equation

Variables	Coefficient	Standard error	t-statistic
Constant	4.565378	-	-
Crude oil	1.000000	-	-
Inflation	−0.782688	0.87926	−0.89017
GDP	−8.984708	1.0778925	−8.33519
Unemployment	−24.38530	4.31767	−5.64780
Short-run analysis			
Crude oil	0.284530	0.29056	0.97925
Inflation	−2.141794	1.76122	−1.21609
GDP	−2.772577	5.338441	−0.51936
Unemployment	2.887182	28.3509	0.10184

Source: Authors' computation using EViews 12

GDP and unemployment have strong and statistically significant negative relationships with crude oil prices. Specifically, GDP has a coefficient of −8.9847 with a t-statistic of −8.3352, while unemployment has a coefficient of −24.3853 with a t-statistic of −5.6478. These values exceed the conventional critical value (|t| > 1.96), indicating statistical significance at the 5% confidence level. Inflation, although negatively related to oil prices (coefficient = −0.7827), is not statistically significant (t = −0.8902). None of the variables exhibits statistically significant effects in the short-run dynamics, as all t-statistics are below 1.96 in absolute terms. Crude oil has a coefficient of 0.2845 (t = 0.9792), inflation is −2.1418 (t = −1.2161), GDP is −2.7726 (t = −0.5194), and unemployment is 2.8872 (t = 0.1018). This indicates a weak short-term responsiveness of macroeconomic variables to changes in oil prices.

4.5. Granger Causality Test

The Granger Causality test was employed to examine the directional predictive relationships among the variables in this study. The test determines whether past values of one variable can predict another, indicating one-way, two-way, or no causality. Based on the P-values reported in Table 5, a causal relationship is inferred when the P ≤ 0.05 significance level. Conversely, P > 0.05 indicate a failure to reject the null hypothesis of no causality. The results in Table 5 are based on a lag length of three and a 5% significance level. All P-values exceeded 0.05, suggesting that none of the variables Granger-cause each other. This suggests the absence of predictive causality among crude oil prices, GDP, inflation, and unemployment during the sample period.

Table 5: Granger causality test results (lags 3)

Null hypothesis	Obs	Probability	Information
GDP does not granger cause crude oil	19	0.6093	Not causality
Crude oil does not granger-cause GDP		0.7655	Not causality
Infl does not Granger-cause crude Oil	19	0.6792	Not causality
Crude oil does not Granger-cause Infl		0.2443	Not causality
Unempl does not Granger Cause Crude Oil	19	0.6726	Not causality
Crude oil does not Granger-cause Unempl		0.5431	
Infl does not Granger-cause GDP	19	0.6105	Not causality
GDP does not Granger-cause inflation		0.5185	
Unempl does not Granger-cause GDP	19	0.7917	Not causality
GDP does not Granger Cause Unempl		0.2699	
Unempl does not Granger Cause Infl	19	0.7550	Not causality
Infl does not Granger-cause Unempl		0.9553	

Source: Authors' computation using EViews 12

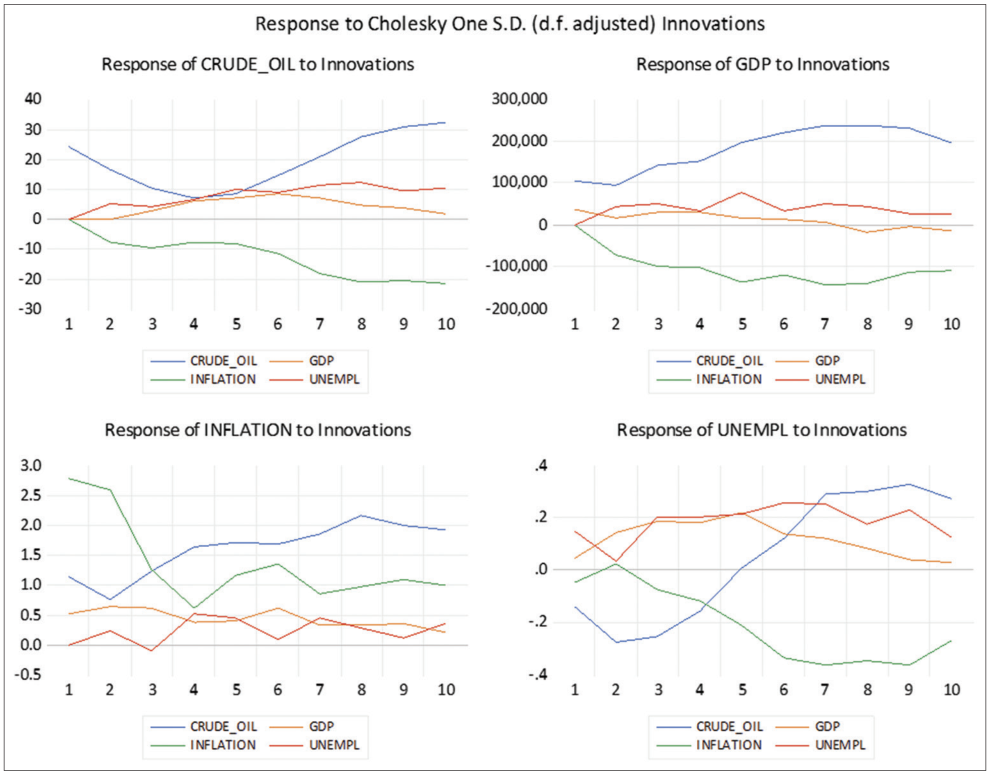
4.6. Impulse Response Functions (IRFs)

The study investigated the impact of oil price shocks on South Africa's key macroeconomic indicators, GDP, inflation, and unemployment, with the dynamic responses illustrated in Figure 1. The results reveal that crude oil prices initially decline following a shock, before gradually increasing over the medium to long term. Inflation exhibits a sustained decrease in the early periods; thereafter, it became more volatile. GDP initially contracted, but showed a brief recovery around the fifth period, and then declined again in later stages. Unemployment exhibits a persistent upward response to oil price shocks, suggesting a long-term adverse effect. Overall, the impulse response analysis highlights that oil price volatility has significant and time-varying effects on macroeconomic performance, particularly destabilizing its impact on output and labour market conditions.

4.7. Variance Decomposition Analysis

Variance decomposition assesses how much of a variable's forecast error variance is explained by shocks versus those from other variables. Results in (Tables 6a-d) reveal that their innovations initially drive crude oil prices, however, by period 10, GDP explains over 58% of its variance, indicating strong feedback from economic activity. GDP remains largely self-driven, although oil prices consistently contribute to changes over time. Inflation shows high self-dependence, with over 80% of its variance explained

Figure 1: Impulse response results



Source: Authors' computation using EViews 12

Table 6a: Variance decomposition of crude oil

Period	S.E	Crude-oil	GDP	Inflation	UNEMPL
1	17.75332	100.0000	0.000000	0.000000	0.000000
2	20.17360	82.48307	0.185956	13.39695	3.934029
3	24.95821	57.77763	23.56278	14.62321	4.036382
4	28.31683	44.90642	38.88078	11.53925	4.673553
5	32.09172	35.22962	50.87558	9.369704	4.525093
6	34.50008	31.13549	56.25459	8.329031	4.280889
7	35.54680	29.77390	58.21277	7.848767	4.164568
8	35.87775	29.55834	58.52747	7.785489	4.128703
9	35.97991	29.69294	58.42576	7.747570	4.133729
10	36.06719	29.89899	58.18496	7.782201	4.133845

Source: Authors' computation using EViews 12

Table 6b: Variance decomposition of GDP

Period	S.E	Crude-oil	GDP	Inflation	UNEMPL
1	111282.8	49.75121	50.24879	0.000000	0.000000
2	133455.2	45.20648	48.64063	5.978901	0.173993
3	161480.2	44.03244	42.49347	13.34914	0.124957
4	180126.2	42.23410	41.89864	15.76480	0.102467
5	194004.7	40.59422	44.21805	14.97911	0.208620
6	207939.1	37.57877	48.79145	13.39036	0.239429
7	219561.4	35.11532	52.19163	12.40233	0.290718
8	229188.2	33.32786	54.32375	12.05717	0.291221
9	236002.4	32.26201	55.32846	12.10806	0.301473
10	241106.6	31.50285	5612919	12.05639	0.311565

Source: Authors' computation using EViews 12

Table 6c: Variance decomposition of inflation

Period	S.E	Crude-oil	GDP	Inflation	UNEMPL
1	2.281717	5.549881	0.052121	94.39800	0.000000
2	2.567202	5.008361	0.674345	91.87197	2.445325
3	2.733748	5.030685	8.683684	84.04345	2.242184
4	2.930390	4.787779	7.719613	85.53394	1.958669
5	2.974968	4.960973	7.494054	85.63098	1.913990
6	2.997637	4.995920	7.845271	84.98208	2.176732
7	3.092581	5.120666	10.41741	82.25790	2.204027
8	3.138705	5.360561	12.08918	80.37117	2.179092
9	3.146419	5.427303	12.32359	80.08014	2.168966
10	3.153414	5.422003	12.33597	80.08051	2.161518

Source: Authors' computation using EViews 12

Table 6d: Variance decomposition of UNEMPL

Period	S.E	Crude-oil	GDP	Inflation	UNEMPL
1	0.214209	31.50992	4.179375	0.074510	64.23619
2	0.399550	22.52330	53.21397	5.078017	19.18471
3	0.480398	32.05773	43.19554	8.119773	16.62696
4	0.528889	36.19170	40.77571	9.213237	13.81936
5	0.556982	41.10666	37.03484	9.155839	12.70267
6	0.579005	43.44614	35.60358	9.195436	11.75484
7	0.609420	43.78979	36.22501	9.363110	10.62209
8	0.637188	43.41403	36.86967	9.998056	9.718246
9	0.664349	42.57993	38.04914	10.42885	8.942076
10	0.687171	41.60658	39.47898	10.53939	8.375058

Source: Authors' computation using EViews 12

by its own shocks throughout. Oil and GDP shocks increasingly influence unemployment, with oil's contribution rising from 31.5% to 41% by period 10. These results highlight the significant long-run influence of oil price fluctuations on output and labour market dynamics.

4.8. Model Diagnostic Test

Diagnostic tests are crucial for verifying the reliability of regression models by assessing key assumptions, such as normality, homoskedasticity, and serial correlation. The Lagrange Multiplier (LM), White, and Jarque-Bera tests were applied in this study. As shown in Table 7, all p-values exceed the 0.05 threshold, indicating no serial correlation (LM = 0.4832), no heteroscedasticity (White = 0.6394), and normally distributed residuals (Jarque-Bera = 0.2749). These results confirm that the VECM model is well-specified and suitable for interpretation.

5. DISCUSSION AND POLICY IMPLICATIONS

The vector error correction model (VECM) findings confirm a statistically significant long-run relationship between crude oil prices, GDP, and unemployment in South Africa. In particular, GDP and unemployment exhibit large and statistically significant negative long-run coefficients of −8.98 and −24.39, respectively, with corresponding t-values exceeding the critical value of 1.96. Inflation also carries a negative long-run coefficient (−0.78), however, its effect is not statistically significant. In contrast, short-run dynamics across all macroeconomic indicators remain statistically insignificant, with t-values below the conventional threshold, indicating weak short-term responsiveness to fluctuations in oil prices.

These results align with prior empirical evidence highlighting the vulnerability of oil-importing economies to fluctuations in oil prices. Berument et al. (2010) found that oil price increases hurt GDP and employment in non-oil-producing nations. Similarly, Olawumi and Oladipo (2020) reported that oil price volatility has long-term adverse effects on growth across sub-Saharan African economies. Ratti and Vespignani (2015) also observed that oil shocks contribute to output contraction in energy-dependent regions. Within the South African context, Du Plessis and Smit (2007) found that higher oil prices lead to long-run declines in output and persistent inflationary pressures, consistent with those of the present study.

More recent studies reinforce these long-run relationships; for example, Mtshali and Niyimbanira (2025) confirmed that crude oil price movements significantly drive both GDP growth and unemployment in South Africa, using a broader dataset (1993-2024) and employing EGARCH and Toda-Yamamoto causality tests. Similarly, Pamba (2024), using a Markov Switching Intercepts VAR model, found that oil shocks negatively affect real GDP growth during expansionary regimes, highlighting the persistent and regime-sensitive nature of these shocks. These findings support the present study's identification of long-run macroeconomic vulnerability to oil price fluctuations.

Other studies, however, challenge some aspects of the present results, particularly regarding short-run dynamics and inflation. Khobai et al. (2024) for instance, employed a nonlinear ARDL model to investigate the asymmetric effects of oil prices on inflation in South Africa. Their results show that inflation responds significantly to positive and negative oil price shocks in the short run, with differing signs and magnitudes - an outcome not captured in the present linear specification. This suggests that the insignificant inflation coefficient found in the current study may be due to model limitations or its failure to account for asymmetric responses. Likewise, Pamba (2024) found that inflation reacts more strongly to oil shocks during recessionary periods, implying that short-run effects may be masked when averaged across regimes.

Table 7: Diagnostic test results

Test	Null hypothesis	Probability
Lagrange multiplier (LM)	No serial correlation	0.4832
White (Chi-square)	No conditional heteroscedasticity	0.6394
Jarque-Bera (BJ)	There is a normal distribution	0.2749

Source: Authors' computation using EViews 12

Conversely, some studies suggest that the impact of oil price shocks diminishes over time. Hamilton (2003) noted that improved energy efficiency and policy frameworks have reduced the sensitivity of output to oil shocks. Blanchard and Gali (2007) suggested that modern monetary policies and more flexible markets have increased macroeconomic resilience to oil price volatility. Edelstein and Kilian (2007) contend that the effects of oil prices are not uniform across economies or time periods, whereas Hooker (2002) argued that the inflationary impact of oil prices weakened significantly after 1980. The present study's finding of statistically insignificant short-run effects across all macro variables is consistent with these arguments; however, newer evidence may discover that this may vary across regimes and depends on the nature of the price shock.

The implications of these findings underscore the cruciality of long-term policy responses. The significant long-run effects of oil price changes on GDP and unemployment suggest that short-term fiscal or monetary interventions may be insufficient. Instead, policymakers should prioritize structural economic reforms, including energy diversification, investment in renewable energy sources, and reducing dependence on imported oil, to enhance macroeconomic stability and resilience against future oil price shocks. Recent recommendations by Mtshali and Niyimbanira (2025) echo this view, calling for increased investment in and diversification of renewable energy to reduce the economy's exposure to volatile oil markets.

The potential for asymmetric and regime-specific responses, highlighted by Khobai et al. (2024) and Pamba (2025), additionally suggests that policy effectiveness may also depend on the broader economic context. Policymakers may, therefore, adopt more flexible and responsive models when assessing oil price risks, considering nonlinearity, asymmetries, and the role of macroeconomic regimes in shaping the transmission of global oil shocks to domestic indicators.

6. CONCLUSION

This study examined the macroeconomic effects of crude oil price fluctuations on GDP, unemployment, and inflation in South Africa using a vector error correction model (VECM). The results confirm the existence of a statistically significant long-run relationship; hence, oil price increases are associated with considerable declines in GDP and higher unemployment. In contrast, the effect on inflation, while negative, was not statistically significant, and all short-run dynamics were found to be weak.

These findings are consistent with earlier studies that highlight the long-term vulnerabilities of oil-importing economies to global energy price shocks. More recent literature reinforces this view, particularly in South Africa, where structural dependencies on imported oil have led to economic sensitivity to external price shifts. The evidence suggests that while short-term fluctuations may not immediately trigger macroeconomic instability, their cumulative long-term impact on growth and labor markets is substantial. The policy implications are clear - reliance on short-term monetary or fiscal responses may be insufficient to mitigate oil price volatility. Instead, the results advocate for long-term structural reforms aimed at diversifying the energy mix, investing in renewable energy infrastructure, and improving energy efficiency. Such strategies can help reduce external vulnerability and support macroeconomic resilience.

The study, nevertheless, has limitations; for instance, the linear VECM framework may not capture asymmetric or nonlinear effects identified in recent studies. Exogenous variables, such as exchange rate volatility, global supply chain disruptions, and domestic policy responses, were not directly accounted for but may have influenced the observed outcomes. Future research could address these limitations by employing nonlinear or regime-switching models to better capture differential effects under varying economic conditions. Further analysis incorporating exchange rates, energy policy instruments, and external shocks would enhance understanding of the transmission mechanisms linking oil prices to macroeconomic outcomes.

Overall, the findings contribute to the growing body of evidence accentuating the strategic value of energy policy and structural transformation in oil-importing countries. For South Africa, ensuring long-term economic stability requires proactive, forward-looking policies addressing the country's root vulnerabilities in relation to global oil market dynamics.

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