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Macroeconomic Effects of Raising Oil Prices: Insights from Morocco

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ABSTRACT

This study examines the impact of Brent oil price shocks on key economic variables—namely inflation, GDP, exchange rate, trade openness, and unemployment rate using annual data from 1990 to 2022. The results of the study show that the variables considered under this study are cointegrated in the long-run which means that there is a relationship between these variables in the long-run. By employing a vector error correction model (VECM), we analyze the impulse response functions to understand the short- and long-term effects of oil price fluctuations on these economic indicators. Our findings reveal that Brent oil price increases lead to higher inflation and depreciation of the exchange rate, with both effects persisting in the short and long run. Conversely, GDP experiences a consistent negative impact from oil price hikes, suggesting a detrimental effect on economic growth over time. Trade openness shows a positive response, indicating increased trade activity due to rising oil prices. Additionally, the unemployment rate decreases in response to higher oil prices, reflecting a potential reduction in joblessness.

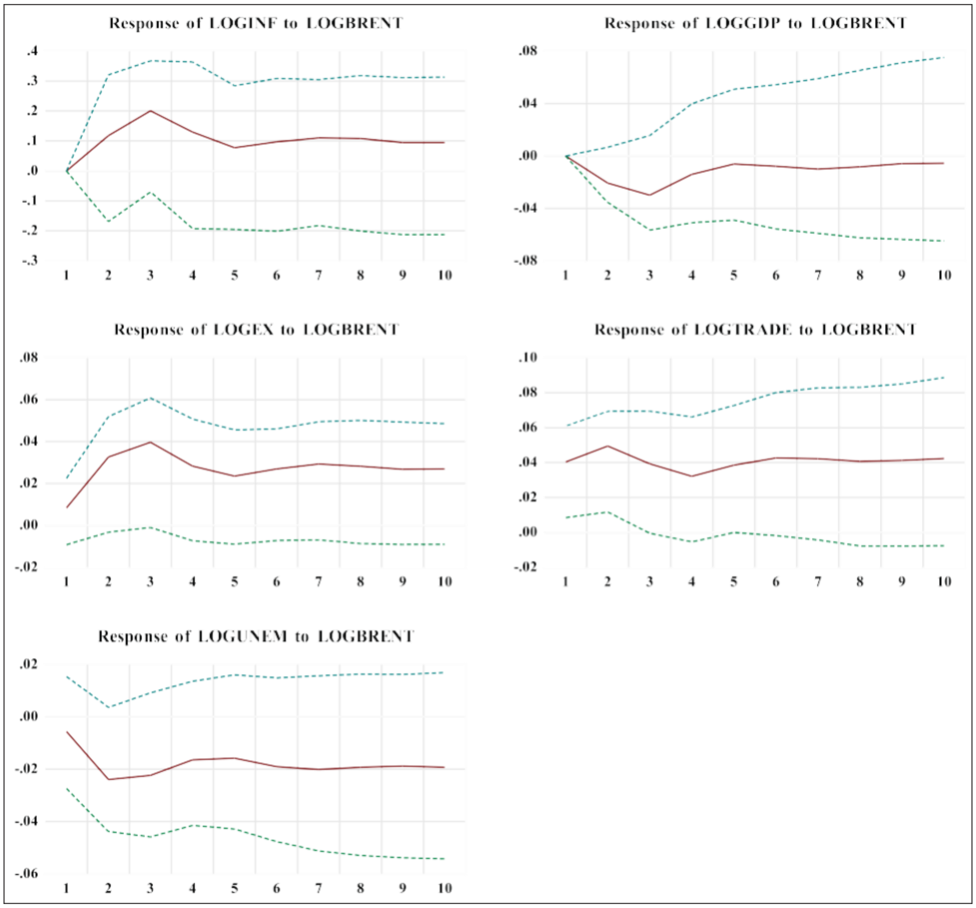
Keywords: Oil Price, Vector Error Correction Model, Inflation, Economic Growth, Exchange Rate
JEL Classifications: E30, E31, O47

1. INTRODUCTION

Energy inflation is a critical issue to address, given its significant impact on the development process. High fuel prices often pose a significant challenge to economic development. Developed nations, with their strong domestic economic conditions, are typically able to withstand the adverse effects of an oil price shock. In contrast, developing countries face much greater difficulties. These nations are heavily impacted due to their lack of access to oil-saving technologies and alternative oil substitution techniques in their production processes. This technological gap exacerbates the economic strain caused by rising fuel costs, further hindering their development efforts. The relationship between fuel prices and economic growth is more complex than it appears. While it is widely accepted in the literature that fuel prices increase inflation, they are also seen to negatively impact economic growth. In this context, environmental protection is given significant attention. Policymakers are encouraged to implement programs that reduce oil consumption and promote renewable energy use to accelerate economic growth. Such measures would not only shield economies from international oil price fluctuations and inflation but also support the sustainable environmental goal of reducing oil consumption.

In addition to the 1973 oil price shocks, other significant oil shocks have occurred, such as the 1979 Iranian Revolution, the 1990 invasion of Kuwait by Iraq, and the increased global oil demand in the 2000s. However, the impact of these events on macroeconomic variables has been less pronounced in recent years compared to the 1970s. The literature attributes this changing effect of oil shocks to several factors. Some authors argue that improved monetary policies have played a crucial role in controlling price movements, thereby mitigating the economic impact. Also, the reduced share of oil usage in the production process has lessened the sensitivity of economies to oil price fluctuations.

Figure 1: Impulse response results



In Morocco, the energy supply is primarily dependent on imports, and any changes in this supply could significantly impact the Moroccan economy. A clear example of this is the severe disruption of the global energy supply caused by the combined effects of the war between Ukraine and Russia and the COVID-19 pandemic, which has also put considerable strain on the Moroccan economy. According to data from Trademap data, the import price of medium oils and preparations, of petroleum increased from 595 USD/MT in 2021 to 1,041 USD/MT in 2022 then declined to 854 USD/MT in 2023. The COVID-19 pandemic and the war in Ukraine have highlighted the global economy's continued vulnerability and dependence on fluctuations in oil and other energy prices. As a result, it is crucial to quantify the effects of oil price changes and their volatility on the moroccan economy.

The research problem of this paper is to estimate the effects of the increase in global energy prices on inflation and economic growth in Morocco. The objective of this research is to estimate not only the direct effects on inflation caused by the increase in energy product prices for final consumers but also the indirect effects on the prices of all other goods and services that use energy as an intermediate input in their production processes. The study compares the effects of rising energy prices with those of other exogenous shocks, such as the sudden growth of gross wages and salaries, the increase in prices of manufacturing intermediate inputs, and the rise in prices of imported goods and services.

To assess the impact of external shocks on the stability of the Moroccan economy, a vector error correction model (VECM) approach was utilized. This research addresses a gap in the literature by empirically examining the price changes resulting from oil price shocks within the Moroccan context. The study's value lies in its empirical analysis of the current situation in Morocco due to rising energy and oil prices, providing recommendations to mitigate the adverse effects on the most vulnerable sectors, including businesses and households. This is considered as important given that rising domestic prices could harm Morocco's international economic competitiveness.

The rest of the paper is structured as follows: following the introduction, Section 2 reviews recent and relevant literature on the effects of rising energy prices. Section 3 details the data sources and the VECM model. Section 4 presents the results on how rising energy prices affect the stability of the Moroccan economy. The discussion and conclusion sections offer policy implications and recommendations for future research.

2. LITERATURE REVIEW

The impact of energy prices on the macroeconomics has been extensively studied by numerous economists. In this section, we lay the theoretical groundwork for this article by reviewing existing literature, focusing on research methodologies, objectives, and findings from prior studies.

From a theoretical perspective, there is a positive correlation between oil prices and the inflation rate. As oil serves as a fundamental raw material for any economy, an increase in its price inevitably raises the costs of final products. Energy price shocks impact inflation through two main channels. The first is a direct effect on costs, particularly in energy-intensive sectors, as higher energy prices increase input costs. The second is an indirect effect involving wage bargaining and price setting, driven by elevated inflation expectations (Wong, 2015) and the transmission from headline to core inflation (Peersman and Van Robays, 2009). Higher energy prices boost inflation expectations, leading to demands for higher wages. Both expected and realized inflation are crucial for understanding how energy price movements affect the macroeconomy. Expected inflation, reflecting uncertainty about the future, influences and is influenced by overall economic conditions. Consumers generally exhibit pessimism when energy prices are high and optimism when they are low, although this effect may be asymmetric.

Research in this area shows that the relationship between energy prices and inflation is robust, though the impact may vary depending on the duration of the observed price period. The extent of this effect also largely depends on the country's level of economic development. Energy prices significantly influence inflation, highlighting the need for coordination between fiscal and monetary authorities. The volatility of oil prices adversely affects the financial development and economic growth of both oil-importing and oil-exporting countries, with the latter being particularly vulnerable to price fluctuations. In developing nations, economic growth coupled with rising prices can be counterproductive, as a negative relationship between inflation and economic growth is observed in both the long and short term. Therefore, oil price inflation in these countries does not significantly benefit economic growth but rather increases the overall price level in the economy. While oil price controls may temporarily delay the impact of oil shocks on inflation, this effect is short-term. Moreover, low fuel prices are not the primary driver of a country's development, and oil-importing countries can thrive despite higher fuel prices. Panic over high fuel prices can exacerbate the inflationary spiral. Hence, fiscal policy should prioritize robust economic growth and the health of public finances over short-term measures to curb inflation.

Blanchard and Gali (2007) present evidence that the impact of oil prices on macroeconomic fluctuations in the 1970s is challenging to compare with that of the 2000s due to the differing nature of the shocks during these periods. They emphasize that the pass-through of oil prices to inflation can be either amplified or mitigated depending on how oil prices affect wages, output, and employment. Consequently, a significant portion of empirical literature concentrates on estimating this indirect channel by analyzing the relationship between oil prices and inflation expectations.

Hooker (2002), using Phillips Curve models that account for various nonlinearities and structural breaks, found no evidence of a causal influence of oil prices on major US macroeconomic variables after 1981. Furthermore, Hooker determined that structural break specifications fit the data better than asymmetric and nonlinear specifications. Similarly, José De Gregorio et al. (2007) analyzed the impact of oil prices on inflation across multiple countries and found that the reduced impact of oil prices on inflation is attributable to decreased oil intensity, reduced exchange rate pass-through, and a more favorable inflation environment. Additionally, they emphasized that the effect of oil prices on macroeconomic variables depends on the source of the oil price shock.

Catik and Karacuka (2012) used a Markov Regime Switching Vector Autoregressive model to investigate the oil inflation pass-through in Turkey under different inflation regimes. Their non-linear, regime-dependent impulse response analysis revealed that a lower inflation environment significantly reduces the pass-through effect of oil prices to inflation. This reduced pass-through was particularly evident during the period of inflation targeting.

De Gregorio et al. (2008) reported findings showing a reduced pass-through of oil prices to domestic inflation, using augmented Phillips curve estimations with data from both developing and advanced economies. They observed a more significant decline in the pass-through effect in advanced economies, attributing this to reduced oil intensity and decreased exchange rate pass-through. Habermeier et al. (2009), analyzing panel data from 50 countries during 2007-2008, concluded that monetary policy is crucial in determining the transmission of oil and food price shocks. They found that countries with inflation targeting frameworks and higher central bank independence tend to have lower transmission rates. Álvarez et al. highlighted an increasing direct impact of higher oil prices on inflation in the euro area over time, driven by households' rising expenditure on refined oil products, although second-round and indirect effects have decreased.

Zoli and Caceres et al. (2009) used vector autoregression to study the impact of commodity price shocks on inflation in emerging markets in Europe and Central Africa. They discovered that relative prices to the EU-15 are key to explaining inflation responses in emerging Europe, while price controls play a significant role in Central Africa.

Hammoudeh and Reboredo (2018) found that the impact of oil price movements on inflation expectations is more pronounced when oil prices exceed USD 67 per barrel. However, when examining different types of oil shocks, the results are mixed. For example, Güntner and Linsbauer (2018) showed that only aggregate demand shocks influence inflation expectations, with a positive effect observed in the initial months followed by a negative effect. In contrast, shocks from the oil supply side play a limited role.

Choi et al. (2018) analyzed the impact of global oil price volatility on domestic inflation across 72 developing and developed countries from 1970 to 2015. They found that a 10% increase in global oil inflation initially raised domestic headline inflation by about 0.4% points, which faded within 2 years. They observed asymmetry, where positive oil price shocks had a stronger impact than negative ones. They highlighted transportation's CPI basket share and energy subsidies as critical factors explaining variations in the impact of oil price shocks among countries over the study period.

Aziz et al. (2016) examined the impact of rising energy prices on consumer welfare in Pakistan using time-series data from 1987 to 2012. Their findings highlighted the significance of energy and income prices, revealing that fluctuations in electricity prices were influenced by global price disturbances. The study concluded that Pakistan should invest in coal, natural gas, electricity generation, and diesel oil to ensure stable growth.

Hossain and Islam (2013) investigated the factors influencing inflation in Bangladesh and found a positive relationship between money supply and inflation. However, they found that interest rates, fiscal deficits, and nominal exchange rates did not significantly affect inflation.

Hanif et al. (2017) analyzed the relationship between global commodity prices and domestic inflation using time-series data from 1992 to 2014. Their research indicated that changes in global commodity prices positively impacted inflation in small open economies, with global price fluctuations affecting overall inflation.

In several studies, the money supply and exchange rate are identified as significant factors linking oil price fluctuations to changes in inflation and economic growth. Another methodological challenge in price transmission studies concerns the selection of a suitable representative price. The guidance on this matter is not straightforward. While prices across all grades of oil are highly correlated, suggesting a single representative price might suffice, economies typically source from multiple suppliers, warranting consideration of an average price. However, the average price remains closely correlated with individual oil prices, aligning with basic econometric principles, thus mitigating concerns in this regard.

Shang and Hamori (2021) evaluated the influence of WTI crude oil on foreign currency markets, discovering that it significantly contributes to volatility and disruptions in returns. Their findings indicate that WTI crude oil has a more substantial impact on the exchange rates of oil-importing countries, especially prior to the COVID-19 period. They propose that countries heavily dependent on American oil experience greater exchange rate volatility due to the spillover effects of WTI crude oil prices.

Ahmad et al. (2020) used high-frequency data to analyze the effects of oil price fluctuations on China's exchange rate, finding a negative impact. Alam et al. (2019) investigated six major currencies against the US dollar, using 5-min interval data to study the causal relationships between exchange rate changes and crude oil prices. They identified stronger causal relationships between the crude oil and currency markets than previously documented, noting that these relationships intensify during periods of economic and financial uncertainty.

3. DATA AND METHODOLOGY

This study aims to explore how various energy sources prices affect the main economy indicators in Morocco, employing a rigorous methodology that includes econometric analyses to assess the impacts of the energy price on key variables such as GDP, trade openness, inflation, exchange rate and unemployment rate.

3.1. Data Sources

Morocco annual time series data ranging from 1990 to 2022 were collected for this study. The Brent spot price in USD per barrel was used to measure the oil price, with data sourced from the U.S. Energy Information Administration (EIA). Additional economic indicators, including the inflation rate, GDP, exchange rate, and unemployment rate, were obtained from the World Bank database. Trade openness, an important variable in our analysis, was calculated based on the World Bank's data. The following table (Table 1) shows the list of variables, their abbreviations, descriptions and sources.

3.2. Analytical Framework

In this study, the vector error correction model (VECM) was intentionally selected to thoroughly analyze the impact of energy prices on macroeconomic variables in Morocco. As noted by Andrei and Andrei (2015), this estimation technique is well-suited

Table 1: Data description and sources

Variable	Abbreviation	Description	Source
Inflation	LINF	Inflation measures the rate at which the general level of prices for goods and services is rising, and subsequently, how purchasing power is falling.	World Bank
GDP	LGDP	GDP represents the total monetary value of all finished goods and services produced within a country's borders in a specific time period, indicating the economic health of the country.	World Bank
Brent spot price	LBRENT	Brent spot price refers to the cost of purchasing Brent crude oil on the spot market, widely used as a benchmark for global oil prices.	U.S. Energy Information Administration
Exchange rate	LEX	The exchange rate is the value of one currency for the purpose of conversion to another, reflecting the relative economic strength and stability of countries.	World Bank
Unemployment rate	LUNEM	The unemployment rate is the percentage of the labor force that is jobless and actively seeking employment, serving as an indicator of economic health.	World Bank
Trade Openness	LTRADE	Trade openness measures the extent to which a country engages in international trade, calculated as the ratio of a country's total trade (exports plus imports) to its GDP.	World Bank

for examining variables with one or more cointegrating vectors. The VECM's capability to capture both short-term fluctuations and long-term equilibrium adjustments aligns with the study's objectives. Utilizing VECM aims to enhance the robustness and reliability of our findings, thereby deepening the understanding of the dynamics of oil prices on the Moroccan economy and offering a foundation for evidence-based policy decisions.

3.3. Unit Root Tests

This study utilized the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests to assess the stationarity of the variables. These tests aimed to confirm that the variables meet the prerequisites for the VECM model, which requires that the variables are integrated of order one. Ensuring that variables are integrated of order one is essential for establishing cointegration, a fundamental aspect of the VECM. Conducting these tests is deemed important to ensure the stationarity of time series data, thereby minimizing the risk of obtaining spurious results in econometric analysis. The unit root test equations for these tests are as follows:

$$\text{Intercept and trend}: \Delta Y_t = \alpha + \beta T + \delta Y_{t-1} + \mu_t$$

$$\text{Intercept}: \Delta Y_t = \alpha + \delta Y_{t-1} + \mu_t$$

$$\text{None}: \Delta Y_t = \delta Y_{t-1} + \mu_t$$

3.4. Cointegration Test

This study utilized the Johansen cointegration approach (Johansen, 1991) to investigate the long-term relationship among the variables. First, after confirming that at least one variable was integrated of order one I(1), the Johansen cointegration test was performed using the maximum likelihood approach. Cointegration suggests that even though individual variables might not be stationary, certain linear combinations of these variables can be stationary, indicating a lasting relationship. This implies that variables X_t and Y_t are integrated of order one I(1) and show a linear combination post-regression. To establish cointegration, the following equation must be formulated:

$$\lambda(r, r+1) = TIn\,(1 - \lambda r + 1)\ \lambda r, r + 1 = TIn1 - \lambda_{r+1}$$

Where:

$\lambda(r, r+1)$ = Likelihood ratio test statistic;

r = Cointegration vectors;

T = Sample size;

λ_r = Estimated value for the *ith* ordered eigenvalue from the π matrix

3.5. VECM Model

In the case that the variables are cointegrated, the vector error correction model (VECM) can be used instead of VAR. The following equation shows the general model for VECM.

$$\Delta y_t = \sum_{t=1}^{q} \beta_i y_{t-1} + \theta x_t + \gamma\, ECT_t + u_t$$

Where Δ is the first difference operator, β_i and θ are the parameters to be estimated, u_t represents the white noise error terms, and q is the maximum lag length.

The vector error correction model (VECM) can be utilized to test Granger causality among the variables energy price GDP, trade openness, inflation, exchange rate and unemployment rate. The empirical equation of VECM is presented as follows:

$$\begin{bmatrix} \Delta INF_t \\ \Delta BRENT_t \\ \Delta GDP_t \\ \Delta EX_t \\ \Delta UNEM_t \\ \Delta TRADE_t \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \\ \alpha_4 \\ \alpha_5 \\ \alpha_6 \end{bmatrix} + \sum_{J=1}^{L} \begin{bmatrix} \beta_{11J} & \beta_{12J} & \beta_{13J} & \beta_{14J} & \beta_{15J} & \beta_{16J} \\ \beta_{21J} & \beta_{22J} & \beta_{23J} & \beta_{24J} & \beta_{25J} & \beta_{26J} \\ \beta_{31J} & \beta_{32J} & \beta_{33J} & \beta_{34J} & \beta_{35J} & \beta_{36J} \\ \beta_{41J} & \beta_{42J} & \beta_{43J} & \beta_{44J} & \beta_{45J} & \beta_{46J} \\ \beta_{51J} & \beta_{52J} & \beta_{53J} & \beta_{54J} & \beta_{55J} & \beta_{56J} \\ \beta_{61J} & \beta_{62J} & \beta_{63J} & \beta_{64J} & \beta_{65J} & \beta_{66J} \end{bmatrix} \begin{bmatrix} \Delta INF_{t-1} \\ \Delta BRENT_{t-1} \\ \Delta GDP_{t-1} \\ \Delta EX_{t-1} \\ \Delta UNEM_{t-1} \\ \Delta TRADE_{t-1} \end{bmatrix} + \begin{bmatrix} \gamma_1 \\ \gamma_2 \\ \gamma_3 \\ \gamma_4 \\ \gamma_5 \\ \gamma_6 \end{bmatrix} ECT_{t-1} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \\ \varepsilon_{4t} \\ \varepsilon_{5t} \\ \varepsilon_{6t} \end{bmatrix}$$

Where α and γ are the coefficients to be estimated, and ECT_{t-1} is the lagged residual term derived from the long-run relationship. A negative and significantly different from zero γ indicates a long-term interplay. L is the maximum lag length, Δ is the first difference operator, and ε is the error term.

The long-term equilibrium is indicated by a negative ECT coefficient. The closer the coefficient values are to zero, the quicker the adjustment towards the long-run equilibrium. This coefficient signifies the adjustment of the variable towards its long-term equilibrium, with a negative value confirming this correction process.

4. FINDINGS AND DISCUSSIONS

The findings of this study cover descriptive statistics, long- and short-run estimations, and diagnostic tests. These results are subsequently followed by a discussion of the findings.

4.1. Descriptive Statistics

The descriptive statistics for the variables under consideration are presented in Table 2, offering an organized and summarized perspective of the data for enhanced interpretability (Wooldridge, 2019). The mean of LBRENT is 3.72, with a median of 3.78, indicating a slight left skewness, as reflected by the skewness coefficient of −0.06, while the kurtosis value of 1.59 suggests a relatively flat distribution compared to a normal distribution. LGDP's mean and median are 24.97 and 25.05, respectively, with a standard deviation of 0.53, reflecting a slight left skewness (skewness −0.22) and a flat distribution (kurtosis 1.44). LINF has a mean of −4.02 and a median of −4.11, with a standard deviation of 0.86, indicating a slight positive skewness (skewness 0.06) and a moderate kurtosis of 2.18. The Jarque-Bera statistics for all variables indicate that they do not deviate significantly from normality, as evidenced by the probability values which are higher than 5%.

4.2. Correlation Analysis

The correlation analysis between the variables of interest reveals significant relationships. There is a strong positive correlation of 0.89 between LBRENT and LGDP, which is statistically significant at the 1% level, indicating that higher oil prices are associated with higher GDP levels. Conversely, LGDP and LINF show a moderate negative correlation of −0.52, also significant at the 1% level, suggesting that higher inflation rates correspond with lower GDP levels. Additionally, LBRENT and LINF exhibit a negative correlation of −0.37, significant at the 5% level, indicating that higher oil prices tend to be associated with lower inflation rates. These correlations highlight the significant interplay between oil prices, GDP, and inflation in the dataset. The correlation analysis of the remaining variables are presented in the following table (Table 3).

4.3. Unit Root Test

The unit root test is crucial for ensuring the validity of our study, as it verifies the stationarity of the time series data used in the model. The Augmented Dickey-Fuller (ADF) test (Dickey and Fuller, 1979) and the Phillips-Perron (PP) test (Phillips and Perron, 1988) are employed to assess stationarity. This test determines whether the series are stationary at level (integrated of order 0, or $I(0)$ or at the first difference $I(1)$. Our analysis focuses on the first difference of the variables, as initial tests indicated that the series were not stationary at level but were integrated of order one $I(1)$. The detailed results are presented in Table 4.

4.4. Lag Length Selection Criterion

The results of the lag-length selection criteria are summarized in Table 5, highlighting the likelihood ratio (LR) test, the final prediction error (FPE), the Schwarz Criterion (SC), and the Hannan-Quinn (HQ) test. According to the findings, all four criteria consistently recommend a one-lag length for the analysis. These tests determine the optimal number of lags to include in the vector error correction model (VECM) to ensure the model's accuracy and reliability.

4.5. Cointegration Test and Long-Run (LR) Stability

The cointegration test is an essential statistical method for any study, as it examines the potential presence of a long-run (LR) correlation among non-stationary variables over the study period. This test helps identify long-run parameters or equilibrium and determines whether two series are cointegrated, meaning they cannot deviate from long-run stationarity. The results of the Johansen cointegration test are presented in Table 6 below.

The results of the Johansen cointegration test, as presented in Table 6, show that the P-values for both the Trace and Max-Eigen test statistics are significant at the 5% level. Both test statistics exceed their respective critical values, leading to the conclusion that there is only one cointegrating equation. This indicates a long-term relationship between the macroeconomic variables and Brent oil price in the Moroccan context, resulting in the rejection of the null hypothesis.

As previously noted, if the data demonstrates a long-run (LR) association among the selected indicators, the VAR model is not appropriate. Referring to the empirical results in Tables 4-6, it is evident that the data are cointegrated of order one, I(1), indicating the existence of an LR association among the selected variables. Consequently, the vector error correction model (VECM) is the suitable model for investigating both the short-run (SR) and long-run (LR) effects of the economic variables and oil consumption.

Table 2: Descriptive statistics

	LBRENT	LEX	LGDP	LINF	LTRADE	LUNEM
Mean	3.72	2.21	24.97	−4.02	−0.51	−2.19
Median	3.78	2.20	25.05	−4.11	−0.52	−2.21
Maximum	4.72	2.43	25.68	−2.53	0.01	−1.96
Minimum	2.55	2.05	24.13	−5.80	−0.87	−2.42
Std. Dev.	0.69	0.09	0.53	0.86	0.24	0.17
Skewness	−0.06	0.45	−0.22	0.06	0.22	0.15
Kurtosis	1.59	2.72	1.44	2.18	1.80	1.36
Jarque-Bera	2.75	1.25	3.59	0.95	2.23	3.80
Probability	0.25	0.54	0.17	0.62	0.33	0.15

Table 3: Correlation analysis

Variables	LBRENT	LEX	LGDP	LINF	LTRADE	LUNEM
LBRENT	1.00					
LEX	−0.36**	1.00				
LGDP	0.89***	−0.15	1.00			
LINF	−0.37**	−0.17	−0.52***	1.00		
LTRADE	0.89***	−0.15	0.92***	−0.30*	1.00	
LUNEM	−0.92***	0.28	−0.88***	0.42**	−0.83***	1.00

*Significant at 10%, ** significant at 5%, *** significant at 1%

Table 4: Unit root tests results

Variables	Unit root	At level		1st difference	
		t-stat	P-value	t-stat	P-value
LINF	ADF	−0.13	0.63	−10.13	0.00
	PP	−0.42	0.52	−11.27	0.00
LBRENT	ADF	−2.07	0.54	−4.93	0.00
	PP	−2.07	0.54	−4.74	0.00
LGDP	ADF	−1.38	0.85	−5.80	0.00
	PP	−1.34	0.86	−5.81	0.00
LEX	ADF	−1.95	0.60	−4.56	0.01
	PP	−2.06	0.55	−4.47	0.01
LTRADE	ADF	−2.90	0.18	−4.44	0.01
	PP	−1.34	0.16	−5.11	0.00
LUNEM	ADF	−1.36	0.85	−3.87	0.03
	PP	−1.44	0.83	−5.68	0.00

Table 5: Lag length criteria results

Lag	LogL	LR	FPE	AIC	SC	HQ
0	56.63293	NA	1.54E−09	−3.26664	−2.989094	−3.176167
1	203.3855	227.2299*	1.27e−12*	−10.41197	−8.469149*	−9.778659*
2	243.7678	46.89556	1.27E−12	−10.69470*	−7.086602	−9.518549

Table 6: Cointegration analysis results

Unrestricted cointegration rank test (Trace)				
Hypothesized No. of CE (s)	**Eigenvalue**	**Trace Statistic**	**0.05 Critical Value**	**Prob.****
None *	0.79	113.13	95.75	0.00
At most 1	0.56	65.45	69.82	0.11
At most 2	0.49	39.90	47.86	0.23
At most 3	0.30	19.05	29.80	0.49
At most 4	0.23	8.19	15.49	0.44
At most 5	0.01	0.23	3.84	0.63
Unrestricted cointegration Rank test (Maximum Eigenvalue)				
Hypothesized No. of CE (s)	**Eigenvalue**	**Max-eigen statistic**	**0.05 critical value**	**Prob.****
None *	0.79	47.67	40.08	0.01
At most 1	0.56	25.55	33.88	0.35
At most 2	0.49	20.86	27.58	0.29
At most 3	0.30	10.85	21.13	0.66
At most 4	0.23	7.96	14.26	0.38
At most 5	0.01	0.23	3.84	0.63

4.6. Long-run and Short-run Estimation Results of the Vector Error Correction Model

The next step involved using the vector error correction model (VECM) to analyze both short-term and long-term relationships, given the established existence of long-term relationships between the variables. The VECM accommodates short-term adjustments while ensuring that the long-term behavior of endogenous variables converges to their cointegrating relationships. It is particularly suitable for measuring corrections from past disequilibrium. A negative and significant coefficient in the VECM indicates a stable long-term association, suggesting that short-term fluctuations between variables ultimately result in a steady long-term relationship.

Table 7 illustrates the long-term relationships between the study variables. The cointegrating equation demonstrates the relationships between inflation (LINF) and the explanatory variables (LBRENT, LGDP, LTRADE, LUNEM, LEX). The cointegrating equation reveals a positive long-term link between the Brent oil price and inflation, GDP growth, unemployment rate and exchange rate. Table 8 illustrates the short-term relationship between the variables.

The significant error correction term, which ranges from zero to negative values, indicates a stable long-term equilibrium. In this study, the error correction term of −0.12 suggests a stable cointegration relationship, indicating a 12% adjustment rate. This rate reflects the speed at which shocks to the independent variables return the Gini coefficient to its equilibrium, reducing the income inequality gap by 12% in the short term.

The R-squared value of 0.52 measures the explanatory power of the model, meaning that 52% of the variation in the dependent variable is explained by the independent variables.

Based on the results of VECM model it is evident that the relationship between oil prices and inflation is notably strong in the long run. The coefficient for oil prices (LBRENT) is 6.51, indicating that a 1% increase in oil prices is associated with a 6.51% increase in inflation. This positive relationship is statistically significant, as evidenced by a t-statistic of 3.95, which exceeds the conventional threshold for significance (1.96). This suggests that rising oil prices lead to higher inflation, due to increased costs of production and transportation, which are passed on to consumers in the form of higher prices.

GDP exhibits a positive and significant relationship with inflation. The coefficient for GDP (LGDP) is 2.98, meaning that a 1% increase in GDP corresponds to a 2.98% rise in inflation. This result is statistically significant, supported by a t-statistic of 4.81. The positive association implies that economic growth is linked to higher inflation rates. This is explained by the increased demand for goods and services, which can drive up prices, reflecting the typical demand-pull inflation scenario where robust economic growth pressures prices upward.

The effect of exports on inflation is negative but not statistically significant. With a coefficient of −4.93, the relationship suggests that a 1% increase in exports would decrease inflation by 4.93%. However, the t-statistic of −1.21 indicates that this effect is not statistically significant at the conventional levels. This lack of significance implies that, although there is a negative association between exports and inflation, the relationship is not strong enough to draw firm conclusions. This is explained by complex dynamics and factors, including how export volumes interact with domestic price levels and other concurrent economic variables.

Trade openness has a positive and statistically significant effect on inflation. The coefficient for trade openness (LTRADE) is 6.35, suggesting that a 1% increase in trade openness is associated with a 6.35% increase in inflation. This relationship is significant, with a t-statistic of 2.31. The positive effect of trade openness on inflation is attributed to different factors such as increased competition leading to higher costs or the complexity of international trade affecting domestic price levels.

4.7. Impulse Function Response

To gain deeper insights into the interrelationships and to validate the results of the VECM model, impulse response functions were employed. These functions demonstrate how economic variables respond to shocks within the system (Lütkepohl, 2008). Figure 1 presents the impulse response functions for different macroeconomic variables to shocks from brent oil price. The Brent oil price impulse leads to an immediate increase in inflation starting from the second period, with a peak response of 0.20 in the third period. After this peak, the response declines but remains positive, indicating a sustained but diminishing impact over the ten periods observed. The consistent positive values suggest that increases in Brent oil prices lead to higher inflation rates. The impact is positive in both the short and long run.

The response of GDP to a Brent oil price impulse is negative throughout the periods observed, starting from the second period. The most substantial negative impact is observed in the third period with a value of −0.030015. Although the negative impact lessens over time, it remains below zero, indicating that rising oil prices have a detrimental effect on GDP growth. The impact is negative in both the short and long run.

The exchange rate shows a positive response to the Brent oil price impulse, starting with a slight increase in the first period and reaching a peak of 0.039681 in the third period. The response then gradually decreases but stays positive throughout the ten periods, indicating that higher oil prices lead to a depreciation of the exchange rate. The impact is positive in both the short and long run.

Trade openness shows a positive response to the Brent oil price impulse, peaking at 0.049435 in the second period. This positive response indicates that higher oil prices initially boost trade openness, likely due to increased trade activity. Although the impact decreases slightly over time, it remains positive, suggesting sustained higher trade activity in response to increased oil prices. The impact is positive in both the short and long run.

The unemployment rate initially decreases in response to the Brent oil price impulse, with the largest negative impact (−0.023991) in the second period. This negative response persists, though it slightly diminishes over time, indicating that higher oil prices are associated with a reduction in unemployment rates. The impact is negative in both the short and long run.

Table 7: Long term relationship results

Dependent Variable: Inflation (LINF)				
Variables	**Coefficient**	**Std. Dev**	**t-Statistic**	**p-value**
LBRENT	6.51	1.64879	3.95	0.001
LGDP	2.98	0.61918	4.81	0.000
LEX	-4.93	4.0666	-1.21	0.240
LTRADE	6.35	2.7477	2.31	0.031
LUNEM	41.16	5.79036	7.10	0.000
ECT(-1)	-0.12	0.05642	-2.11	0.045
R-squared			0.515336	
Adj. R-squared			0.394169	
Log likelihood			-30.13026	
Akaike AIC			2.395501	

4.8. Diagnostic Test of VEC Model

To ensure the robustness of the VECM model presented in Table 7, it is essential to perform several diagnostic tests, including the LM test for residual normality and the residual heteroskedasticity test.

4.8.1. Serial correlation

The serial correlation of error terms is detailed in Table 8. To test for serial correlation, we use the LM test. The null hypothesis (H_0) for this test states that there is no serial correlation up to lag 5, while the alternative hypothesis (H_1) asserts that serial correlation is present.

Table 8: Short run relationship estimation

Short run est.	D (LINF)	D (LBRENT)	D (LGDP)	D (LEX)	D (LTRADE)	D (LUNEM)
LINF(-1)	-0.61	0.06	0.02	-0.02	0.01	-0.01
	(0.15181)	(0.05501)	(0.01552)	(0.01132)	(0.0193)	(0.01238)
	[-3.99048]	[1.08347]	[1.28937]	[-1.66898]	[0.53043]	[-0.90057]
LBRENT(-1)	-1.39	0.52	-0.02	0.00	0.15	-0.05
	(0.8615)	(0.3122)	(0.08808)	(0.06424)	(0.10952)	(0.07028)
	[-1.61327]	[1.66052]	[-0.23821]	[0.05941]	[1.36136]	[-0.69411]
LGDP(-1)	1.82	-0.63	-0.08	0.38	0.30	-0.17
	(2.44629)	(0.88651)	(0.25012)	(0.18241)	(0.31099)	(0.19957)
	[0.74233]	[-0.71069]	[-0.33043]	[2.09694]	[0.96454]	[-0.86229]
LEX(-1)	2.97	-1.82	-0.20	0.59	0.22	-0.22
	(3.45959)	(1.25371)	(0.35373)	(0.25797)	(0.43981)	(0.28224)
	[0.85948]	[-1.45009]	[-0.56567]	[2.28549]	[0.49245]	[-0.77942]
LTRADE(-1)	5.12	-1.45	0.40	0.04	-0.50	-0.14
	(2.54574)	(0.92255)	(0.26029)	(0.18982)	(0.32363)	(0.20768)
	[2.0119]	[-1.57695]	[1.51858]	[0.22917]	[-1.53427]	[-0.69071]
LUNEM(-1)	-1.08	1.46	0.76	-0.18	-0.02	-0.21
	(2.98402)	(1.08137)	(0.3051)	(0.2225)	(0.37935)	(0.24344)
	[-0.36045]	[1.35323]	[2.48548]	[-0.80323]	[-0.04515]	[-0.86667]

Notes: Values in () represent standard deviation, values in [] represent t-Statistic

The decision rule for the LM test involves comparing the P-value to a chosen significance level, typically 0.05. If the $P > 0.05$, we fail to reject the null hypothesis, indicating no serial correlation in the error terms. Conversely, if the $P < 0.05$, we reject the null hypothesis, suggesting the presence of serial correlation.

The key aspects of this assessment include the F-statistic and R-squared tests along with their probabilities. These values help determine whether the null hypothesis can be rejected.

Referring to Table 9, the reported results show the P-values for the LM test. Since the probabilities of the F-statistics are >0.05, we fail to reject the null hypothesis.

4.8.2. Normality

Numerous scholars believe that regression models often exhibit normality in their residuals. To verify this assumption, we can perform normality tests to determine whether the residuals follow a normal distribution. This is an important step in ensuring the reliability and validity of the regression model's results.

To assess normality, we typically use tests such as the Jarque-Bera test, which evaluates whether sample data has the skewness and kurtosis matching a normal distribution. The null hypothesis (H_0) for this test states that the residuals are normally distributed, while the alternative hypothesis (H_1) asserts that the residuals are not normally distributed.

The rule of decision for the Jarque-Bera test is straightforward: If the P-value is greater than a chosen significance level (commonly 0.05), we fail to reject the null hypothesis, suggesting that the residuals are normally distributed. Conversely, if the P-value is less than the significance level, we reject the null hypothesis, indicating that the residuals do not follow a normal distribution.

Table 9: Serial correlation results

Serial correlation (Null hypothesis: No serial correlation at lag h)						
Lag	**LRE* stat**	**df**	**Prob.**	**Rao F-stat**	**df**	**Prob.**
1	33.51	36.00	0.59	0.91	(36, 59.8)	0.615
2	29.13	36.00	0.78	0.77	(36, 59.8)	0.803
3	37.27	36.00	0.41	1.04	(36, 59.8)	0.441
4	31.19	36.00	0.70	0.83	(36, 59.8)	0.720
5	26.79	36.00	0.87	0.69	(36, 59.8)	0.880

Table 10: Normality results

Component	Jarque-Bera	df	Prob.
1	0.66	2.00	0.718
2	0.96	2.00	0.619
3	0.48	2.00	0.786
4	0.10	2.00	0.954
5	0.08	2.00	0.959
6	0.73	2.00	0.696
Joint	3.01	12.00	0.996

Table 11: Homoskedasticity results

Heteroskedasticity (Null hypothesis: Errors are homoscedastic)		
Chi-sq	**df**	**Prob.**
325	294	0.105

Referring to Table 8, the P-value is reported for the normality test. If this P-value is above the 0.05 threshold, we fail to reject the null hypothesis, confirming that the residuals of the model are normally distributed.

4.8.3. Heteroskedasticity

The diagnostic tests for heteroscedasticity are performed using the error-term heteroscedasticity test. This test checks for heteroscedasticity, which occurs when the variance of the residuals varies across the observations in the data. The null hypothesis (H_0) suggests that the residuals are homoscedastic (constant variance), while the alternative hypothesis (H_1) indicates that the residuals are heteroscedastic (varying variance).

Referring to Table 11, the reported results show the P-values for the heteroscedasticity test. The decision rule for this test involves examining the P-value of the F-statistic. If the P-value is greater than the chosen significance level, typically 0.05, we fail to reject the null hypothesis, indicating that the residuals are homoscedastic. Conversely, if the $P < 0.05$, we reject the null hypothesis, indicating the presence of heteroscedasticity.

In this case, the P-values for the F-statistics are >0.05, leading us to fail to reject the null hypothesis. This means there is no evidence of heteroscedasticity, and the residuals are homoscedastic.

5. CONCLUSION

The global economic uncertainty caused by the Russia-Ukraine war has raised concerns about the Korean economy. International oil prices have surged due to the conflict and the ongoing COVID-19 pandemic. As an energy-importing nation, Morocco is experiencing a significant increase in oil prices. This study examines the macroeconomic impacts of rising energy prices, focusing on Morocco as a case study. Since numerous energy products derived from crude oil, such as Fuel Oil No. 2 and Diesel, are extensively used in the industrial and transportation sectors, fluctuations in oil prices have both direct and indirect effects on various economic indicators. An increase in oil prices leads to higher production costs, which in turn are passed on to product prices. This is because petroleum products are essential inputs in transportation, industry, and service sectors. The increase in production costs due to external factors results in higher inflation. Conversely, rising inflation contributes to increased oil prices through economic activities such as exploration, extraction, distillation, and distribution of oil. Therefore, the mutual interaction between oil prices and inflation is inevitable. Also, since Morocco is an importing country of energy, higher energy prices results in a higher import bill, worsening the trade balance by increasing the trade deficit. Additionally, the increased demand for foreign currency to pay for more expensive oil imports can put downward pressure on the domestic currency, leading to depreciation.

The results from VECM model suggest that oil prices changes have an effect on inflation, in fact an increase in oil prices tends to increase inflation in the short and long run. The increase of inflation includes an increase of transport CPI, food CPI, and energy CPI (Suleman and Opoku, 2023). From public policy perspective, policymakers should consider oil price changes when formulating economic policies mainly on industrial, transport and energy sectors. Given the significant impact on industrial and transportation sectors in Morocco, priority should be given to strategies, resources, and policies for the transport sector.

Our research corroborates the findings of Sek et al. (2015), which identified a significant impact of oil price fluctuations on domestic inflation and a long-term relationship between changes in the CPI and oil prices. Similarly, Choi et al. (2018) found a long-term nexus between inflation and oil prices, consistent with our results. Zakaria et al. (2021) conducted similar research in South Asian nations, revealing that a shock to world oil prices has a long-term beneficial impact on inflation, as indicated by impulse-response functions. Also the findings of this study are aligned with the results of Cao et al. (2024) indicating that oil prices are positively connected to inflation in selected G20 countries in the long run.

Regarding economic growth, the results indicate that rising oil prices tend to cause instability in macroeconomic variables, disrupt productivity, consumption, and investment expenditures, and consequently negatively impact GDP growth in Morocco in the short term. The negative impact of energy prices in our findings contrasts with those of previous studies, such as Lee and Chang (2005), Behboudi et al. (2013), Amri (2017), and Bekhet et al. (2017), which reported a positive relationship between oil prices and economic growth. These studies suggest that rising oil prices can stimulate economic growth. Additionally, our findings indicate that in the long run, oil prices have no significant effect on GDP in Morocco. This observation aligns with the results of Sekkach et al. (2022), who employed an ARDL model to determine the absence of a long-term relationship between oil prices and economic growth in Morocco. This lack of a long-term impact suggests that other factors may play a more critical role in shaping Morocco's economic trajectory over time. The implications of these findings are significant for policymakers as they present the importance of diversifying the economic base and reducing dependency on oil prices as a determinant of economic stability and growth.

Also, the results of the study have shown that the rising oil prices have led to a depreciation of the local currency. As the increase of oil prices result in a higher import bill, placing downward pressure on the dirham. This currency depreciation occurs because the demand for foreign currency risTes to cover the increased cost of oil imports, while the supply of dirhams remains relatively unchanged. Consequently, Morocco may experience a widening trade deficit, as the cost of energy imports escalates, leading to reduced investor confidence and further currency depreciation.

The policy implications for Morocco are substantial. To mitigate the adverse effects of rising oil prices, Morocco should focus on diversifying its energy sources. Investing in renewable energy projects, enhancing energy efficiency, and promoting alternative domestic energy resources can reduce dependency on imported oil. Also, building and maintaining substantial foreign exchange reserves can help stabilize the currency and provide a buffer against the volatility of global oil prices.

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