Crude-Currency : An Economic Perspective on the Interrelation Between Oil Prices and Exchange Rates

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Abstract

Purpose : This study aimed to investigate the relationship between oil prices and exchange rates from January 2008 to December 2023. The study has been conducted using West Texas Intermediate (WTI) crude oil prices expressed in US dollars.

Methodology : Granger causality and vector autoregression (VAR) models were employed to understand the interdependencies between these variables.

Findings : In July of 2008, oil prices hit an all-time high of $147 a barrel. But from its 2008 high, the price fell by about 70%, with a low of $39.09 per barrel in February 2009. In 2014, the price of a barrel of oil dropped below $50. The global epidemic caused the price of oil to drop sharply in 2020 to a low of $11.26 per barrel. Since then, the price has been gradually rising. As of February 27, 2024, the WTI crude oil price was $78.78 per barrel. On the other hand, since 2008, the value of the US dollar has steadily increased. The study's conclusions showed a significant inverse relationship between the US dollar's value and crude oil prices.

Practical Implications : The results suggested potential implications for various stakeholders. The traders could utilize the negative correlation between oil prices and exchange rates to formulate their trading strategy and diversify their portfolios. Speculators could capitalize on the trade patterns, while arbitrageurs can identify price differentials to earn profit. Policymakers and regulators can make well-informed judgments about foreign exchange and the energy market by examining their interdependencies.

Originality : The study examined large datasets in addition to analyzing the relationship between oil prices and the US dollar exchange rate over a long period to gain a thorough understanding of the relationships between oil prices and other currencies. Additionally, the research helps us understand the implications of events like the 2014 oil price fall as well as the long- and short-term patterns.

Keywords : exchange rates, crude oil, US dollar, West Texas Intermediate (WTI)

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Crude oil, which is also referred to as liquid gold, plays a crucial role in the economy serving as the primary source of energy. The majority of the oil transactions are priced in US dollars. Thus, any fluctuations in oil prices or supply chain disruptions significantly impact the dollar value. The ongoing Russia–Ukraine war has significantly influenced the economy around the world. Russia is among one of the largest oil-producing nations of the world while Ukraine serves as an oil supply route to Europe. Thus, the conflict between Russia and the US has impacted the oil supply chains, the currency market, and the global economy (Zhang et al., 2024). The price of crude oil and the value of the US dollar have an inverse relationship (Cifarelli & Paladino, 2010; Yousefi & Wirjanto, 2004). This means that as the price of oil rises, the dollar's value decreases. Oil price is inversely related to the dollar's value because oil is priced in US dollars globally.

Dollar fluctuations have an impact on nations that import and export oil. The strength of the nation will rise if the dollar declines in relation to the price of its commodities (Sankararaman et al., 2018). However, when the value of the dollar rises, importing countries may face oil shocks, causing economic turbulence owing to an increase in crude supplies. Variations in oil prices have an effect on the economy's supply side, which affects practically every economic sector either directly or indirectly. Energy production and transportation are critical industries that are hugely influenced by oil price fluctuations. Recently, there have been initiatives to transition to greener energy sources. However, the use of energy derived from oil is still widely used. As was previously noted, the US dollar is the most often used means of exchange in the oil trade, so knowing the relationship between US dollars and oil prices is essential to understanding the global economy.

Literature Review

The US dollar and oil prices have been found to be correlated multiple times by empirical study. This aligns with previously put forward views elucidating the connection between oil prices and exchange rates.

Lizardo and Mollick (2010) showed a significant role in the price of oil in explaining long-run US dollar fluctuations using cointegration analysis for the monetary approach to the determination of the exchange rate, which supports the negative relationship between oil prices and the US dollar. Basher et al. (2012) discovered that short-term positive shocks to oil prices tend to lower stock prices and USD exchange rates. The conclusion was drawn by using the structural vector autoregression (VAR) model to analyze the relationship between exchange rates and the price of oil.

Several empirical investigations have emphasized the impact of a weaker USD on oil prices. Sadorsky (2000) studied the connection between different USD exchange rates and oil futures prices. Based on the study evidence of Granger causality was reported from exchange rates to energy futures prices. Exchange rate movements also affect oil prices, as reported by Indjehagopian et al. (2000).

Findlay and Rodriguez (1977) viewed an increase in oil prices as an increase in a nation's import bill. They attempted to utilize a foreign intermediate input in the Keynesian model. Their analysis of the exchange rate impact on oil-importing countries was done in 1977, following a significant rise in oil prices. In the Mundell–Fleming model (Wang, 2020), they viewed oil as an imported intermediate input. The Mundell–Fleming model and the IS-LM model, which is a mathematical characterization of the Keynesian model, might be regarded as near relatives. The IS-LM model assumes a closed economy, whereas Mundell–Fleming built its assumptions on an open economy with fully mobile capital and variable exchange rates. This is the primary distinction between the two models. Alternatively, Kilian and Vigfusson (2011) explained the oil price and the dollar exchange rate have a nonlinear connection and indicate that it is impossible to predict with certainty how oil price shocks would affect the actual economy and exchange rate.

Although most studies on the connection between oil prices and stock prices have looked at developed economies, there is growing interest in looking at this relationship in emerging markets as well. A study by Hammoudeh et al. (2004) has contributed significantly to this area, providing evidence that fluctuations in oil prices indeed impact stock prices in emerging markets. The results imply that fluctuations in oil prices have a major impact on how stock markets move in emerging nations, even though the processes behind this link may be different from those in industrialized ones.

Beckmann et al. (2020) revisited the relationship between oil prices and exchange rates. The authors critically analyze existing theories and empirical evidence regarding this relationship to offer a comprehensive understanding. They review various theoretical frameworks, including the traditional macroeconomic models and more recent approaches that account for financial market dynamics and global economic interdependencies. The study also looks at empirical research that looks at the connection between exchange rates and oil prices over various time periods and geographical areas.

Reboredo et al. (2014) examined the relationship between USD and oil prices. Data were separated into two segments because the study period was before and after the start of the 2008 financial crisis. Two significant discoveries included the low strength of the USD-oil price negative association. Furthermore, after the global financial crisis began, it was found that there was a greater negative correlation between the US dollar and oil prices.

Kim and Jung (2018) studied the structure of dependence between crude oil prices and exchange rates. The study concluded that after the global financial crisis, oil exchange rate linkages were found to be stronger for most countries that were dependent on oil. Additionally, Granger causality research demonstrated that exchange rates are Granger-caused by crude oil prices.

The majority of empirical research has offered multiple explanations for the connection between the price of crude oil and the USD exchange rate. First, when non-US customers' oil prices decline due to a depreciation of the US dollar, their oil demand is impacted, ultimately driving up prices (Hu & Yan, 2024). Second, some countries that export oil choose to use currencies tied to the US dollar in order to keep the buying power of their exports in USD relative to purchases in non-USD currencies. Finally, investment in oil becomes more appealing because a weaker USD translates into lower returns on USD-denominated financial assets. Nevertheless, there is a negative association between the USD and oil.

Mittal (2015–2016) studied daily data files of spot prices of crude oil and natural gas and observed that the correlation between the two became negative after 2009. In their study, Jothi and Suresh (2016) noted that the volatility of gold prices, US dollar exchange rates, and crude oil prices had a positive impact on the Indian stock markets. Lakshmanasamy (2022) found that the volatility and spillovers from one Indian market produced volatility and spillovers in other Indian markets after examining the price of crude oil, gold, exchange rates, inflation, and stock returns.

Research Methodology

Granger causality and VAR models were employed in order to quantitatively investigate the relationship between oil and the USD exchange rate. A statistical test called the Dickey–Fuller test determines whether an autoregressive (AR) time series model has a unit root (Mushtaq, 2011). The null hypothesis (H_0) of the Dickey–Fuller test is the presence of unit root in the time series sample. The alternative hypothesis, on the other hand, is different depending on which version of the test is used but is usually stationarity or trend-stationarity. The Dickey–Fuller test involves running a regression on the "first difference" of the series against the series lagged by one period, an intercept, and possibly a time trend. The more negatively the test statistic is, the more strongly the null hypothesis (H_0) is rejected. The Augmented Dickey–Fuller (ADF) test is an extension of the Dickey–Fuller test using, which eliminates the structural effects in the time series. It then tests the same procedure. The ADF test is one of the most frequently implemented statistical tests for analyzing the stationarity of a series. Initially, the ADF test statistic at a 5% level of significance was greater than 0.05; therefore, to rectify the same, the data series was detrended using the Hodrick–Prescott (HP) filter. The HP filter is a mathematical tool utilized in macroeconomics. It is most frequently used in actual business cycle theory to take away the cyclical aspect of a time series from raw records. It is far used to attain a smoothed-curve representation of a time collection, one that is more sensitive to long-term than to short-term fluctuations. The adjustment of the sensitivity of the fashion to brief-time period fluctuations is carried out via editing a multiplier.

The reasoning for the methodology makes use of thoughts related to the decomposition of data from time series. The series is made from a trend element and a cyclical element such that given a properly selected, positive value of the element, there is a trend factor. The equation:

$$\underset{\{T_t\}}{min} \sum_{t=1}^{i}(y_t - T_t)^2 \sum_{t=2}^{i} + (T_t - 2T_{t-1} + T_{t-2})^2 \quad (1)$$

The initial term of the equation is the sum of the squared deviations, which penalizes the cyclical component. The second term is a multiple of the second differences' sum of squares for the trend component. This second term penalizes variations in the growth rate of the trend component. The punishment rises in proportion to the amount. Hodrick and Prescott suggest 1600 for quarterly data (Silvia, 2011).

Granger causality and VAR can be used after the series has been detrended. Granger causality is a statistical concept of causality that is based on prediction. It is a statistical hypothesis test used to determine whether one time series can predict another. Suppose a signal X_2 "Granger-causes" (or "G-causes") is a signal X_1. In that case, previous values of X_2 should hold information that helps predict X_1 other than the information contained in past values of X_1 alone. Furthermore, it is important to highlight that Granger causality does not imply real causality in the sense of cause and effect. Rather, it tests whether one variable precedes another in a time series (Jones, 1989). The Granger causality test is typically implemented through a pair of regressions, and the test statistic is based on the sum of squared residuals. Equations for the bivariate Granger causality test are as follows:

Restricted model (RM): This model does not support Granger causality from Y to X. The equation is:

$$X_t = \alpha_0 + \alpha_1 X_{t-1} + \alpha_2 X_{t-2} + \ldots. + \alpha_p X_{t-p} + \varepsilon_t \quad (2)$$

where X_t is the current value of X, $X_{\{t-1\}}, X_{\{t-2\}}, ..., X_{\{t-p\}}$ are the previous values of X, p represents the number of lags, $\alpha_0, \alpha_1, ..., \alpha_p$ are the parameters to be estimated, and ε_t is the error term.

Unrestricted model (UM): This model allows for Granger causality from Y to X. The equation is:

$$X_t = \alpha_0 + \alpha_1 X_{t-1} + \alpha_2 X_{t-2} + \ldots. + \alpha_p X_{t-p} + \beta_1 Y_{t-1} + \beta_2 Y_{t-2} + \ldots. + \beta_q Y_{t-q} + \varepsilon_t \quad (3)$$

where $Y_{\{t-1\}}$, $Y_{\{t-2\}}$, ..., $Y_{\{t-q\}}$ are the previous values of Y, q represents the number of lags, and $\beta_1, \beta_2, ..., \beta_q$ are the parameters to be estimated.

Granger causality's null hypothesis (H_0) is that the coefficients of the lagged Y terms in the unrestricted model are all zero, i.e., Y does not Granger-cause X. This is tested by comparing the sum of squared residuals from the restricted and unrestricted models. If the sum of squared residuals is significantly higher in the unrestricted model, the null hypothesis (H_0) is accepted, and it is concluded that Y Granger causes X.

A VAR model is a multivariate forecasting algorithm that is used in cases where two or more time series exercise influence over each other (Akkaya, 2021). This means that the relationship between the time series involved is bi-directional. In the VAR model, every variable is modeled as a linear combination of preceding values of itself and the preceding values of other variables in the system. The VAR model generalizes the univariate autoregressive model by allowing for multivariate time series.

VAR (p) model equation:

$$Y_t = c + A_1 Y_{\{t-1\}} + A\, Y_{\{t-\}} + \ldots\ldots + A_p Y_{\{t-p\}} + e_t \quad (4)$$

where:

- It is a vector of endogenous variables (i.e., variables we are interested in explaining or predicting).
- c is a vector of constants (intercepts).
- A_1 is a matrix of coefficients for the ith lag.
- It is a vector of error terms.

The order "p" means that up to p-lags of each variable in the model are used as predictors.

Here, we use VAR when dealing with multivariate time series data, like the one provided with multiple variables in our data. VAR models capture the interdependencies among multiple time series variables by modeling each variable as a linear function of its lagged values and the lagged values of all other variables in the system. This allows us to analyze how changes in one variable affect other variables in the system over time. Other types of autoregression (AR) models, such as simple AR or autoregressive integrated moving averages (ARIMA), are typically used for univariate time series data. Since our data involves multiple variables and we are interested in understanding the relationships among them over time, VAR is the appropriate choice.

The decision to use VAR instead of other techniques like the vector error correction model (VECM), Bayesian VAR, Bayesian TVCVAR, or switching VAR depends on various factors, including the nature of the data, the underlying economic theory, the research objectives, and the specific hypotheses being tested. If the data series are stationary or exhibit a stable long-run relationship, a VAR model may be appropriate. VAR models are generally used for analyzing the dynamic relationships between non-stationary time series data. Furthermore, if the research questions can be adequately addressed using a simpler modeling approach, there may be no need to introduce additional complexity. However, suppose the primary focus of the analysis is on forecasting or understanding short to medium-term dynamic interactions between the variables. In that case, a VAR model can provide valuable insights without the need for error correction mechanisms or Bayesian inference. Prior research in the field also considered VAR models and has yielded satisfactory results, therefore, we would be following a similar approach to ensure consistency and comparability.

Data

We use daily records from January 2008 to December 29, 2023, to analyze the link between the exchange rate and crude oil prices. We used the oil price for West Texas Intermediate (WTI) in US dollars because it is used as a benchmark to determine WTI. This is closely related to other oil prices in the US and other crude oil markets and against the currencies of euro currency countries (EUR), Australia (AUD), Canada (CAD), Japan (JPY), Russia (RUB), India (INR), and Nominal Broad US Dollar Index (DTWEXBGS). The data was further bifurcated into two terms, one from January 2008 to December 2014 and January 2015 to December 2023 to study if the 2014 oil price crash caused any effect on the interrelation between the US dollar and the oil prices. The respective data has been attached in the annexure.

Analysis and Interpretation

Analysis of the Correlation Between Oil Prices (WTI) and Exchange Rate

The graphs can be used to provide a basic understanding of the relationship between WTI crude oil spot prices and major exchange rates. The respective graphs have been attached in the annexure. The graphs in Figures 1 and 2

Figure 1. ***WTI Oil Spot Prices and Major Exchange Rates for the Period January 2008 to December 2014***

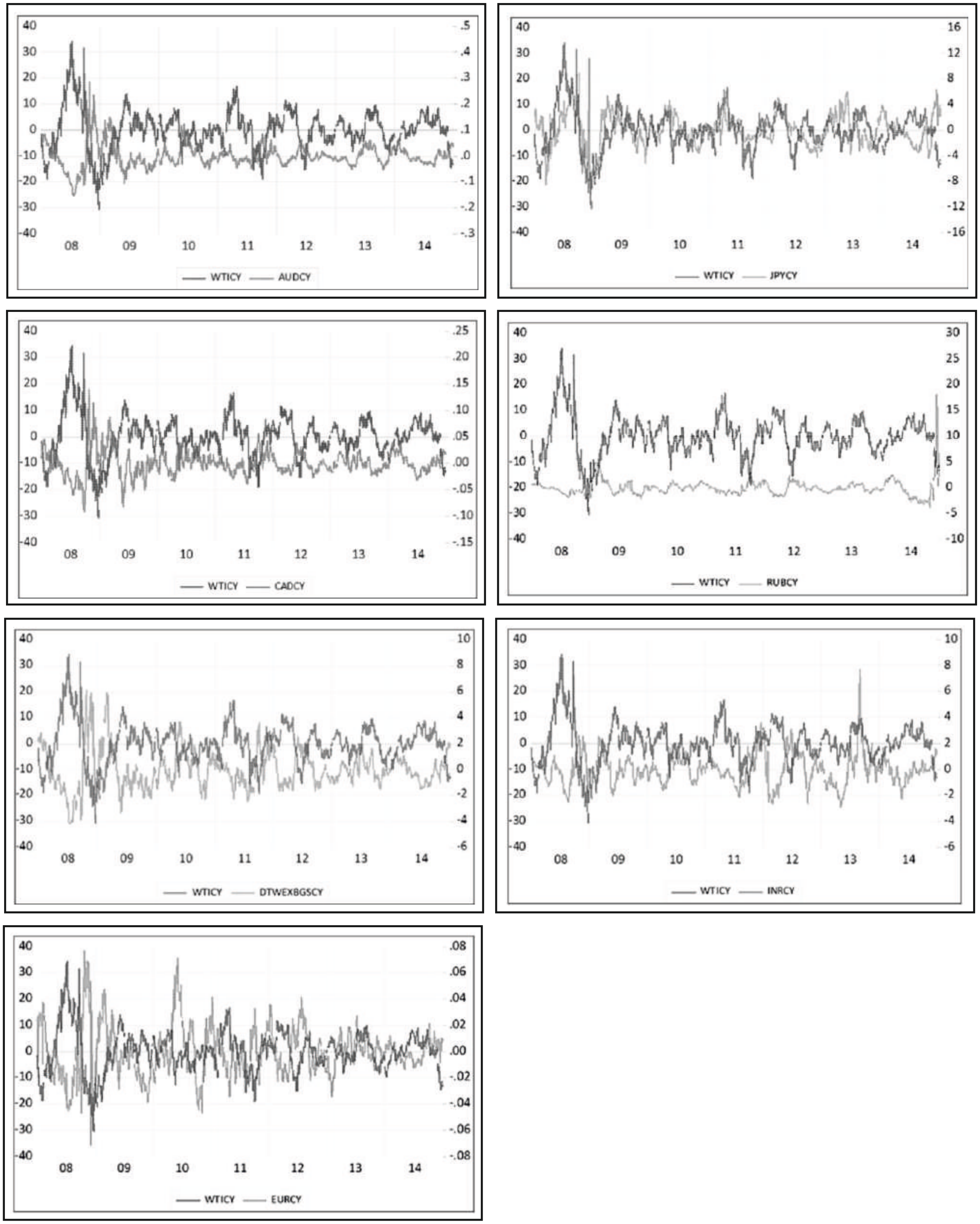
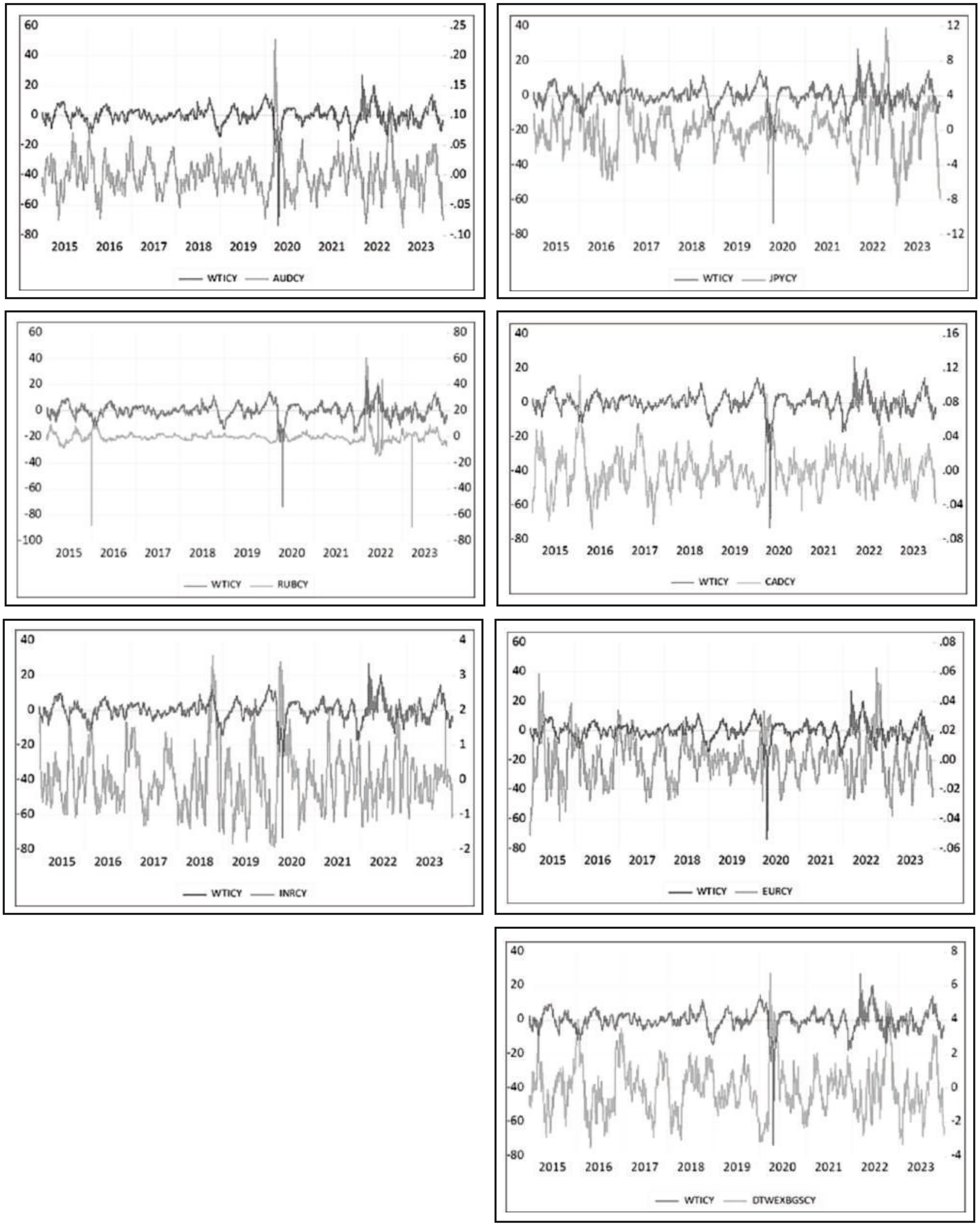


Figure 2. ***WTI Oil Spot Prices and Major Exchange Rates for the Period January 2015 to December 2023***



demonstrate that there is a negative relationship between major exchange rates and WTI crude oil spot prices. In the case of net oil importers like Australia, Japan, and India, this is particularly pronounced. Moreover, it is evident that after the 2014 oil price collapse, the negative correlation has grown.

Analysis of Descriptive Statistics

It is generally hypothesized there exists an inverse relation between exchange rate and oil prices (Cifarelli & Paladino, 2010). Table 1 provides evidence in support of this claim. All other currencies, with the exception of the Japanese Yen, exhibit a negative relationship with oil prices. The fact that oil prices are listed in US dollars necessitates the conversion of domestic currencies into US dollars, which is the primary factor supporting the negative correlation. If the value of the dollar increases, oil will become more expensive, which will reduce demand and cause oil prices to decline.

Further, countries that have free-floating exchange rates have a higher degree of negative correlation with oil. This can be attributed to the fact that their currencies move freely to adjust according to demand and supply. The market conditions are automatically taken into account by the exchange rate. The demand for local currency declines when the US dollar appreciates, decreasing the rate, and oil prices rise in home currency. The association is minimal in the case of nations with stable arrangements, such as India, throughout the first half of the study

Table 1. ***Descriptive Statistics for Daily Oil Price and Exchange Rate for the Period from January 2008 to December 2023***

	Mean	Median	Std. Dev.	Skewness	Kurtosis	Jarque–Bera	Corr. with Oil
			Panel A : January 2008 to December 2014				
WTI	0.0009431	0.2355611	7.91382816	0.160759407	4.8221436	251.6332452	1.00000
AUD	–4.02E–05	–0.0042904	0.04543781	0.748213631	6.7102216	1176.370366	–0.67513
CAD	–8.25E–06	–1.20E–03	0.02352512	0.460467358	6.1525985	792.8443357	–0.66698
DTWEXBGS	–1.28E–03	–0.1671851	1.48421595	0.652276911	4.6059929	314.6589376	–0.63288
EUR	–1.37E–05	–0.0016226	0.01906884	0.583903186	4.1617112	199.4308352	–0.46862
INR	–0.0005824	–0.0045231	1.17253801	0.72210906	6.1008813	860.0404806	–0.24666
JPY	–0.0015742	–0.0103451	2.52444614	–0.08882115	3.7137045	39.75842586	0.35741
RUB	–1.421E–09	–0.1388938	1.48674249	3.32947266	32.731393	68229.84998	–0.38569
			Panel B : January 2015 to December 2023				
WTI	–0.000898	–0.043533	5.82587	–1.09719	15.35373	15388.77	1.00000
AUD	7.52E–06	–0.0017	0.031609	1.104369	8.207697	3127.866	–0.33984
CAD	2.10E–05	–1.34E–05	0.022248	0.507177	4.615799	355.7825	–0.45235
DTWEXBGS	–5.26E–09	–0.064339	1.489376	0.606655	3.785516	204.215	–0.33150
EUR	2.19E–05	–0.00037	0.014797	0.461281	3.681502	128.5966	–0.11765
INR	–0.000581	–0.095133	0.811995	0.76143	4.151219	356.2411	–0.15822
JPY	–0.000549	0.066815	2.524662	0.299451	5.04139	442.4123	0.12624
RUB	0.000298	–0.379677	5.419919	2.447634	62.74372	351242.7	–0.04684

Notes. Daily data for the period January 2008 to December 2023. Data are split into two samples: (a) Panel A: January 2008 to December 2014 (before the 2014 oil crisis) and (b) Panel B: January 2015 to December 2023 (after the onset of the crisis). The table highlights the basic statistics for the data, including mean, median, standard deviation (Std. dev.), skewness, kurtosis and Jarque–Bera test for normality based on skewness and excess kurtosis. Corr. Refers to the correlation coefficients.

period because of central bank regulation and intervention. Long-term currency fluctuations are permitted in a stable system; nevertheless, the central bank controls immediate shocks.

Moreover, after the 2014 oil price collapse, there was a significant decrease in the correlation between oil prices and exchange rates. This decrease can be attributed to a number of factors, such as the increased use of alternative fuels in recent years, a move away from using US dollars to buy oil, and stricter rules put in place by central banks after the financial crisis. The relationship between oil prices and exchange rates falls in tandem with a decline in the reliance on oil and the US dollar. Exchange rates are becoming outdated as more and more nations attempt to sign currency swap agreements. As a result, there is a decrease in the relationship between oil prices and the exchange rate.

Granger Causality Analysis

Granger causality analysis is used to assess if one time series can be used to forecast another, as shown in Tables 2 and 3. Suppose p-values > 0.05, the null hypothesis (H_0) is accepted at a 5% level of significance. As can be seen from Table 2 for the years 2008–2014, except in the case of India, the null hypothesis (H_0) is rejected for all other currencies. This implies that a change in the oil prices Granger causes all other currencies. The hypothesis can be explained by the fact that most of the countries analyzed are net importers of oil; therefore, any change in the oil prices can influence the exchange rate. Since there is a stable system in place in India, changes in oil prices cannot have a direct impact on the exchange rate because the central bank would mitigate any negative effects. A similar situation exists in data from 2015 to 2023 (Table 3). The null hypothesis (H_0) is rejected for every currency except the euro and ruble. Once more, the currency rate will be impacted by changes in oil prices because the remaining nations are all net importers. The RBI's efforts to lessen its intervention in recent years can be blamed for the shift in the INR. Since Russia is now a major exporter of natural gas and oil, it is encouraging the use of rubles rather than US dollars to purchase oil; thus, the influence of oil prices on the exchange rate is not as great in this situation.

Table 2. ***Oil Prices and Exchange Rates : Granger Causality Test, January 1, 2008 to December 31, 2014***

Null Hypothesis	*F*-Statistic	Prob.	Result
AUD does not Granger Cause WTI.	3.39901089	0.065404	Accept
CAD does not Granger Cause WTI.	0.0383073	0.845391	Accept
DTWEXBGS does not Granger Cause WTI.	0.00060191	0.97949	Accept
EUR does not Granger Cause WTI.	0.17107417	0.681418	Accept
INR does not Granger Cause WTI.	0.05091614	0.821503	Accept
JPY does not Granger Cause WTI.	1.77460431	0.182986	Accept
RUB does not Granger Cause WTI.	0.2804205	0.596493	Accept
WTI does not Granger Cause AUD.	12.4806633	0.000422	Reject
WTI does not Granger Cause CAD.	28.8581679	8.82E–08	Reject
WTI does not Granger Cause DTWEXBGS.	9.91357447	0.001668	Reject
WTI does not Granger Cause EUR.	12.9191823	0.000723	Reject
WTI does not Granger Cause INR.	3.46862706	0.060074	Accept
WTI does not Granger Cause JPY.	7.55850736	0.006034	Reject
WTI does not Granger Cause RUB.	18.9588463	1.41E–05	Reject

Note. In parentheses, p-values <0.05 indicate rejection of the null hypothesis (H_0) for the associated statistical tests at the 5% level.

Table 3. ***Oil Prices Versus Exchange Rates : Granger Causality Test, January 1, 2015 to December 31, 2023***

Null Hypothesis	*F*-Statistic	Prob.	Result
AUD does not Granger Cause WTI.	1.41459172	0.243233	Accept
CAD does not Granger Cause WTI.	1.76383902	0.171613	Accept
DTWEXBGS does not Granger Cause WTI.	2.26916473	0.103626	Accept
EUR does not Granger Cause WTI.	0.67269854	0.51034	Accept
INR does not Granger Cause WTI.	4.13538179	0.016114	Reject
JPY does not Granger Cause WTI.	0.16048203	0.851743	Accept
RUB does not Granger Cause WTI.	0.84765852	0.428548	Accept
WTI does not Granger Cause AUD.	20.6522874	1.29E–09	Reject
WTI does not Granger Cause CAD.	76.5238222	6.42E–33	Reject
WTI does not Granger Cause DTWEXBGS.	3.83806841	0.021671	Reject
WTI does not Granger Cause EUR.	2.923472	0.053943	Accept
WTI does not Granger Cause INR.	3.11274954	0.044663	Reject
WTI does not Granger Cause JPY.	3.61646652	0.027028	Reject
WTI does not Granger Cause RUB.	0.88942639	0.41103	Accept

Note. In parentheses, the *p*-values <0.05 indicate rejection of the null hypothesis (H_0) for the associated statistical tests at the 5% level.

Alternatively, in data for 2008–2014 and 2015–2023, it can be seen that almost no currency granger causes the oil prices. This can be attributed to the fact that oil markets involve a large number of buyers. Exchange rate changes in the case of any currency would have an insignificant impact on the overall demand and supply. Since OPEC controls oil prices, the impact of exchange rate changes is not seen. The impact of exchange rate fluctuations on oil prices is minimal because no single nation can influence the supply or demand of oil among all OPEC members.

Further, in most cases, the "*p*-value" has declined from 2008–2014 to 2015–2023. This decline can be attributed to decentralization in the sale of oil. More and more countries are trying to establish currency swap agreements that remove the requirements of a third currency for buying oil. The purchase and sale are carried out in local currencies, and thus, the impact of the exchange rate has further declined (Betts & Devereux, 2000).

Vector Autoregression Estimates Analysis

Regression analysis for the years 2008–2014 has been presented in Table 4. The analysis of the regression models uncovers several noteworthy findings. The *R*-squared values for the exchange rates (AUD, CAD, DXY, EUR, INR, JPY, and RUB) concerning oil prices (WTI) range from approximately 0.882 to 0.947. These high *R*-squared values indicate a strong explanatory relationship between oil prices and rates during the period. The positive coefficients for the exchange rates suggest that lower oil prices are associated with lower values of the respective exchange rates and vice versa. The magnitude of the coefficients provides information about the

Table 4. ***Vector Autoregression Estimates for 2008–2014***

	WTI	*AUD*	*CAD*	*DTWEXBGS*	*EUR*	*INR*	*JPY*	*RUB*
WTI(–1)	0.9147	–0.000527	–0.000421	–0.006613	–0.000241	0.001897	0.037378	–0.027517
	–0.02699	–0.00017	–0.000096	–0.005	–0.00009	–0.00401	–0.01279	–0.00568

	[33.8864]	[–3.14079]	[–4.39434]	[–1.32308]	[–2.69439]	[0.41165]	[2.92309]	[–4.84108]
WTI(–2)	–0.01602	0.000563	0.000431	0.006251	0.000284	–0.004824	–0.03187	0.010494
	–0.03624	–0.00023	–0.00013	–0.00671	–0.00012	–0.00619	–0.01717	–0.00763
	[–0.44194]	[2.49905]	[3.35536]	[0.93156]	[2.36447]	[–0.77981]	[–1.85645]	[1.37523]
WTI(–3)	0.139501	–0.00072	–0.000408	–0.007379	–0.000273	0.008869	0.009682	0.002072
	–0.03629	–0.00023	–0.00013	–0.00762	–0.00012	–0.0064	–0.0179	–0.00763
	[3.84438]	[–3.19323]	[–3.16928]	[–1.09823]	[–2.27098]	[1.40275]	[0.56324]	[0.27115]
WTI(–4)	–0.05643	0.000439	0.000168	0.002158	0.000191	–0.002468	–0.01094	0.01178
	–0.03651	–0.00023	–0.00013	–0.00691	–0.00012	–0.0062	–0.0174	–0.00765
	[–1.54531]	[1.93505]	[1.29593]	[0.31191]	[1.58077]	[–0.39814]	[–0.63254]	[1.53213]
WTI(–5)	–0.06337	1.21E–05	0.000214	–0.002658	2.30E–05	–0.011055	–0.005874	–0.006173
	–0.03657	–0.00023	–0.00013	–0.00677	–0.00012	–0.00624	–0.01733	–0.0077
	[–1.73275]	[0.05313]	[1.16482]	[–0.39250]	[0.18964]	[–1.77075]	[–0.33905]	[–0.80150]
WTI(–6)	0.079612	–0.000488	0.000102	0.013718	–0.00016	0.003591	0.053736	0.008867
	–0.03644	–0.00023	–0.00013	–0.00675	–0.00012	–0.00622	–0.01726	–0.00767
	[2.18445]	[–2.21534]	[0.78878]	[2.03280]	[–1.32389]	[0.57715]	[3.11248]	[1.15504]
WTI(–7)	–0.0646	1.67E–04	–3.94E–05	–0.00743	0.000175	–0.002094	–0.04575	–0.012733
	–0.0366	–0.00023	–0.00013	–0.007678	–0.00012	–0.00625	–0.01734	–0.00771
	[–1.76516]	[0.73497]	[–0.30354]	[–1.09647]	[1.44154]	[–0.33519]	[–2.63905]	[–1.65240]
WTI(–8)	0.035286	–0.000433	0.000077	–0.002588	–0.000631	0.003726	0.001749	0.006448
	–0.02743	–0.00017	–0.000097	–0.005088	–0.00009	–0.00468	–0.01299	–0.00578
	[1.28652]	[–0.25425]	[0.72597]	[–0.50950]	[–0.69425]	[0.79576]	[0.13458]	[1.11641]
***R*-squared**	0.946592	0.936986	0.923733	0.947524	0.898611	0.929242	0.88204	0.933087
Adj. *R*-squared	0.944757	0.934601	0.920846	0.945538	0.894774	0.926564	0.877576	0.930554
Sum sq. resids	5875.979	0.226868	0.07398	4.001462	0.064603	171.2212	1318.638	260.3545
S.E. equation	1.864096	0.011583	0.006614	0.345163	0.006181	0.318205	0.883061	0.392526
***F*-statistic**	468.2916	392.8813	320.016	477.0851	234.1782	346.9885	197.5691	368.4459
Log-likelihood	–3552.14	5370.116	6353.983	–590.6166	6472.983	–447.815	–2240.162	–816.4112
Akaike AIC	4.119743	–6.042274	–7.16285	0.747676	–7.298387	0.584072	2.62547	1.003885
Schwarz SC	4.32225	–5.839767	–6.960344	0.949223	–7.09588	0.786578	2.827976	1.206392
Mean dependent	0.003921	–0.000356	–0.000123	–0.01198	–0.000977	–0.000374	–0.013236	–0.002864
***S.D.* dependent**	7.917655	0.045293	0.02351	1.479037	0.01905	1.174226	2.523816	1.489518
Determinant resid covariance	**1.67E–16**							
Determinant resid covariance (dof adj.)	**1.23E–16**							
Log-likelihood	**12228.91**							
Akaike information criterion	**–13.3359**							
Schwarz criterion	**–11.7158**							
Number of coefficients	**520**							

strength of the relationship between each exchange rate and oil prices. Moreover, the adjusted R-squared values, though marginally lower, persist at high levels, indicating the absence of excessive complexity and the avoidance of overfitting. The sum of squared residuals, which gauges the difference between observed and predicted values, shows relatively small values, indicating that the models fit the data well, and the equation's standard error shows small values, indicating improved accuracy in the coefficient estimation.

Furthermore, the F-statistic, gauging the overall significance of the regression model, attains high values, affirming its statistical significance. Moreover, metrics for model comparison, such as Log Likelihood, Akaike information criterion (AIC), and Schwarz criterion (SC), manifest lower values, indicating superior model fit, with a preference for the model exhibiting the lowest value.

Furthermore, the mean and standard deviation provide information about the dependent variable's dispersion and central tendency across data. Finally, if values are abnormally tiny, the determinant residual covariance, which highlights the determinant of the residual covariance matrix, may indicate possible problems with multicollinearity or singularity.

In conclusion, while the analysis underscores high explanatory power, good fit, and statistically significant relationships within the regression models, a thorough examination is warranted to ensure adherence to regression analysis assumptions and accurate interpretation of the coefficients' significance. It is essential to address issues with the residual covariance determinant in order to strengthen the validity of model estimations.

Table 5 displays the results of a VAR analysis for the period of 2015–2023. The analysis sheds important light on how successfully VAR models account for variations in oil future prices across various currencies. The R-squared values for the exchange rates (AUD, CAD, DXY, EUR, INR, JPY, and RUB) concerning oil prices (WTI) range from approximately 0.632 to 0.954. For the years 2015–2023, these R-squared values show a significant explanatory association between exchange rates and oil prices, just like they did for the years 2008–2014. The positive coefficients pertaining to the exchange rates indicate a positive correlation between increased oil prices and higher exchange rate values and vice versa. Similar to the years 2008–2014, the magnitude of the coefficients indicates the degree to which each exchange rate and oil price are correlated.

Table 5. *Vector Autoregression Estimates for 2015–2023*

	WTI	*AUD*	*CAD*	*DTWEXBGS*	*EUR*	*INR*	*JPY*	*RUB*
WTI(–1)	0.746083	–0.00238	–0.000525	–0.009247	9.67E–05	0.001812	0.02481	0.050119
	–0.02135	–0.00072	–0.00049	–0.00377	–0.000036	–0.00256	–0.00619	–0.03392
	[34.9534]	[–3.29918]	[–10.6441]	[–2.45213]	[2.67076]	[0.70880]	[4.00827]	[1.47765]
WTI(–2)	0.108513	0.00217	0.000391	0.009301	–0.000252	0.006444	–0.011133	0.054956
	–0.02659	–0.00009	–0.000061	–0.0047	–0.000045	–0.00318	–0.00771	–0.04225
	[4.08155]	[2.41829]	[6.36710]	[1.98021]	[–0.55951]	[2.02416]	[–1.44404]	[1.30083]
WTI(–3)	0.026694	0.000112	0.0000794	0.003962	–0.000248	–0.006451	–0.002789	–0.066691
	–0.02684	–0.000091	–0.000082	–0.00474	–0.000046	–0.00322	–0.00839	–0.04225
	[0.99460]	[0.12420]	[1.28143]	[0.83557]	[0.05450]	[–2.00733]	[–0.35831]	[–1.56374]
WTI(–4)	0.073764	–7.05E–06	0.000077	–0.009082	–0.000081	0.001616	0.000234	–0.052285
	–0.02673	–0.00009	–0.000062	–0.00472	–0.000045	–0.0032	–0.00775	–0.04247
	[2.76009]	[–0.07820]	[1.24752]	[–1.92348]	[–1.78718]	[0.50492]	[0.03017]	[–1.2319]
WTI(–5)	–0.011162	–1.14E–05	0.0000641	0.004744	–0.000199	–0.00039	0.00236	0.024615
	–0.02187	–0.000074	–0.000054	–0.00347	–0.000037	–0.00262	–0.00634	–0.03415
	[–0.51044]	[–0.15435]	[–1.26973]	[1.05447]	[0.53710]	[–0.12545]	[–0.21810]	[0.70839]
***R*-squared**	0.873927	0.951229	0.953637	0.939775	0.942798	0.906197	0.943535	0.632165

Adj. *R*-squared	0.871735	0.950381	0.952831	0.938728	0.941803	0.904566	0.942553	0.625768
Sum sq. resid	10031.7	1.0442	0.053502	313.1196	0.028878	143.8425	843.5439	25330.47
S.E. equation	2.088446	7.05E–03	4.82E–03	0.36897	0.003543	0.25008	0.60566	3.318621
***F*-statistic**	398.5865	1121.483	1182.725	897.2541	947.7014	555.4886	960.8383	98.82001
Log-likelihood	–5025.014	918.652	–966.9837	9908.457	–56.49118	–2126.981	–6109.199	13084.54
Akaike AIC	4.328077	–7.054874	–7.813456	0.861156	–8.430119	0.08329	1.852183	5.254335
Schwarz SC	4.428297	–6.954023	–7.712607	0.962007	–8.329268	0.184141	1.953034	5.355185
Mean dependent	0.001366	–2.64E–07	0.0000977	0.001462	0.00011	–0.000963	–0.002792	0.00134
***S.D.* dependent**	5.831348	0.031639	0.022207	1.490593	0.014668	0.809521	2.526725	5.424841
Determinant resid covariance (dof adj.)	**1.20E–15**							
Determinant resid covariance	**1.04E–15**							
Log-likelihood	**13084.54**							
Akaike information criterion	**–11.51349**							
Schwarz criterion	**–10.70668**							
Number of coefficients	**328**							

When a model's sum of squared residuals, which gauges how well it fits the data, is low, it usually indicates a good fit with little unexplained variation.

Furthermore, it is noteworthy how precisely the estimated coefficients are estimated, as indicated by the standard error of the equation, where smaller values denote estimates of the correlations between oil prices and currency values that are more accurate. The models are statistically significant overall, indicating that the correlations between oil prices and currency values are not only the result of random variation, according to the high *F*-statistic values (except AUD).

We can select the best models with the aid of model comparison measures such as the SC and AIC, where lower values denote a better fit. The mean and standard deviation of the dependent variable provide details of the spread of oil prices and central tendency. Lastly, very small values of the determinant of the residual covariance matrix may suggest potential issues with multicollinearity or singularity in the data, which need to be carefully considered.

An understanding of how variations in WTI oil prices affect different exchange rates (AUD, CAD, DTWEXBGS, EUR, INR, JPY, and RUB) over time can be gained from Figures 3 and 4 of the impulse response function (IRF) graph. The influence on exchange rates that results from a positive shock to WTI oil prices can be seen by looking at the IRF graph. This analysis highlights cross-effects or the ways in which changes in one currency may have an impact on others due to interconnection, in addition to individual currency reactions. Additionally, spillover effects are clearly visible, demonstrating how shocks to one currency have an impact on others. The response's height denotes its magnitude, but its duration is just as important in differentiating between transient effects and those that are long-lasting. Policymakers can utilize this information to evaluate the consequences of oil price fluctuations on exchange rates, while investors can make informed decisions by understanding how different currencies respond to oil shocks. It is crucial to remember that the lag order selected for the VAR model determines the precise form of the IRF graph, highlighting the need for meticulous modeling and interpretation.

Thus, the analysis demonstrates that VAR models are valuable for predicting and making decisions in financial markets because they are good at comprehending the links between currency values and oil prices.

Figure 3. ***Response to Cholesky One S.D. (d.f. Adjusted)***

Structural VAR impulse responses (2008–2014)

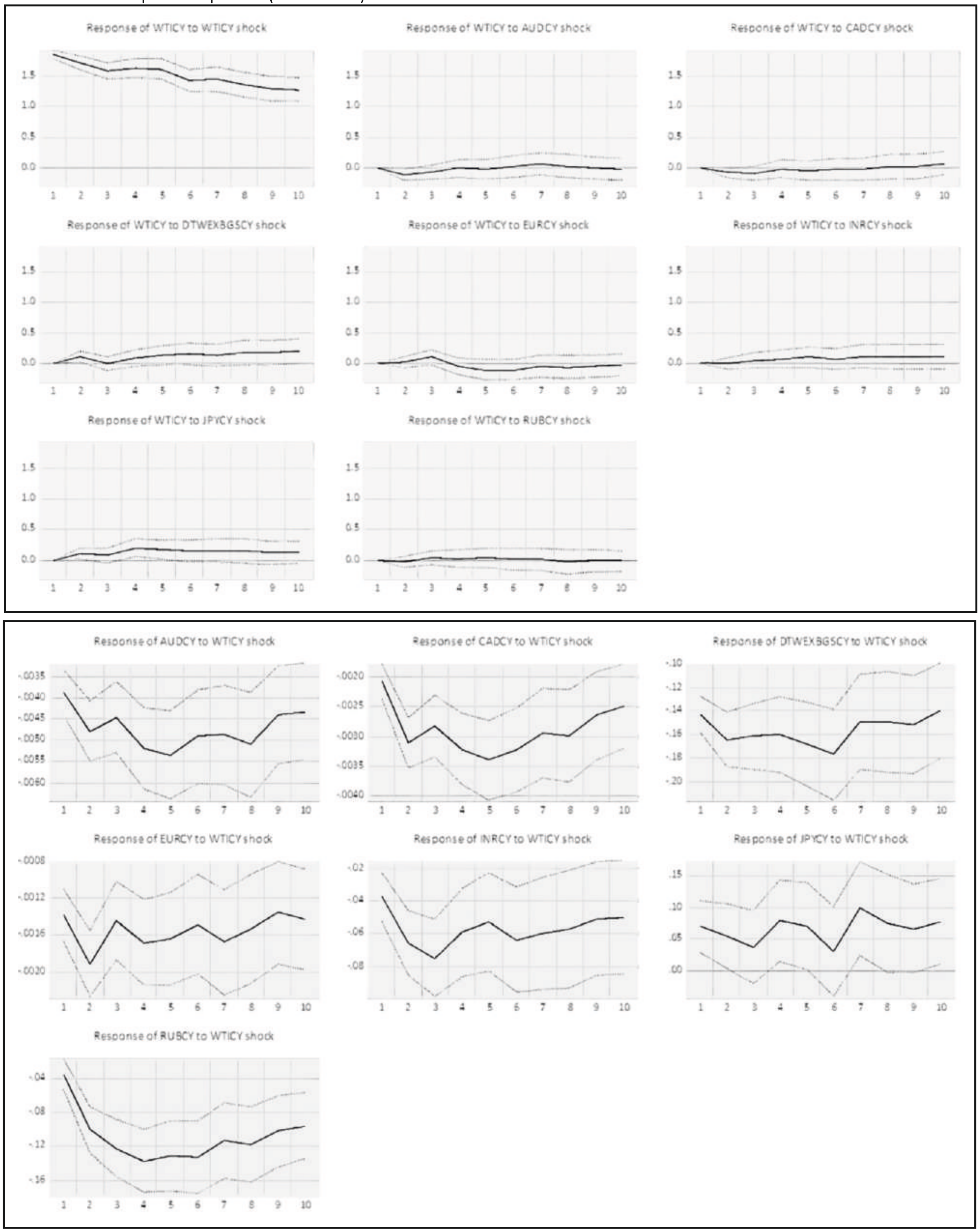
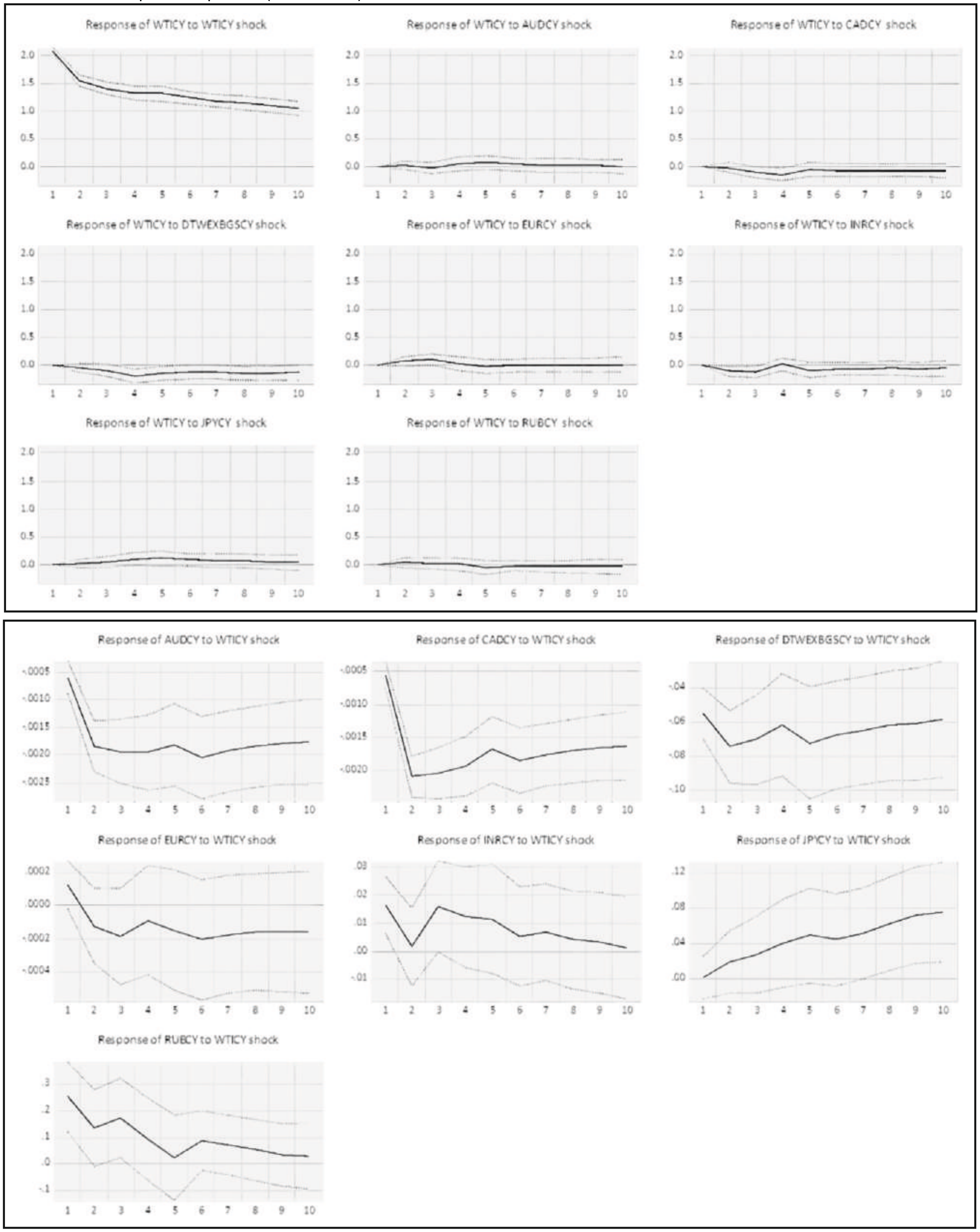


Figure 4. ***Response to Cholesky One S.D. (d.f. Adjusted) Readjusted))***

Structural VAR impulse responses (2015–2023)



Overall, the analysis suggests that the VAR models of oil future prices with various currency prices are well-specified and statistically significant. The models provide a good fit to the data and offer valuable insights into the relationships between oil prices and currency prices. However, further examination of the coefficients and their economic interpretation is necessary to fully understand the dynamics between these variables. For analyzing the correlation between oil prices (WTI) and exchange rates (AUD, CAD, DXY, EUR, INR, JPY, and RUB) for the periods 2008–2014 and 2015–2023, we can examine the R-squared values and coefficient estimates from the VAR models for each period.

Overall, the data suggests that there was a significant positive correlation between oil prices and exchange rates from 2008 to 2014 and from 2015 to 2023. Increased oil prices are typically correlated with higher exchange rate values, suggesting that changes in oil prices may have an impact on currency exchange rates.

Results

Reboredo et al. (2014) found that the USD and oil prices were marginally correlated negatively. The data did not address the 2014 oil price issue, but it did cover the global financial crisis. Therefore, we used the period from the onset of the global financial crisis to the 2014 oil crisis. Furthermore, we used data from 2015 to 2023 to provide a more comprehensive view and investigate whether the events changed the relationship in any way. The results showed that between 2008 and 2014, there was a rather high degree of correlation between the USD and oil prices. This work bridges that gap by investigating possible post-crisis reactions from central governments and markets, as well as long-term consequences. We also looked at data from 2015 to 2023 and found a decline in the association. Potential reasons for the same were previously explored in the analysis section.

Using Granger causality, Kim and Jung (2018) found that exchange rates are Granger caused by oil prices. As Kim and Jung's (2018) data was only available until 2015, we chose to extend the data set to include information through 2023. To investigate the effects of the oil and global financial crises, we split the data into two halves and analyzed the results. Our analysis reveals that oil prices influence the exchange rate but that the contrary is not always true. Our results were consistent with those of Kim and Jung (2018). Because of this, additional data was employed, and independent analyses were conducted to address the gap caused by the short research period.

The VAR analysis reveals a significant explanatory relationship between crude oil prices and currency rates for the years 2008–2014 and 2015–2023. The IRF provided examples of how oil price fluctuations affect exchange rates over time and how each currency reacts due to interdependence. The graphics demonstrate how shocks to one currency affect another.

Conclusion

An inverse relationship between the US dollar and oil prices can be deduced from the preceding data. The price effect, supply and demand, and other factors are some of the causes of the inverse relationship. It is important to acknowledge that the link between the two has decreased throughout the two time periods examined. A host of factors could lead to such changes, such as reduced dependence on oil and push for cleaner fuels, decreased dependence on US dollars for transactions and increased controls by the central banks to ensure domestic stability. Furthermore, the data shows that while the prices of oil affected the exchange rates for the majority of the currencies, the prices of oil did not specifically depend on any one currency. From 2008 to 2014, it is evident that there is a robust relationship between exchange rates and oil prices across various currencies. The high R-squared values indicate that changes in oil prices can explain a considerable proportion of the exchange rate variability during this period.

Additionally, the positive coefficients suggest that lower oil prices are generally associated with lower values of the respective exchange rates and vice versa. This positive correlation emphasizes how much the changes in oil prices have affected the movements of currencies throughout this period of time. Policymakers, investors, and enterprises must comprehend this relationship in order to effectively navigate the global economic landscape. A noteworthy correlation has been observed between oil prices and exchange rates in an examination of data spanning from 2015 to 2023. The strong correlation suggests that the fluctuations in oil prices significantly impact the values of exchange rates, with higher oil prices generally associated with higher exchange rates and vice versa. This finding underscores the interconnectedness of global financial markets and the importance of considering oil price dynamics when analyzing currency movements. Governments, businesses, and investors must understand this connection in order for them to make informed decisions in the global economy.

Implications

Statistics on exchange rates and oil price dependency have a wide range of financial and policy ramifications. The results can be relevant for policymakers, researchers, and traders, such as speculators and arbitragers. The negative relationship that exists between different currencies and oil prices might help traders spot patterns and trends. It is feasible to infer potential future trends from these underlying relationships. The negative link between the price of oil and the USD exchange rate presents trading opportunities. Speculators can utilize this to identify new trends and make wise bets.

Furthermore, arbitrageurs can find mismatches and profit from them by using these negative correlations. Granger causality analysis makes it simpler to determine which variable causes another to Granger cause another. This technique can assist researchers in finding the impacts of factors on one another. Further, the data can be used to identify which variables do not affect the other variables. Thus, a better understanding of the impact of variables on each other can be gained. The analysis is also beneficial for policymakers as it helps to identify the correlation between the variables. This correlation can help policymakers to identify the possible impact of variation in one variable on the other variable.

Additionally, the impact of less reliance on oil and US dollars, respectively, can be investigated with the growing usage of green energy and currency swaps. Furthermore, the impact of structural adjustments, such as using oil itself or reducing reliance on the US dollar to purchase oil, may be somewhat predicted prior to the plan being implemented. Although these studies provide insightful information on certain parts of the relationship among oil prices, stock prices, and USD exchange rates, the larger economic backdrop and plausible causal mechanisms that underlie these relationships may not be well covered.

Limitations of the Study and the Way Forward

The results can be utilized in several ways; however, it must be noted that only a limited number of currencies are used in the above research. The impact of other currencies should also be considered for increased coverage. Further, oil prices are analyzed based on the WTI index, and it may be noted that other indices in the regional context may be more relevant if the study is based on a currency other than the US dollar. To make the analysis more appropriate, it can take into account additional macroeconomic variables that may moderate the link. Further research could explore the underlying economic mechanisms driving the found correlations and dependencies by examining variables such as monetary policy, macroeconomic conditions, and geopolitical events. In order to improve our comparative examination of how energy economics affects supply and demand around the world, we might investigate alternative energy sources like coal and natural gas.

Authors' Contributions

Dr. Arjun Mittal and Prof. Dr. Anand Mittal have developed the conceptual framework for the paper.

Deepankar Joshi and Sourabh Sheet have conducted an extensive literature review and conducted tests, which Dr. Arjun Mittal analyzed. Hritwiza Das, in consultation with other authors, finalized the paper.

Conflict of Interest

The authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

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References

Akkaya, M. (2021). Vector autoregressive model and analysis. In B. A. Mercangöz (ed.), *Handbook of research on emerging theories, models, and applications of financial econometrics* (pp. 197–214). Springer. https://doi.org/10.1007/978-3-030-54108-8_8

Basher, S. A., Haug, A. A., & Sadorsky, P. (2012). Oil prices, exchange rates and emerging stock markets. *Energy Economics*, *34*(1), 227–240. https://doi.org/10.1016/j.eneco.2011.10.005

Beckmann, J., Czudaj, R. L., & Arora, V. (2020). The relationship between oil prices and exchange rates: Revisiting theory and evidence. *Energy Economics*, *88*, 104772. https://doi.org/10.1016/j.eneco.2020.104772

Betts, C., & Devereux, M. B. (2000). Exchange rate dynamics in a model of pricing-to-market. *Journal of International Economics*, *50*(1), 215–244. https://doi.org/10.1016/S0022-1996(98)00036-1

Cifarelli, G., & Paladino, G. (2010). Oil price dynamics and speculation: A multivariate financial approach. *Energy Economics*, *32*(2), 363–372. https://doi.org/10.1016/j.eneco.2009.08.014

Findlay, R., & Rodriguez, C. A. (1977). Intermediate imports and macroeconomic policy under flexible exchange rates. *The Canadian Journal of Economics*, *10*(2), 208–217. https://doi.org/10.2307/134439

Hammoudeh, S., Dibooglu, S., & Aleisa, E. (2004). Relationships among U.S. oil prices and oil industry equity indices. *International Review of Economics & Finance*, *13*(4), 427–453. https://doi.org/10.1016/S1059-0560(03)00011-X

Hu, Z., & Yan, L. (2024). Nonlinear responses of crude oil prices to the US dollar exchange rates: The role of inventories. *Empirical Economics*, *66*(4), 1491–1510. https://doi.org/10.1007/s00181-023-02502-x

Indjehagopian, J. P., Lantz, F., & Simon, V. (2000). Dynamics of heating oil market prices in Europe. *Energy Economics*, *22*(2), 225–252. https://doi.org/10.1016/S0140-9883(99)00034-1

Jones, J. D. (1989). A comparison of lag–length selection techniques in tests of Granger causality between money growth and inflation: Evidence for the US, 1959–86. *Applied Economics*, *21*(6), 809–822. https://doi.org/10.1080/758520275

Jothi, M., & Suresh, G. (2016). An econometric analysis of the causal relationship between gold, crude oil, U.S. dollar rates and S&P BSE 100 in India. *Indian Journal of Research in Capital Markets*, *3*(2), 20–30. https://www.samvad.sibmpune.edu.in/index.php/ijrcm/article/view/102593

Kilian, L., & Vigfusson, R. J. (2011). Nonlinearities in the oil price-output relationship. *Macroeconomic Dynamics*, *15*(S3), 337–363. https://doi.org/10.1017/S1365100511000186

Kim, J.-M., & Jung, H. (2018). Dependence structure between oil prices, exchange rates, and interest rates. *The Energy Journal*, *39*(2), 259–280. https://doi.org/10.5547/01956574.39.2.jkim

Lakshmanasamy, T. (2022). The causal relationship between volatility in crude oil price, exchange rate, and stock price in India: GARCH estimation of spillover effects. *Indian Journal of Research in Capital Markets*, *8*(3), 8–21. https://doi.org/10.17010/ijrcm/2021/v8i3/167954

Lizardo, R. A., & Mollick, A. V. (2010). Oil price fluctuations and U.S. dollar exchange rates. *Energy Economics*, *32*(2), 399–408. https://doi.org/10.1016/j.eneco.2009.10.005

Mittal, A. (2015–2016). Pricing relationship between oil and natural gas. *Business Analyst, 36*(2), 185–197. https://www.srcc.edu/system/files/Pg%20185-197%20Arjun%20Mittal%3B%20Pricing%20Relationship%20Between%20Oil%20and%20Natural%20Gas.pdf

Mushtaq, R. (2011). *Augmented dickey fuller test*. Available at SSRN. https://doi.org/10.2139/ssrn.1911068

Reboredo, J. C., Rivera-Castro, M. A., & Zebende, G. F. (2014). Oil and US dollar exchange rate dependence: A detrended cross-correlation approach. *Energy Economics*, *42*, 132–139. https://doi.org/10.1016/j.eneco.2013.12.008

Sadorsky, P. (2000). The empirical relationship between energy futures prices and exchange rates. *Energy Economics*, *22*(2), 253–266. https://doi.org/10.1016/S0140-9883(99)00027-4

Sankararaman, G., Suresh, S., Komatheswari, T., Surulivel, S. T., Selvabaskar, S., VijayAnand, V., & Rengarajan, V. (2018). A study on the relationship between price of US dollar and selected commodities. *International Journal of Pure and Applied Mathematics*, *119*(15), 203–224. https://acadpubl.eu/hub/2018-119-15/4/643.pdf

Silvia, P. J. (2011). Subjective scoring of divergent thinking: Examining the reliability of unusual uses, instances, and consequences tasks. *Thinking Skills and Creativity*, *6*(1), 24–30. https://doi.org/10.1016/j.tsc.2010.06.001

Wang, P. (2020). The Mundell–Fleming model. In *The economics of foreign exchange and global finance* (pp. 149–172). Springer. https://doi.org/10.1007/978-3-662-59271-7_7

Yousefi, A., & Wirjanto, T. S. (2004). The empirical role of the exchange rate on the crude-oil price formation. *Energy Economics*, *26*(5), 783–799. https://doi.org/10.1016/j.eneco.2004.06.001

Zhang, Q., Hu, Y., Jiao, J., & Wang, S. (2024). The impact of Russia–Ukraine war on crude oil prices: An EMC framework. *Humanities & Social Sciences Communications*, *11*, Article No. 8. https://doi.org/10.1057/s41599-023-02526-9

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