Dynamic adjustment between exchange rate returns and crude oil returnsin oil-importing countries

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Abstract

Financial markets are characterized by fluctuations that arise from investor reactions to market activities and broader macroeconomic indices. This research examines the interconnectivity between returns on exchange rates and crude oil prices for ten oil-importing countries. Quarterly data spanning the period from 2000Q1 to 2022Q4 was used in the estimation. Returns had to be calculated from raw data, which were exchange rates and crude oil prices. The research methodologies include quantile regression and VAR-GARCH estimations. The study revealed a long-term association between crude oil market returns and foreign exchange markets, with currency fluctuations negatively impacting crude oil returns. The spill-over effect from the currency market to the oil market is weaker than the transmission effect from the oil market to the currency market of oil-importing countries. In particular, it was empirically established that shocks from past volatility in the currency markets of countries that import oil had commensurately lower volatility in the oil market by 6 percent. Whereas, the spillover from the crude oil market to the currency market depicts that increased turbulence on the crude oil market in the current period stimulated 55.66 percent amplified volatility in the currency market for oil-importing nations. Oil returns had a volatility persistence value of 0.1255, ratifying the weak volatility persistence of oil returns. The size of the volatility persistence of exchange rate returns is 0.997, an indication of high volatility persistence for currency returns. The study found the absence of leverage effects for currency values given a positive coefficient with a magnitude of 0.8529. In other words, bad news does not cause higher turbulence in exchange rate returns than good news will. For crude oil returns, the size of the leverage effects term is -0.0529, which is negative and significant ($p<.05$), implying that bad news in oil-importing economies has asymmetric impacts on the volatility of returns on crude oil prices. In effect, the oil price returns react more strongly to bad news than these returns react to good news. The findings of the study underscore the intricate relationships between local currencies and energy prices within the context of a global financial market, highlighting the significance of understanding these dynamics for effective decision-making and risk management in an increasingly interconnected world. It was recommended, among others, that internationalcollaboration amongst countries is crucial given the global nature of energy markets.

Keywords: Bad news, good news, leverage effects,oil importing countries, returns, volatility persistence, VARGARCH model

JEL Classification: C14, E23, D40

Original research article

1. Introduction

Global marketplaces are structures that enable interactions between sellers and buyers. These trading mechanisms may be found in markets dealing with securities, bonds, futures, energy goods, and other transferable commodities. Investors and other market players typically participate with the hope of wealth optimization or at least favourable returns as a reward for bringing cash into the market. However, these markets do not function in isolation. Instead, they operate in the context of financial developments that elicit varied investor decisions, resulting in price volatility and, eventually, return. The macroeconomic literature refers to these variations as volatility. Economies globally have mediums of exchange in common, referred to as local currencies, with peculiar names further emphasized with a descriptive country origin, such as the Chinese yen, Kenyan shillings, and Malaysian ringgit. The globalization trends, from trade to

migration to improved international diplomacy and soft power, impact countries, and these impacts are felt in the interrelationships among countries' currencies that have values controlled by marketplace dynamics (supply and demand), often known as the flexible exchange rate system or maintained through government initiatives presented as a fixed exchange rate regime. However, currencies are not only intertwined with one another. Rather, they are constantly used in other commodity markets and could have a significant effect on these markets and the economy at large. In recent years, global financial markets have seen a noticeable trend of substantial integration, resulting in greater complexity and dependency. Consequently, these markets have been bedevilled with volatilities internal to the markets themselves and those that spill over from other markets (Syed, 2022).

Recent crises, for instance, the Russian-Ukraine war occurred in the Euro-Asia region and transmitted as food crises and instability in energy prices globally with the reduction in supply of exports from the war giants and simultaneously less imports for other countries. In the same manner, currency markets impact a nation's economy given that the value of the currency is directly proportionate to the purchasing power of residents within the jurisdiction. Further still, such value is evident in the markets where the currencies are traded alongside other currencies. The currency value also arises as investors in other markets such as gold, grains, and other investment markets may require a medium of exchange (currency) to hold some of these assets, including energy assets. Ben-Salem *et al*. (2024) opine that energy prices, with a focus on oil prices, happen to be one of the most volatile financial investments and thus can be a source of volatility for other markets given the universality of energy usage and diversification of portfolios by financial market investors. Castro and Jiménez-Rodríguez (2020) confirm the spilling of volatility from these markets, stating that oil-price volatility can lead to currency depreciation in oil-importing economies, shifting revenue from petroleum-importing to petroleum-exporting countries. In contrast, a spike in oil prices may improve the currency value of oil-exporting nations owing to higher income. This volatility fuels uncertainty in the oil and forex markets. Over the last decade, research has concentrated on the influential evidence of the value of oil prices on currencies, with trade and wealth channels identified as significant factors. Olstad *et al*. (2021) suggest that trade channels entail the depreciation of real exchange rates due to higher pricing of tradable items, which causes foreign currency to weaken compared to the US dollar. This is owing to the foreign economy's dependence on petroleum imports. On the contrary, wealth pathways involve a rise in wealth in countries that export oil. This wealth is then invested in assets denominated in US dollars, resulting in the US dollar gaining value over other currencies. Both channels have significant impacts on influencing the fluctuations of oil prices and currency exchange rates. The relevant questions therefore are: How do oil prices adjust to fluctuations in currency values in oil-importing countries? How do currency rates react to fluctuations in oil prices in nations that import oil? The research therefore aims to determine the adjustments of crude oil returns to fluctuations in exchange rates and also the dynamic effect of exchange rate returns on volatility in oil prices in oil-importing countries.

The significance of the research is situated around the fact that an understanding of how oil market value changes affect currency values can inform currency trading decisions. Moreover, the research findings are also germane to corporate executives and risk managers, who, on the basis of the research findings, will obtain strategies on how to mitigate risks associated with exchange rate and oil price volatility by developing hedging strategies. By adjusting pricing strategies or using financial instruments like futures contracts, companies that heavily rely on imported oil can mitigate adverse currency movements and better manage their exposure to these risks. Given the recent state of the geopolitical landscape globally, it is crucial to study and establish the reaction of exchange rates on commodity prices, especially energy commodities, and vice versa due to the fact that among those countries that are continuously engaged in geopolitical tensions are those major producers of crude oil, such as Russia and the

United States of America. Having this research-based knowledge and empirical information gives investors an upper hand regarding the overall market behaviour, especially in the currency trading ecosystem. Additionally, this study provides a comprehensive overview of global marketplaces, highlighting their complexities and interconnectedness. It effectively and empirically interprets the dynamics of various markets and the roles of local currencies in these markets in the wake of globalization. Overall, the research findings are indeed informative and insightful, offering a detailed examination of global marketplaces, currency dynamics, and the interrelated impacts of energy prices and currency rates. It successfully bridges theoretical concepts with practical applications, making it a valuable empirical resource for both academic and professional audiences. Besides, the discussion on investor behaviour and the pursuit of wealth optimization provides insight into the motivations driving market participation. Highlighting the role of financial and macroeconomic volatility in influencing investors' decisions offers a nuanced view of the factors contributing to price fluctuations. The study in general offers a practical explanation for corporate executives and risk managers, emphasizing the relevance of the research findings in recommending risk mitigation strategies. Subsequent portions of this research work entail the literature review section, which pulls together findings and assertions from different empirical and theoretical literature to serve as a basis for grasping the concepts of the study and mechanisms that could anchor eventual study findings. The preceding section is the methodology section, which spells out the theoretical anchor, apriori expectations, and variable definitions for data gathering, data sources, and econometric models that guide analysis. Empirical results are contained in the next section after adequate diagnostic tests, and these tests are duly interpreted and explained in the light of current policy realities. This study concludes with a final section that itemizes findings, emphasizes the contribution of this work to knowledge, and offers recommendations for policy and future research.

2. Literature review

2.1. Theoretical literature review

The theoretical basis for the crude oil-currency rate connection is (i) the law of one price, (ii) the wealth effect, and (iii) the terms of trade effect (Nandelenga & Simpasa, 2020). First, the law of one price states that the homogeneity of crude oil indicates that the declining value of the US dollar lowers the value of oil in the international oil market. Blomberg & Harris (1995) anticipated that weakening values in the US dollar would benefit other nationalities. Second, the crude oil-currency rate link has characteristics of a wealth effect channel. Accordingly, oil consumption in oil-importing countries is inelastic. As a result, an increase in oil prices transfers money from importers to exporters. Third, the conditions of the trade channel take shape and construct the oil price-exchange rate connection based on the country's usage of both traded and non-traded goods. Keeping non-traded products constant across two nations, rising oil prices raise the cost of commodities sold in countries importing them. Holding non-traded products constant between two nations, an increase in oil prices enhances the cost of commodities traded in the oil-importing nation relative to the oil-exporting economy. This causes a depreciation of the native currency of the oil-importing country (Nandelenga & Simpasa, 2020).

2.2. Empirical literature review

Ben-Salem et al. (2024) studied the link between crude oil costs and currency exchange rates. The research utilized the VAR and DCC-GARCH techniques on Shanghai crude oil futures and WTI crude, along with foreign exchange markets. The research examined everyday information from March 2018 to August 2023. The findings confirm the persistent nature of turbulence using dynamic correlations. The study also discovered substantial proof of volatility transfers between the prices of petroleum and forex platforms. Zhao et al. (2024) used the Diebold and Yilmaz index approaches to investigate return spillovers between prominent crude oil futures markets. The study also used the static and fixed functions of SC and JCO in the crude

oil futures market, while the dynamic research investigates the dynamics of spillover during recent chaotic periods. The static data reveal that SC and JCO play a smaller role in the system, serving as substantial net beneficiaries as compared to Brent, WTI, and Oman. The COVID-19 pandemic had a substantial impact on the market's net spillover, with Brent and WTI's net spillover decreasing while Oman and JCO's increased overall. Total spillover across markets soared during the epidemic.

Bagchi et al. (2024) assessed the current Russia-Ukraine war and its significant influence on global economic circumstances. In this setting, the current paper seeks to investigate the effects of the sharp increase in crude oil prices on indices of the stock market and exchange rates in the five largest oil-importing nations. The study employed the DCC-MMGARCH on daily information, which uses the linear form of the univariate GARCH with time-sensitive weights. The study found significant short-run and long-run volatility spillover impacts among all considered markets. The research by Yu et al. (2023) finds substantial differences in return linkages and fairly comparable forms of volatility spillover. Before the volatility shock, return linkage was observed with exchange rates for the International Energy Exchange; after the shock, there was none. For Brent oil, there were noticeable spillovers from oil returns to returns on currency rates of exchange. In addition, before the shock, a unidirectional form of spillovers was found from exchange rate volatility to crude oil prices, but after the shock, it was bidirectional. Both China and the UK exhibit similar return-and-volatility spillover patterns when using offshore exchange rates. These findings have significant practical implications.

Kocoglu et al. (2023) investigated how fluctuations in oil prices affect the currency rates of ASEAN's five economies. The study uses a rolling and recursive evolving window approach to discover changes in the relationship between oil price and currency rate for five ASEAN nations from January 1988 to June 2022. The study expands on the current research by employing the time-varying Granger causality approach, which incorporates sensitivity over many time horizons. The data demonstrated that the influence of oil prices on the exchange rate varied in relevance and size throughout time. Our empirical findings show the correlation of oil price and foreign exchange rate fluctuations with key dates and occurrences.

Stojkov et al. (2023) analysed the asymmetric impacts of oil price variations on stock market indices in a sample of greater and lower-class importers of oil. The research outcomes are based on impulse response functions from the VAR model, in addition to the Granger causality analysis of the link between indexes of stock markets and price changes in the oil market. The VAR (Vector Auto Regression) model is examined from 2013M1 to 2023M1 to determine the independent impact of oil price variations on stock market indices in selected European economies. The study's findings suggest an asymmetric mechanism for addressing the effect of oil disruptions on EU member nation’s stock markets.

Li et al. (2022) investigate the choices and actions of international firms, foreign investors, and regulatory authorities by developing a risk spillover effect measuring model utilizing the GARCH-CoVaR methodology. The study focuses on the newly established Shanghai crude oil futures market, which has a strong negative volatility transmission implication for the onshore currency exchange market and a bi-directional and direct volatility spillover influence on the offshore currency market.Onodje et al. (2022) evaluated the impact of the cost of crude oil on the Nigerian currency market, with a focus on delineating between the impacts of beneficial and detrimental movements in the price of crude on the currency's value. Using monthly data from January 1996 to June 2019, non-linear ARDL (NARDL) and Wald equations were engaged for co-integration and asymmetrical analysis. The study outcome revealed that both favourable and adverse crude price fluctuations had considerably different nominal effects on nominal exchange rates across both the short and lengthy terms. Nevertheless, the disparities were only in terms of effect magnitude.

Ren (2022) applied a trivariate VAR-BEKK-GARCH method to look at the evolving links between worldwide oil prices, gold prices, and European stock markets. This research detects minor return ripple effects from the oil market to six European stock markets, as well as from gold to Iceland, but there is no proof of rebound spillovers from equity markets to oil or gold. The absence of return links between gold and stocks (oil) shows that the gold market serves as a safe haven. In terms of volatility consequences for other markets, the findings indicate a clear asymmetric bidirectional variance connection between the European markets and the international gold or oil markets. Greater shock and fluctuation transmissions from the European stock market to both gold and crude oil commodities are noted in comparison.

Alexey-Mikhaylov (2021) employed the VAR framework to calculate the average volatility transmission between Brent crude oil costs and local currency volatility from 2001 to 2021. The report contributes to the expanding body of research on the implications of COVID-19 on the ripple impact on international exchange rates in oil-producing nations that export petroleum. Recent research has revealed how the spillover impact has altered in oil-exporting countries. All three recent oil price shocks (2008, 2012, and 2020) have been communicated to oil-producing countries' currency markets. At the same time, the Russian currency conversion rate has not properly reflected the final shock of 2020, which was produced by the COVID-19 epidemic. The major cause is the element of diminishing economic pressure.

Thai (2020) uses both Diebold and Yilmaz's spillover index and wavelet techniques to investigate the effects of spillovers from return and dynamic time frequency connections between the cost of crude oil and five established markets for stocks in Europe prior to and during the COVID-19 outbreak. The results show that the IBEX and CAC stocks are net risk receivers, whereas the other assets are net shock transmitters in the pre-Covid-19 timeframe. In contrast to the data from the pre-Covid-19 period, LSE, CAC, and IBEX are net receivers of return spillovers, reaching a peak of around 23% during the Covid-19 pandemic. Specifically, compared to pre-Covid-19 times, the spillover becomes more obvious.

Wen et al. (2020) used crude oil prices and exchange rates from seven prominent petroleum-exporting and importing economies from the year 2000 to the year 2018. It was discovered that there are both positive and adverse risk spillovers. Risk transference from currency exchanges to petroleum products or securities is more significant compared to those from oil to foreign exchange rate platforms. Furthermore, risk spillovers are substantially greater for those who export oil than for those who import. The study also shows that the severe risk reliance connecting the two markets became stronger during the 2008–2009 financial meltdown era.

Maitra & Dawar (2019) assessed the amount of return and volatility transfer between commodities, stock, and foreign exchange rate sectors. The study investigated if there is an alteration in return and volatility spillovers throughout a crisis and after the particular crisis, in addition to any differences in the behaviour of spillover shifts between agribusiness and non-agribusiness products. The study employed vector auto-regression, complemented by Granger causality, to investigate the causation of returns. They conducted multivariate volatility analysis to investigate the probability of the co-movement of various assets. A single-direction spillover from commodity currencies to stock indices and currency rates has been identified. Stock indices have been proven to impact exchange rate returns.Katusiime (2018) studied the transmission effect of volatility in oil prices on the value and fluctuations of the Ugandan shillings. Using the Multivariate Generalised Autoregressive Conditional Heteroskedasticity (MGARCH) and Generalised Vector Autoregressive (GVAR) techniques, the research found minimal levels of volatility spillover and market interconnectedness, with the exception of crisis moments, when cross-market risk transfer and market interconnectedness abruptly and significantly expand.

3. Methodology

Quantile regression was adopted to test the effect of exchange rate returns on crude oil returns and vice versa at varying quantiles for oil importing economies examined by the study. The quantile regression method attempts to assess the impact of predictor factors on various quantiles of the outcome variable. Previous research has found that regressors have various magnitudes of impacts on the dependent variable across quantile conditional distributions. In other words, OLS powers the slope coefficient to be the same for all quantiles, implying that there is inadequate information on the impact on various nations at different quantiles. Quantile regressions eliminate discrepancies that may arise from outlier findings.The quantile regression model specifications are as follows:

$$\emptyset_{\tau m}(R_X|R_C) = \mu_{0m,\tau} + \mu_{1m,\tau}R_C \quad (1)$$

$$\emptyset_{\tau m}(R_C|R_X) = \gamma_{0m,\tau} + \gamma_{1m,\tau}R_X \quad (2)$$

By variable definition, $\emptyset_{\tau m}(R_X|R_C)$isτ-th quantile of the conditional distribution of exchange rate returns as affected by crude oil returns; $\emptyset_{\tau m}(R_C|R_X)$ is τ-th quantile of the conditional distribution of crude oil returns as affected by exchange returns; $\mu_{0,\tau}$, $\gamma_{0,\tau}$are the constant term of the τ-th quantile; $\mu_{1,\tau}$, $\gamma_{1,\tau}$ are coefficients of predictor returns. The presence of non-linearities in the quantile model estimations required further estimation using asymmetric or non-linear estimations, hence the VAR-GARCH analysis. First was the test for ARCH effects. The test was conducted as a pre-requisite to VAR-GARCH estimations. This was derived by obtaining ARCH heteroscedasticity values from OLS estimations. Next, the panel series are subjected to VAR estimations to retrieve the residuals. Asymmetric GARCH modelling was then applied to the retrieved residuals. The symmetric GARCH (p,q) model is expressed as a conditional mean equation below:

$$R_X = E(R_X|I_{t-1}) + v_{1it} \quad (3)$$

$$R_C = E(R_C|I_{t-1}) + v_{2it} \quad (4)$$

Where R_X is the returns on exchange rate at time *t* for the i[th] country,$R_C$is the returns on crude oil at time *t* for the i[th] country,$E(R_X|I_{t-1})$ is the expected returns on exchange rate conditional on all available market information, $E(R_C|I_{t-1})$ is the expected returns on oil conditional on all available market informationε_{it} is the hetreroskedastic eror. The conditional mean equations for returns on exchange rates and crude oil:

$$R_X = \alpha_0 + \sum_{i=1}^{p} A_{mi}R_{Xt-1} + v_{1it} \quad (5)$$

$$R_C = \alpha_0 + \sum_{i=1}^{p} A_{mi}R_{Ct-1} + v_{2it} \quad (6)$$

The variance regression equation is specified as:

$$\sigma^2_{R_X,t} = [b_{11}^2 + b_{12}^2] + [g_{11}^2 + g_{12}^2]USD_{t-1} + d_{11}^2\sigma^2_{R_X,t-1} + 2d_{11}d_{21}\sigma^2_{R_{XC},t-1} + d_{21}^2\sigma^2_{R_C,t-1} + \beta_{11}^2\upsilon^2_{1,t-1} + 2\beta_{11}\beta_{21}\upsilon_{1,t-1}\upsilon_{2,t-1} + \beta_{21}^2\upsilon^2_{2,t-1} \quad (7)$$

$$\sigma^2_{R_C,t} = [b_{11}^2 + b_{12}^2] + [g_{11}^2 + g_{12}^2]USD_{t-1} + d_{11}^2\sigma^2_{R_C,t-1} + 2d_{11}d_{21}\sigma^2_{R_{XC},t-1} + d_{21}^2\sigma^2_{R_X,t-1} + \beta_{11}^2\upsilon^2_{1,t-1} + 2\beta_{11}\beta_{21}\upsilon_{1,t-1}\upsilon_{2,t-1} + \beta_{21}^2\upsilon^2_{2,t-1} \quad (8)$$

where $\sigma^2_{R_X}$ = variance of returns on exchange rates, $\sigma^2_{R_{XC}}$ = covariance of returns on exchange rates and crude oil, and $\sigma^2_{R_C}$ = variance of returns on crude oil. The spilloverof volatility was measured by$d_{21} \neq 0$ and$d_{12} \neq 0$. Accordingly, following the work of Olson, Vivian, & Wohar (2014), we have in equation (8) conditioned the correlation between the returns on exchange rates and returns on crude oil on the US dollar.

3.1. Data description

The data for the study comprised exchange rate returns and crude oil returns. The World Bank database was the major source of our data. The data used in the estimation are quarterly, spanning from 2000Q1 to 2022Q4. Returns were calculated from raw data of exchange rates and crude oil prices for both current and previous periods ($EX_t, EX_{t-1}, OP_t, OP_{t-1}$) as follows:

$$R_X = \frac{EX_t - EX_{t-1}}{EX_{t-1}} \quad (9)$$

$$R_C = \frac{OP_t - OP_{t-1}}{OP_{t-1}} \quad (10)$$

Returns were subjected to descriptive statistics: mean, minimum, and maximum values as measures of central tendencies, and standard deviation to determine spread across the distribution. Kurtosis was also evaluated to test the normality of the data distribution. The analysis of the data through the rigorous methodology and justified statistical techniques employed has enhanced the reliability of the findings. Hence, by focusing on the volatile reaction between macroeconomic indicators (exchange rates) and crude oil price movement, the research is comprehensive.

4. Results

The data for the study comprised exchange rates for oil-exporting and oil-importing countries as well as crude oil prices. The figures below are graphical representations of exchange rate returns per country and returns on crude oil prices between the periods 2000Q1 to 2022Q4. Figure 1 is a plot of a quarterly time series of global crude oil prices. Volatility is observed across time.

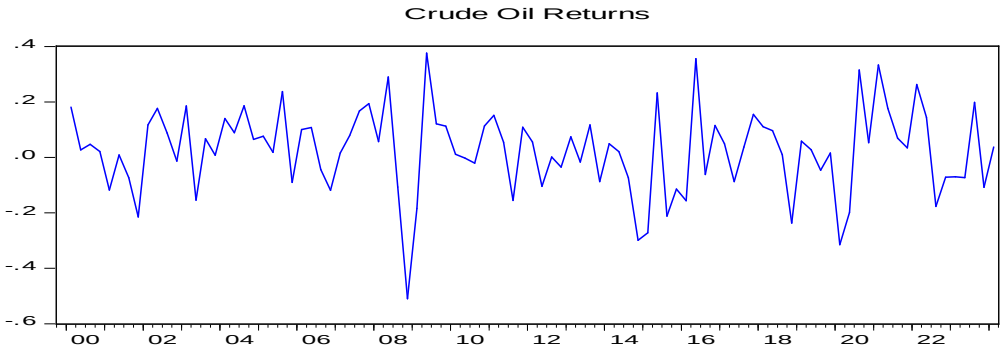


Fig 1 :quarterly time series of global crude oil prices

Figure 2 comprised exchange rate fluctuations of ten selected oil-importing countries. Rates were generally more turbulent than the previous group.

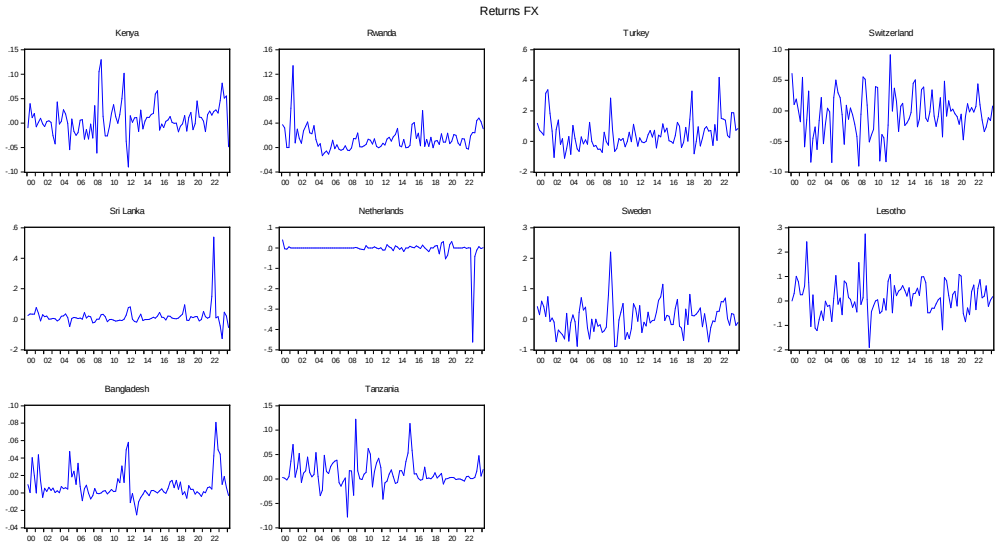


Figure 2: Plots of exchange rate returns of oil-importing countries

According to Table 1, the mean quarterly change in exchange rates spanned between 0.0006 and 0.044 (in absolute terms). Turkey had the highest average returns, while the Netherlands had the fewest returns. Minimum values were also negative, confirming quarters of currency value falls. Except for Switzerland, which has a kurtosis value of 3, other countries have currency returns that do not follow normal distribution.

Table 1: Exchange rate returns -Descriptive statistics

Country	Mean	Max	Min.	Std. Deviation	Kurtosis
Bangladesh	0.00730	0.08087	-0.02526	0.01576	8.92939
Kenya	0.00576	0.12946	-0.08978	0.03149	6.73381
Lesotho	0.01375	0.27419	-0.19089	0.07209	4.92079
Netherlands	0.00060	0.04078	-0.05341	0.01157	10.10375
Rwanda	0.01268	0.13380	-0.01344	0.01925	19.06339
Sri Lanka	0.01934	0.53853	-0.04849	0.06123	58.38291
Sweden	0.00380	0.22003	-0.08997	0.05031	5.43803
Switzerland	-0.00458	0.09168	-0.09020	0.03628	3.02461
Tanzania	0.01222	0.12246	-0.07797	0.02779	7.16698
Turkey	0.04402	0.41875	-0.11039	0.09585	6.18001
All	0.011489	0.538528	-0.190885	0.050863	26.64546

Source: Authors' results using Eviews 13

Table 2 shows that both exchange rate returns and the returns on crude oil market price are stationary at first difference.

Table 2: Panel unit root tests results ofexchange rate returns and crude oil returns

Method	Rx		Rc	
	Stat.	Prob.**	Stat.	Prob.**
Levin, Lin & Chu t*	-23.7042	0.0000	-34.3765	0.0000

Breitung t-stat	-13.7015	0.0000	-20.6218	0.0000
Im, Pesaran and Shin W-stat	-23.7042	0.0000	-27.4179	0.0000
ADF - Fisher Chi-square	-13.7015	0.0000	462.656	0.0000
PP - Fisher Chi-square	-23.7042	0.0000	460.819	0.0000

Source: Authors' results using Eviews 13

The co-integration results of Table 3 ratify the existence of long-run association between exchange rate returns and the returns on crude oil market price.

Table 3: Panel co-integration test results ofexchange rate returns and crude oil returns

Measures	Statistic
Panel-rho-Statistic	-32.17002**
Panel-PP-Statistic	-22.41414**
Panel-ADF-Statistic	-22.44692**
Group-rho-Statistic	-25.74057**
Group-PP-Statistic	-22.76698**
Group-ADF-Statistic	-22.07159**

Source: Authors' results using Eviews 13

The quantile regression results with exchange rate returns as a predictor variable, explaining variations in the outcome variable, crude oil returns, are reported in Table 4 below. The intercept values across quantiles were all significant and represent the returns from crude oil investments when currency returns are zero. The negative values in the first three quantiles confirm that when currency returns are equal to zero, crude oil prices will either dwindle by the varying coefficients expressed as percentage points or rise by fewer magnitudes. These constant values differ from the constant values of equations in the upper distributions of the quantile process, in which constant values take up positive numbers, confirming rising prices in the crude oil market. The predictor parameters of the first five quantile regressions (10^{th} to 50th quantiles) are -1.0289, -0.7447, -0.8245, -0.4758, and -0.4258, and all values are found to be significant in the respective equations. This implies that a percentage decline in exchange rate returns in oil-importing economies would cause returns in the energy market to rise by the magnitude of the coefficient across percentiles.

The analysis conducted within the 70^{th} and 80th percentile spans revealed a noteworthy and statistically significant negative coefficient of -0.2757 and -0.3186 ($p<.05$). The findings indicate that a proportional shift of 0.28% and 0.32% in crude oil returns occurs for each percentage alteration in the currency return values of nations importing oil. Additionally, the intercept, computed as 0.001, reaffirms that when no changes occur in the currencies of countries producing oil, the pace of crude oil adjustments would experience a quarterly increase of 0.1%, although this value was found to be insignificant in the model ($p = 0.13 > .05$). The quantile regression outcome for the 90th percentile regression exhibited a coefficient of -0.1217, yielding a p-value above 0.05. This coefficient, established as statistically insignificant, reveals no significant influence originating from the top 10 percent range of exchange rate returns on the crude oil prices of economies that import oil. To elaborate, a fractional modification in currency returns within this upper echelon is linked to a decline of 0.01217 percent in crude oil returns. Simultaneously, the constant term within the same equation was determined to be 0.191, possessing statistical significance at the 0.05 threshold. This suggests that, in a scenario where currency fluctuations or exchange rate returns remain dormant at zero under comparable economic circumstances, a percentage shift in crude oil returns stands at 19 percentage points.

Table 4: Quantile regression estimates (Dependent variable: Rc)

Variable	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Rx	-1.0289*	-0.7447*	-0.8245*	-0.4758*	-0.4258*	-0.2469	-0.2757*	-0.3186*	-0.1217
	(0.3585)	0.2506	0.2172	0.1839	0.1680	0.1323	0.1026	0.0872	0.0865
C	-0.1542*	-0.0860*	-0.0364*	0.0142*	0.0397*	0.0659*	0.1023*	0.1433*	0.1908*
	0.0095	0.0072	0.0076	0.0055	0.0050	0.0047	0.0056	0.0062	0.0070

Source: Authors' results using Eviews 13

In Table 5, the coefficients are larger in the former than the latter. Proceeding to a more detailed interpretation, the 10th, 20th, and 30th quantile regression results with crude oil returns as a predictor variable, explaining variations in currency returns, show that the intercept values are -0.033, -0.013, and -0.004, respectively, and all of these values exhibit significance in their respective equations. The negative magnitudes confirm that when crude oil returns are equivalent to zero, currency returns will either decrease according to the specified percentage points or experience comparatively minor increases. These constant values contrast with the constants observed in equations at higher percentiles of the quantile process, where positive values affirm ascending exchange rates. The predictor coefficients also vary for all three equations, measuring -0.0639, -0.0374, and -0.0222, respectively, while maintaining significance at the 5% level. In simpler terms, a one-percent reduction in crude oil price returns in oil-importing economies would lead to an upsurge of 0.06%, 0.03%, and 0.02% in exchange rate returns, depending on the position of crude oil price returns within the 10th, 20th, or 30th percentiles.

Taking the next three sets of estimates in Table 5, the constant term of the 40th, 50th, and 60th quantiles are quantified at 0.0006, 0.0050, and 0.0106, with the last two significant at the 0.05 threshold. This is a confirmation that when petroleum returns equal zero, currency returns per quarter for oil-importing countries would be 0.0006, 0.0050, and 0.0106, respectively. The coefficients of the explanatory variable for the respective equations in the same order as earlier listed would be -0.0141, -0.0259, and -0.0318 ($p<0.05$). The negative coefficients, which were also found to be significant, show that returns from fluctuating petroleum prices impact substantially alterations in currency rates in oil-importing jurisdictions, such that a unit change in crude oil returns would reflect in exchange rate markets by corresponding 0.0141, 0.0259, and 0.0318 percent in opposite directions.

The last three equations, the 70th to 90th quantiles, have crude oil returns with significant and negative coefficients of -0.0462, -0.0738 and -0.1022 ($p = 0.00<0.05$). Intercept values labelled "C" are observed to consistently rise through ascending quantile equations with 0.020, 0.036, and 0.065 for each of the three quantiles discussed in this paragraph. For the 70th quantile, a 1 percent increase in returns in the crude oil market would reflect in the exchange rate market as decreasing returns by 0.046 percent in oil-importing countries. Examining the parameters of the 80th quantile equation, a 1 percent increase in returns in the crude oil market would reflect in the exchange rate market as decreasing returns by 0.074 percent in oil-importing countries. Lastly, the 90th quantile equation would have a 1 percent rise in returns in the crude oil market, marked by a corresponding decline of 0.102 percent in the exchange rate market of oil-importing economies. Controlling for exchange rates, exchange rates in six out of ten quantiles significantly influence returns as expected, with a positive impact from the first to fifth quantile and a negative impact by the last quantile. The negative turn experienced in the latter quantiles reveals that with rising currency amounts per dollar, investors will have fewer returns on their investments or speculations.

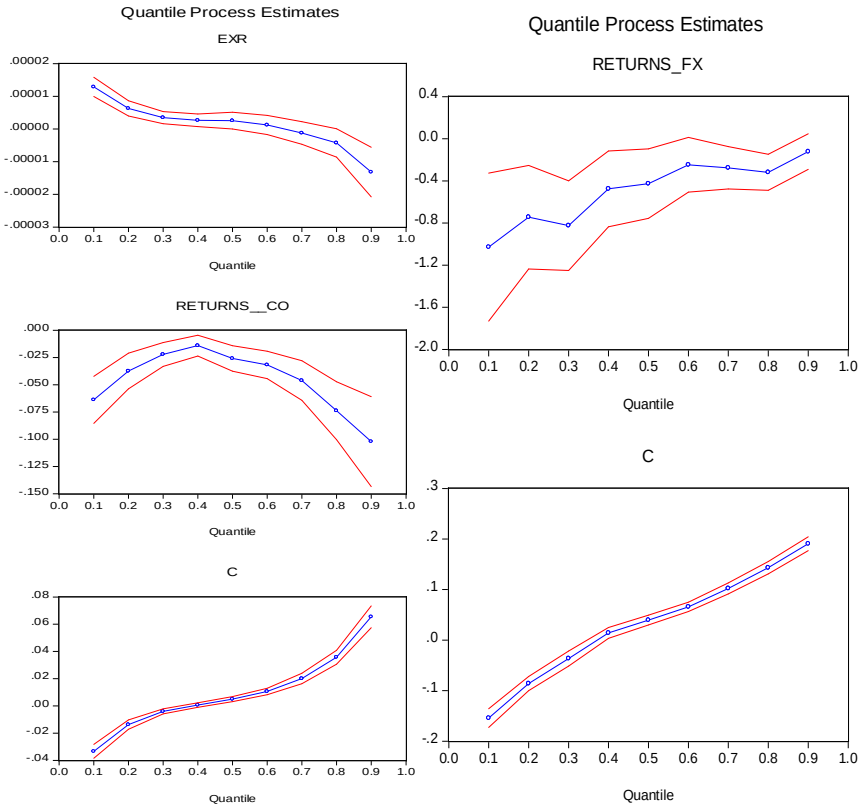
Table 5: Quantile regression estimates (Dependent variable: Rx)

Variable	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
exr	0.0513*	0.0196*	0.1325*	0.1347*	0.0913*	0.0831	-0.134	-0.0284	-0.0113*

	0.1442	0.0201	0.4501	0.01201	0.6501	0.1201	0.0542	0.0702	0.0154
Rc	-0.0639*	-0.0374*	-0.0222*	-0.0141*	-0.0259*	-0.0318*	-0.0462*	-0.0738*	-0.1022*
	0.0110	0.0084	0.0056	0.0049	0.0060	0.0064	0.0093	0.0135	0.0210
C	-0.0334*	-0.0137*	-0.0040*	0.0006	0.0050*	0.0106*	0.0201*	0.0357*	0.0655*
	(0.0026)	(0.0018)	(0.0009)	(0.0008)	(0.0010)	(0.0012)	(0.0020)	(0.0026)	(0.0041)

Source: Authors' results using Eviews 13

Figure 3a is a plot of quantile process coefficient which tilts towards a quadratic representation, with the highest effects plateauing between the third quantile equation and the median equation. Quantiles prior to the 40^{th} quantile also had lower effects. Larger values of exchange rate fluctuations have less effect on the crude oil markets. The quantile effects of crude oil returns on exchange rate returns are more linear in that the effects of crude oil price fluctuations on currency fluctuations generally rise as crude oil returns rise. Below these points, effects weaken continually until the tenth percentile, while above the median point; effects fall steeper than on the other side of the plot until the 80^{th} quantile. This implies that lower crude oil fluctuations have lower impacts on currencies until the fluctuations reach the average value for the period. Higher than average values of returns in crude oil markets would further reduce the effect on the currencies of oil-exporting countries.For Figure 3b, the highest effect of currency returns on crude oil returns is seen at the 90^{th} quantile, although the effects have undulating patterns along the slope from the tenth percentile. Larger values of exchange rate fluctuations averagely have greater effects on the crude oil markets. The rising pattern of the plot reveals that at lower rates of currency returns, the effect on crude oil markets will be lower than when currencies begin to fluctuate at higher rates. However, as exchange rate returns continue to go higher, the rate of change in crude oil returns rises by lesser rates, implying the crude oil markets would begin to adjust to equilibrium.



(a) ***(b)***

Figure 3(a-b): Plot of quantile process estimates of oil-importing countries
Source: Authors' results using Eviews 13

Table 6 shows an insignificant Ramsey Reset QLR statistic of 0.05, indicating that the model is adequately specified for the study variables. For the model explaining crude oil returns, the exchange rate had to be included in the model to obtain a model without misspecifications. Quantile slope equality test results reveal that quantile estimates are significantly different from one another across all quantiles ($p > 0.05$). The symmetries quantile test on the quantile effects of exchange rate returns on crude oil returns confirms that the effects of exchange rate returns on crude oil returns are not symmetrical across quantiles ($p<.05$). For the second model, the effects of crude oil returns on currency returns can be termed symmetrical ($p > 0.05$).

Table 6: Post Diagnostic Test Estimations

Test	Statistic	Rc-Rx	Rx-Rc
		Value (p-value)	Value (p-value)
Stability Test: Ramsey Reset Test	QLR L-statistic	3.2793(0.07)	1.7171(0.19)
	QLR Lambda-statistic	3.2756(0.07)	1.7165(0.19)
Quantiles Slope Equality Test: Wald Test	Chi-Sq. Statistic	20.935(0.00)	208.89(0.00)
Symmetries Quantile Test: Wald Test	Chi-Sq. Statistic	25.889(0.00)	66.242(0.00)

Source: Authors' results using Eviews 13

In Table 7, lag 3 was significant for VAR estimations for both currency and crude oil returns. VAR outputs from which residuals were retrieved as series for asymmetric GARCH estimations are not reported for sake of brevity.

Table 7: Lag selection criteria for oil-importing countries

Endogenous variable: Rx						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	1402.616	NA	0.002874	-3.014229	-3.009030	-3.012246
1	1442.520	79.63525	0.002643	-3.097892	-3.087494*	-3.093926*
2	1442.723	0.405197	0.002648	-3.096179	-3.080581	-3.090230
3	1446.269	7.060703*	0.002633*	-3.101653*	-3.080857	-3.093721
4	1446.694	0.846271	0.002637	-3.100418	-3.074422	-3.090503
Endogenous variable: Rc						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	419.7732	NA	0.023791	-0.900588	-0.895388	-0.898605
1	423.4706	7.378779	0.023653	-0.906388	-0.895990	-0.902422
2	429.3009	11.62310	0.023409	-0.916776	-0.901179*	-0.910827
3	432.1728	5.719058*	0.023315*	-0.920802*	-0.900005	-0.912870*
4	432.3038	0.260673	0.023358	-0.918933	-0.892937	-0.909018

The presence of the ARCH effect was established for both returns on exchange rate and oil prices, given a significant p value that is less than 0.05. This indeed necessitated the VAR_GARCH estimation returns.

Table 8: ARCH effects test results

Test	Rc	Rx
F-Statistic	34.622(.00)	17.263(.01)
Obs*R-squared	64.053(.00)	51.191(.00)

Source: Authors' results using Eviews 13

Table 9 reports the VAR_GARCH results for oil-importing countries, with exchange rate returns as the response variable. The coefficient labeledC(1), 0.0016, represents the unconditional variance of the equation modeling exchange rate returns in oil-importing countries, while C(2), at 0.0302 ($p<.05$), is the unconditional variance for oil price returns. In other words, these values represent the baseline volatility that the respective returns would exhibit over a long time if the past squared innovations and lagged variances were held constant. Comparing both values, the returns on oil prices are more volatile than the returns on the currencies of the sampled oil-importing nations. The arch term for exchange rate returns is represented as A_{11} at 0.7490 and shows the impact of the past squared innovations of the exchange rate returns on its own current volatility. This value is found to be significant and confirms the level to which shocks from past volatilities of these returns influence the current level of turbulence from currency exchange rates. In the same vein, oil price returns had an arch effect of 0.3703. The sum of 0.7490 and 0.3703 is greater than 0, and thus does not invalidate the variance equation. The GARCH coefficients for exchange rate returns and oil price returns are given as B_{11} and B22, respectively, with values of 0.2480 and -0.2448. Volatility persistence for exchange rate returns and oil returns was calculated by summing up ARCH and GARCH terms. For exchange

rate returns, volatility persistence is 0.9970 obtained from (0.7490 + 0.248), which is less than and close to 1, confirming high volatility persistence. Oil returns had a volatility persistence value of 0.1255, which is far less than 1 but closer to 0, confirming the weak volatility persistence of oil returns. This implies that the impact of volatility shocks stemming from preceding fluctuations dissipates as soon as volatility occurs. The leverage effects parameter for exchange rate returns had a significant positive value of 0.8529 at a significance level of 0.05 ($p<.05$), indicating the absence of leverage effects. In other words, bad news does not cause higher turbulence in currency values than good news will. For crude oil returns, the leverage effects term (-0.0529 is negative and significant at 0.05 ($p<.05$), implying that bad news in oil-importing economies has asymmetric impacts on the volatility of crude oil prices. In other words, the oil price returns will react more strongly to bad news than these returns will react to good news.

The spill-over effects of volatility across both markets are also found to be significant, with b12 and b21 at -0.0642 and 0.5565, respectively. The coefficient b12 at -0.0642 confirms that shocks from past volatilities in currency markets of countries that import oil impact inversely and significantly on current volatilities in crude oil markets. In other words, higher volatilities in currency markets would have commensurately lower volatility in the oil market by the magnitude of the spill-over coefficient. The spillover from the crude oil market to the currency market has a different pattern given the significant and positive spillover coefficient, and this depicts that increased turbulence on the crude oil market in the current period is associated with increased volatility in the currency market for oil-importing nations. Furthermore, the spill-over effect from the currency market to the oil market is weaker than the effect from the oil market to the currency market of oil-importing countries. The shape parameter is -0.4829 and is significantly less than 1, confirming the weak persistence earlier found. The log likelihood value of 2046.37 confirms the empirical fit of the model in predicting own and cross-volatilities.

Table 9: VAR_GARCH results of for oil-importing countries- Exchange rate returns

Variable	Coefficients	Std Error
Mean(Rx)	0.0092*	0.0002
Mean(Rc)	0.0654*	0.0003
C(1)	0.0016*	0.00001
C(2)	0.0302*	0.00022
A(1,1)	0.7490*	0.00698
A(1,2)	0.0814*	0.00026
A(2,1)	-0.0160*	0.00008
A(2,2)	0.3703*	0.00098
B(1,1)	0.2480*	0.00139
B(1,2)	-0.0642*	0.00000
B(2,1)	0.5565*	0.0170
B(2,2)	-0.2448*	0.00168
D(1)	0.8529*	0.0165
D(2)	-0.0529*	0.00086
F(2,1)	-0.4829*	0.00318
Log Likelihood	2046.37	
Useable Observations	940	

*Note: *significance at 0.05*
Source: Authors' results using Eviews 13

Figure 3 depicts volatility charts of exchange rate returns in oil-importing countries. The sampled economies importing oil or without significant oil reserves have volatility in their currencies, as estimated by the GARCH models represented graphically above. Switzerland had the most volatile returns. Tanzania had volatility that spiked in 2010 and 2016. Turkey also had varied spikes and other points of tranquilly across the periods. Lesotho, Kenya, and Sweden had spikes through the periods. Sri Lanka had the most stable currency across the periods, followed by Rwanda.

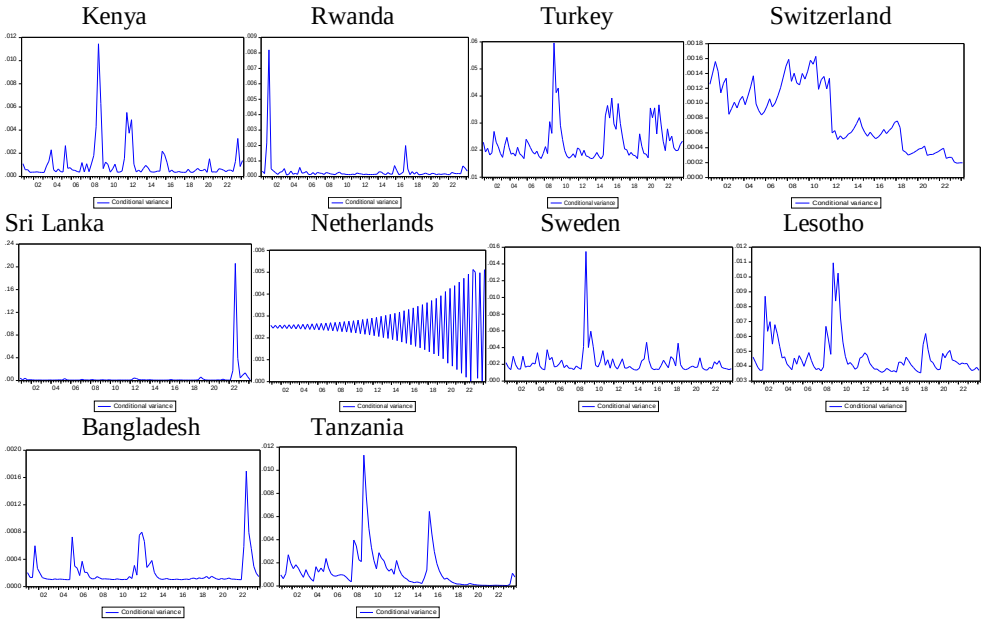
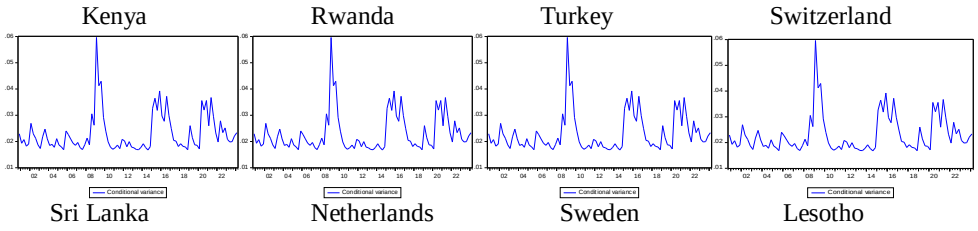


Figure 4: Volatility charts of exchange rate returns in oil-importing countries
Source: Authors' results using Eviews 13

Figure 4 shows the volatility charts of crude oil returns in oil-importing countries. For oil returns, conditional variance is similar across countries, as observed in similar periods of spikes. However, volatility is of different magnitudes, and more clustering is observed in the plots of Kenya, Sri Lanka, Turkey, and Sweden than in others. Persistence is also found in the charts, as small volatilities cluster in the first six years, 2000–2006, and higher volatilities are found between 2015 and 2016. Turbulence is also observed to rise from 2005 to 2022 compared to the period before 2006. The spike in 2006 is rather a one-off occurrence as volatilities return to regular patterns till 2015.



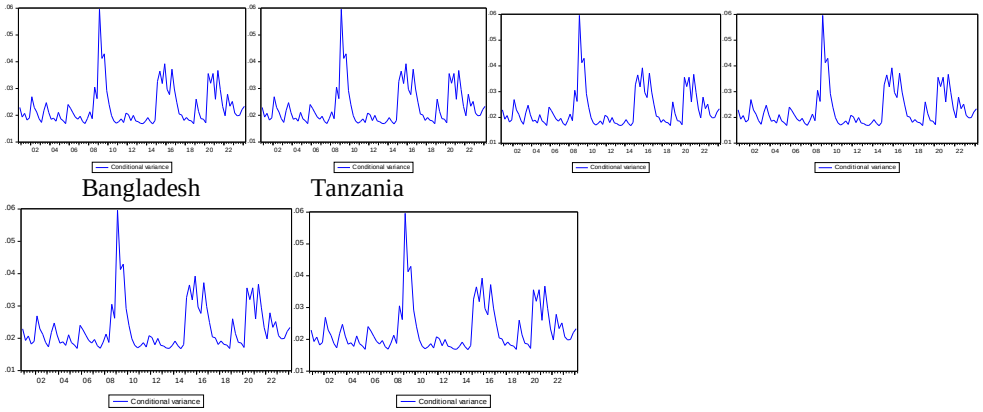


Figure 5: Volatility charts of crude oil returns in oil-importing countries
Source: Authors' results using Eviews 13

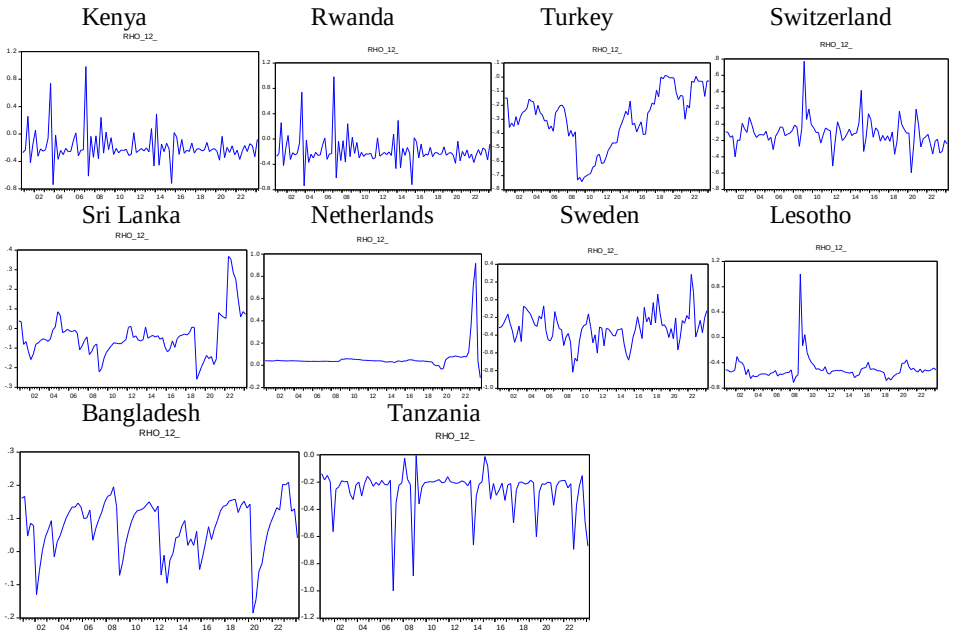


Figure 6: Volatility charts of correlation for volatility of oil and exchange rate prices
Source: Authors' results using Eviews 13

Discussions

Oil-importing nations are exposed to variations in global oil prices since they rely substantially on imported oil for energy production. Rising oil prices raise the cost of importing oil, resulting in depleted country reserves and portfolio reallocation (Castro & Jiménez-Rodríguez, 2020). This put pressure on the indigenous currency, resulting in currency depreciation. A currency's depreciation has an impact on financial markets because investors review the attractiveness of assets in that currency. Increased uncertainty and risk aversion might cause capital outflows from impacted countries, placing additional downward pressure on the currency. Currency depreciation can have an influence on different nations due to economic and monetary connections. The feedback loop can also have an impact on prices in commodity markets, particularly crude oil, since a weaker currency makes commodities more costly, thereby lowering demand and driving lower prices. Lower oil prices can adversely influence the economies of oil-importing countries, potentially resulting in lower government revenue, budget deficits, and economic instability (Raji et al., 2018). The wealth transmission effect arising from currency devaluation can also be explained through the trade transmission mechanism, where rising oil prices raise the cost of importing oil, resulting in increased import bills over exports, causing trade imbalances (Castro & Jiménez-Rodríguez, 2020). This could lead to the devaluation of the native currency due to the added pressure. Oil-importing countries benefit from decreased oil prices by saving on import expenses, potentially leading to enhanced trade balances and stronger currencies. Nevertheless, this benefit could be offset by reduced profits for countries that trade oil, impacting the general economic situation and exchange rates. Fluctuations in oil prices significantly impact both inflation rates and monetary policy. Rising oil prices stimulate higher inflation rates, attracting foreign investors and strengthening the local currency. Olstad et al. (2021) suggest that rising oil prices dwindle the current account of countries that import oil, leading to a decrease in currency exchange rates.

Shifting to countries that rely on oil imports, the considerable adverse impact of currency fluctuations on crude oil markets is due to the fact that changes in currency can influence the economic well-being of these nations, leading to changes in their energy consumption and demand for crude oil, ultimately impacting global oil prices. The devaluation of currency can raise production costs for industries in oil-importing nations that heavily rely on oil-based materials like transportation, manufacturing, and agriculture. Increased production expenses can lower profits and potentially result in decreased production, impacting supply dynamics and affecting oil prices. Currency value fluctuations can impact consumer actions and buying choices. A decrease in the value of a currency could result in lower buying power, affecting consumer expenditures on oil-related goods and services, ultimately influencing oil demand and prices. Trade imbalances from exchange rate fluctuations can potentially widen the current account deficit of importing nations as more currencies are used for the purchase of oil from oil-producing counterparts, despite the rising demand for oil for industrial and household purposes. This can put downward pressure on the currency's value and affect investor sentiment, impacting crude oil prices. Currency movements can trigger market sentiment and speculative activities of investors within these economies, making them respond to changes in currency values by adjusting positions in oil futures and derivatives, which can amplify price volatility in the crude oil market.

Leverage effects were absent in the currency returns of oil-importing countries. Countries that rely on oil imports also experienced the transfer of turbulence from currency markets to crude oil trade arrangements in the opposite direction. This shows that fluctuations in currency market volatility impact the volatility of crude oil trade for oil-importing nations, usually moving in the opposite direction. Currency devaluation in nations that rely on oil imports may lead to higher expenses for importing crude oil and result in increased inflation levels. Central banks might choose to increase interest rates in order to lower inflation and decrease fluctuations in the currency market. Nevertheless, if the currency appreciates, it leads to a decrease in import expenses, which in turn reduces inflation and could result in a reduced necessity for tight fiscal measures. A decrease in currency value affects the economic growth predictions of countries that rely on oil imports, as it leads to decreased consumption and economic growth forecasts, leading to a drop in crude oil demand and reduced prices. The negative impacts of currency fluctuations in oil-exporting and oil-importing nations imply that economies reliant on crude oil would have to diversify their energy sources to reduce exposure to market volatility. Investing in renewable energy sources like solar, wind, and hydro could reduce dependency on crude oil. Enhancing the economy's resilience to external shocks, including currency fluctuations and crude oil price volatility, is crucial. This could involve broadening the economic base by promoting sectors like manufacturing, services, and technology. Building robust financial systems and reserves can help buffer against economic shocks. International coordination and cooperation can help mitigate the adverse impacts of oil market volatility. Governments can work with international organizations like the International Monetary Fund (IMF) and the World Bank to develop frameworks for stabilizing currency markets and crude oil prices. Bilateral and multilateral agreements on currency stabilization and energy cooperation can also be beneficial. To support industries and consumers affected by oil price volatility, governments can provide targeted subsidies or tax relief. Social safety nets and assistance programmes can help consumers cope with increased costs of living due to higher fuel prices. Policymakers should focus on maintaining market stability through sound economic practices, such as transparent monetary policies, prudent fiscal management, and effective regulatory frameworks. Crude oil market interventions may be necessary to manage short-term volatility, such as strategic petroleum reserves, coordinated production adjustments among oil-producing countries, and regulatory measures to prevent excessive speculation. Overall, economic diversification is essential for both oil-exporting and importing nations, with reduced reliance on crude oil revenues and expenditures to mitigate the

adverse effects of market volatility across both markets. Investment in human capital and infrastructure is also essential.

On the other hand, more robust currencies can lead to higher expectations for consumption and economic growth, which in turn can drive up demand and prices. Fluctuations in currency value affect oil-importing countries' current account balances, as weaker currencies enhance trade balances by lowering export costs and increasing import expenses, whereas stronger currencies lead to trade deficits due to elevated prices. Elevated crude oil prices can result in higher manufacturing expenses, decreased consumer consumption, and decreased economic growth projections, potentially causing a depreciation of the currency and heightened currency market fluctuations. Olstad et al. (2021) also discovered that higher oil prices can reduce the amount of money people have to spend, which could put pressure on the worth of the currency. Meanwhile, decreased petroleum prices can decrease production expenses, enhance consumer expenditures, and raise economic growth projections, which might bolster the currency and decrease currency market fluctuations.

Conclusion

The study aimed at exploring the interconnectivity between exchange rate returns and crude oil returns in ten oil-importing countries. The theoretical explanation of the VAR-GARCH methodology and the empirical discussion of the estimated model were adequately and appropriately provided. The study delineated the trade and wealth channels to provide a clear framework for understanding how oil prices influence exchange rates. This dual approach offered a useful guide for grasping the multifaceted impacts of commodity prices on currency values. The specific examples of trade channels causing currency depreciation and wealth channels strengthening the US dollar are particularly enlightening. All the diagnostic checking regarding the estimation exercise was performed and reported to ensure the robustness of the research findings. In specific terms, the emphasis on diagnostic tests and their interpretation in relation to current policy realities demonstrates a commitment to rigorous analysis and practical relevance. The findings also showcased and highlighted the long-term correlations between the variables of interest, the impact of currency returns on crude oil returns, and vice versa, as well as the leverage effects. Henceforth, the research is scientifically robust and technically sound. The empirical findings are summarized here: There is a long-term correlation between returns in the petroleum and foreign exchange markets; currency returns of all economies have significant and negative impacts on crude oil market returns, especially when these economies thrive in the import or export of fossil fuels; returns in crude oil market arrangements in the same vein have notable negative effects on the returns of the respective exchange rates of different economies, and this effect is found to transcend their capacities as importers of Brent or WTI crude oil; and oil-importing countries have evidence of leverage effects present in petroleum price adjustments. This result confirms that for countries with no oil reserves, negative shocks to the petroleum market tend to exert a more a more pronounced influence on the volatility of other assets in the system than equivalent positive shocks. By exploring the association between currency returns and petroleum price returns, the study provides evidence on the interconnectedness of global foreign exchange and energy markets and how positions in the supply chain of crude oil influence such interconnectedness.

In terms of energy prices and market interdependence, the results on energy prices, particularly oil, as a source of volatility in financial markets are critical. It underscores the significant influence of energy commodities on global economic stability. The references to scholarly works, such as those by Ben-Salem et al. (2024) and Castro and Jiménez-Rodríguez (2020), lend credibility to the research findings about oil price volatility and its effects on currency values. Significant fluctuations in crude oil prices can result in unpredictability in energy expenses for countries that rely on oil imports. Governments should implement risk

management approaches like creating strategic oil reserves, expanding energy sources, and engaging in long-term supply agreements to lessen the impacts of sudden oil price adjustments on their economies. For oil-importing economies, weak persistence in crude oil returns by oil-importing nations is a pointer to the need to engage in the diversification of their economies, reduced sensitivity to oil price fluctuations, flexible policy responses, and the complex array of global economic interactions. These factors collectively contribute to a faster dissipation of the effects of past volatility shocks on future exchange rate movements. Besides, oil-importing countries may react to currency-driven fluctuations in oil prices by enacting energy policies and upholding strategic oil reserves. These steps can assist in stabilizing the local supply and offering protection from abrupt price increases. Central banks in oil-importing countries may have to make changes to monetary policies to be able to offset the repercussions of currency devaluation. Modifications in interest rates or other policy actions intended to stabilize currency rates can impact borrowing costs, investment choices, and overall economic activity, thus affecting oil demand and prices. Executing the relevant and appropriate methodological approach has paved the way for the replication of similar research as well. The identification of key research questions regarding price adjustments, hedging strategies, and financial instruments like futures contracts sets a clear agenda for further investigation.

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