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Oil Price Shochs'S Asymmetric Responses on Food Inflation in Middle East and North Africa Countries in the time of Ukraine-Russia Crisis

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Abstract: The war between Russia and Ukraine began on February 24, 2022, and it has lasted for more than a year. The world economy has been negatively influenced by the war and the series of events that followed it in a number of ways, including the stock market, and trade. The energy market and food prices have seen a significant decline. This empirical study examined the unequal effects of oil price shocks on food inflation in MENA countries during the Russian aggression using a Panel Asymmetric Granger Causality Test and a Non-linear Panel Autoregressive Distributed Lag Model. Empirical evidence demonstrated the asymmetry between the inflation of food and oil, with the majority of the effects of oil price shocks being positive on food inflation. The empirical data supporting the short- and long-term asymmetries in food and oil prices was revealed, with the majority of the evidence pointing to the beneficial impacts of oil price shocks on food inflation. Additionally, the estimations indicated that the food prices rose in both eras (after the war between Russia and Ukraine and when the complete sample was chosen) in response to increases in the price of oil.

Keywords: Oil prices, Food inflation, Panel-NARDL Approach, MENA nations, Russia & Ukraine Crisis.

Introduction

What is the impact of the war in Ukraine on world food prices? The Food and Agriculture Organisation has presented the following inquiry. According to the Food and Agriculture Organization (2022), Libya, Oman, Saudi Arabia, Yemen, Tunisia, Iran, Jordan, and Morocco are among the nations that make up the Middle East and North Africa (MENA). But since the end of the war between Russia and Ukraine, the two countries have exported less food, mostly wheat, maize, and sunflower oil, which has raised the cost of these goods. It has also altered the kinds and amounts of crops that growers want to produce globally, by driving up demand for substitutes such as alternative cooking oils and decreasing fertilizer exports from the Black Sea. Politics are impacted by food costs everywhere, but especially in the MENA regions. In 2011, the Food and Agriculture Organization's Food Price Index reached its highest level in 50 years, which happened to occur during the Arab Spring. The MENA region's vulnerability to rising global food prices depends on various variables, including government capacity and international responses.

Additionally, most research in this area has concentrated on the impact of oil price shocks on advanced economies that rely on oil imports, such as China, the United States, and numerous European countries, and in particular, how they affect the food market. Food prices and energy costs are closely related in this scenario since energy is a key input cost. Since fertilizers require a lot of energy to create, rising energy costs also raise the cost of farming equipment like tractors. This leads to a rise in the cost of generating fertilizer. This will also directly influence the quantity of marijuana distributed internationally. The second motivator is the requirement for biofuels. Corn, rapeseed, and soybeans are among the biofuel crops in high demand due to rising oil costs. There won't be as much food-grade wheat available due to the switch to biofuel crops, which will raise the costs (Food and Agriculture Organization, 2022).

The Middle East and North Africa region is particularly sensitive to food shocks since it depends so heavily on food imports. According to Emediegwu (2022) and Rivlin (2022), the Middle East and North Africa region is particularly vulnerable to trade shocks because of its substantial reliance on food imports. Egypt, Sudan, and Yemen are three of the poorest countries in the region and heavily rely on cereal imports from Russia and Ukraine. Wheat is a significant calorie source in Middle Eastern countries, with Egypt being the largest buyer of wheat. Over 60% of its consumption is imported, with 85% coming from Russia and Ukraine. This has led to increased food costs in the region. This study aimed to respond to two research queries about food and crude oil prices during the Russia & Ukraine Conflict; (a) Can food costs rise or fall in response to oil prices? (b) In the context of the Russia & Ukraine war, is it possible to experimentally test the symmetry or asymmetry and co-integration between oil prices and food inflation for MENA nations? (c) How do changes in oil prices affect the MENA region's food inflation? (d) Are the impacts of the oil prices shocks on food inflation substantial or weak, more specifically? how symmetrical or asymmetrical it is?

Problem Statement

This research sought to explore the asymmetrical relationships between oil prices and food inflation in the Middle East and North Africa region. In order to examine the nonlinear impact of oil price fluctuations on food inflation of selected nineteen countries (Algeria, Bahrain, Egypt, Iran, Iraq, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Qatar, Saudi Arabia, Syria, Tunisia, United Arab Emirates, Palestine, Yemen, and Sudan), the asymmetries between oil price fluctuations and food inflation were investigated for nineteen selected economies using the Panel NARDL model. The following significant research gaps that have not yet been explored in previous studies were filled by this study;

Overall studies on extreme events' impact on crude oil prices and food frequently rely on event analysis methods, yet they often fail to consider additional factors, resulting in measurement bias and potential errors in decision-making. Based on this, the article proposed an Panel NARDL mode analysis framework and took the Russia–Ukraine war as an example to calculate the net impact of extreme events on oil prices and food market, which was the first innovation of this article. The paper's second innovative concept was the application of multiresolution asymmetrical Granger causality to differentiate the impacts of various mixed events within the event window. This approach could assist isolate the net effect of events on oil prices by identifying the causal relationship between sub-sequences based on sequence decomposition as well as the relationship between events and other factors, the food market, and oil prices.

Most of research investigations have employed time-series data to facilitate either symmetrical or linear econometric modeling or asymmetrical economic modeling (Almalki et al., 2022; Kirikkaleli & Darbaz, 2021; Olayungbo, 2021). This last point may be the most important. To our knowledge, the empirical analysis of asymmetrical relationships between exchange rate movements and stock indexes using the Panel Nonlinear Autoregressive Distributed Lag (NARDL) modeling approach has not yet been conducted in existing literature. For the first time, the Panel NARDL modeling approach was used in this work to examine the asymmetric links between changes in oil prices and food inflation for three distinct regimes: the pre-economic recessionary regime, the post-economic recessionary regime, and the entire sample period. This study used short- and long-term dynamic models to analyse empirical results before and after the Ukraine-Russia war regime, focusing on food security and price stability for effective policy.

Literature Review

Food and energy are critical resources that play vital roles in the industrial process and overall economy. They serve as fundamental components necessary for sustaining life and fueling economic activities. Food provides essential nutrients and energy for human consumption, while energy sources such as fossil fuels and renewable resources power machinery and drive industrial production. Together, they can be likened to the "green blood" circulating through the veins of the global economy, fueling growth, productivity, and prosperity. But, economic and other crises could lead to high lunch prices due to changes in energy prices, as energy is a crucial resource in the food industry. For example, the invasion of Ukraine by Russia has sparked a surge in global oil and gas prices, a trend that has been exacerbated by sanctions against Russia and the volatility of the European war. This has led to increased inflation in the US, particularly in relation to oil and food prices. The fact that oil prices have always fluctuated has undoubtedly increased the pressure on politicians to take action. As a result, a vast body of research focuses on how Food Price could be affected by shocks to the price of oil (Abay et al., 2023; Al-Rousan et al., 2024; Bagchi & Paul, 2023; Hamulczuk et al., 2023; Headey & Hirvonen, 2023; Kilfoyle, 2023; Raga et al., 2024; Rashad et al., 2023; Tass et al., 2024; Zhang et al., 2024). Studies indicate that oil price shocks during the Ukraine-Russian war negatively affect food prices in both petroleum- importing and petroleum-exporting countries.

In the same context, researches were investigating the effects of fluctuations in oil prices on food prices within key economies amid the ongoing war between Russia and Ukraine. Studies conclude that crude oil price shocks caused by the conflict impacted agricultural markets (Hanif et al., 2024; He et al., 2023; Lin et al., 2023).

According to El Bilali and Ben Hassen (2024), and Kim (2022) the Ukraine war has led to global agricultural and food system disruptions, resulting in food insecurity, malnutrition, poverty, and migration, necessitating evidence-based strategies and sustainable policies.The data indicates that global trade disruptions are posing a threat to global food security due to the surge in competition for essential mineral fertilizers. Chen et al. (2020) utilised a DOLD and FMLOS to study how the price of oil affected the food inflation in both high- and low-income oil exporting nations. On the basis of full samples and subsamples in high-income countries, the results showed a long-term inverse relationship between oil and food inflation. The scenario is different during a crisis: FMOLS and Dynamic Ordinary

Least Squares analyses show that food and oil prices co-move over the long term in low-income countries and across all countries (DOLS). According to our research, the economic environment and unforeseen events influence the behaviour and interactions of the oil and food markets (crises).

A panel of 21 nations with economies that import food and export oil were analysed in a recent study by Olayungbo (2021). The objective was to evaluate the causal relationship between oil and food inflation and the co-integration between them using a panel ARDL model. Even if there were long-term advantages, a short-term analysis showed a negative correlation between food costs and oil prices. In their 2011 analysis, Nazlioglu and Soytas examined the relationship between global agricultural product prices and 24 oil prices. In order to examine changes in the relative strength of the US dollar in a panel environment, the study's data analysis used monthly data from January 1980 to February 2010. The econometric model was constructed for a panel of 24 agricultural products using panel co-integration and Granger causality methods. The results showed that there was strong evidence on how changes in the price of crude oil affected the pricing of agricultural commodities.

According to Lucotte (2016) by using a VAR analysis on two subsample periods: the period previous to the commodity boom (1990:M1-2006:M12) and the following era (2007M1–2015M5). According to the current research, there were significant positive co-movements between the prices of food and crude oil during the commodity boom, but there were none during the time leading up to the boom. The presented findings thus provided more empirical evidence for the links between the markets for crude oil and agricultural goods. In a related study, Peersman et al. (2021) examined the relationship between the price of mongoil and the price of food items using data for the years before and after the year 2000. A structural time-varying-parameter Bayesian vector autoregression (TVP-BVAR) study was used to achieve this. According to the econometric data, oil price increases resulting from disruptions in the oil supply had favorable spillover effects in more recent times, particularly the time period surrounding the Great Recession, but did not affect the pricing of agricultural commodities before the turn of the millennium.

This study showed a short-term, positive, and substantial association between the volatility of the prices of the chosen foods and the price of oil, according to Nwoko et al. (2016). The given results showed that there was no long-term relationship between the price of oil and the price volatility of any particular food between 2000 and 2013. As stated by Mohamed Taher (2020) this study examined the effect of oil prices on food prices using monthly worldwide data from the World-Bank-Database 2017 covering the prices of rice, wheat, soybeans, and crude oil from August 2013 to June 2017. In the Vector-Autoregressive Model, which is utilized to determine the short-term causal relationship between oil and the prices of the selected commodities, the Granger-Causality-Test and Impulse Response Function were used as post-estimation approaches. The results supported a significant causal short-term relationship between oil prices and wheat prices but show no long-term association between the variables. A nonlinear autoregressive distributive lag framework was used to analyse the asymmetric short- and long-term effects of oil shocks on food prices in Nigeria. The results showed that both financial development and economic growth Granger cause the reduction of poverty in both the short- and long-term. The results showed that although negative changes in oil prices have no effect, positive changes had a favourable and considerable influence on food costs.

Khan and Ahmed (2011) investigated the transmission channels through which the global food and oil price shocks affects selected macroeconomic variables, including inflation rate, output, money balances, interest rate, and real effective exchange rate for Pakistan, using monthly data covering the period 1990M1-2011M7. The real effective exchange rate's appreciation, the impact of the oil price shock on industrial production, and both the positive and negative effects on inflation and interest rates are all confirmed by the calculated SVAR model. Despite increases in industrial output following shocks to food prices. The inflation rate increases following shocks to the price of food, much like the interest rate does. However, the variation in interest rates brought on by food price shocks is far larger than that induced by oil price shocks. Using a generalised impulse response functions, the most major source of disruptions following shocks to the price of either food or oil is the real effective exchange rate. Generalised forecast variance decompositions analysis provides more evidence in favor of the generalized impulse response function-based results. “Do rising oil prices lead to higher food prices?” by Baumeister and Kilian (2014) is another paper. They showed that increases in the real prices of corn, soybeans, wheat, and rice that U.S. farmers have received have been influenced by increases in the real price of oil.

The study by Almalki et al. (2022) used structural vector autoregressive (S-VAR) and nonlinear autoregressive distributed lags (NARDL) models to capture both short- and long-run asymmetries between these variables to examine the effects of structural oil shocks on the food prices in Saudi Arabia between 1986 and 2020. These structural oil shocks include the index of industrial production, global oil production, and spot crude oil prices. It was shown that there was a short- and long-term asymmetries between industrial output and food inflation, and that the negative shocks to industrial production predominated in their effects on food inflation. This implies that a decline in economic activity results in a decline in industrial production, a shortage of food, and an increase in the inflation of food. Saudi Arabia's food prices are heavily influenced by fluctuations in crude oil prices. Research has revealed that there are both short- and long-term imbalances between industrial output and food inflation in the country. Additionally, it was found that negative shocks to industrial production have a greater impact on food inflation compared to other factors. This implies that a decline in economic activity results in a decline in industrial production, a shortage of food, and an increase in the inflation of food. It was shown that there was a substantial association between negative shocks in crude oil prices and food inflation in Saudi Arabia, both in the short-run and the long-run. Krätschell and Schmidt (2017) examined the short- and long-term relationships between oil and the cost of food commodities using the frequency domain Granger causality test. They found proof of long-term Granger causation, especially for the era after 2007. They found that as the production of biofuel increases, there is a correlation between the prices of food commodities and crude oil. Additionally, they find Granger causality for a number of food commodities in the short run, which is more in line with speculation on the commodity market. By using the Toda-Yamamoto causality and spectral BC causality tests, Kirikkaleli and Darbaz (2021) evaluate the relationship between energy costs and food inflation as well as whether this relationship is the same in the food sub-groups forming the used food inflation index. Food inflation increased by over twofold during the 2008 financial crisis. The causality test suggests that there is a mutual causal relationship between the energy price index and the various food inflation indexes, including grains, other food, and oils.

In addition to causing great hardship to people, the protracted war between Russia and Ukraine has sparked worries about the state of the world economy. Due to its strong reliance on agricultural imports from both countries, Turkey is vulnerable to market shocks. A research article investigated the economic effects of food price increases brought on by the conflict on the Turkish economy using a Computable General Equilibrium model. Significant effects on trade imbalances, welfare losses, and agricultural imports were discovered by the study. The importance of taking food prices and macro- and microeconomic factors into account is emphasized in the policy proposals that are explored (Ozturk & Faizi, 2023). The study provided novel theoretical and practical viewpoints. The impacts of positive and negative shocks to the price of oil on food inflation in MENA countries were effectively investigated using a non-linear panel autoregressive distributive lag model and a panel asymmetric Granger casualty test. The main argument was that the relationship between oil price swings and food inflation depended on the economic structure and uncertain economic events, such as the war in Russia and Ukraine. The 210 observations for the entire sample period of December 2021 to July 2022, 60 observations for the pre-Ukraine-Russia Conflict regime from December 2021 to January 2022, 60 observations for the post-Ukraine-Russia war regime from June 2022 to July 2022, and 60 observations for each regime made up the cross-sectional time-series data. In order to analyse empirical results both before and after the

Ukraine-Russia war regime and to better understand the relationship and behavior of food and oil prices, the study utilised short- and long-term dynamic models. It is crucial for effective policy on food security and price stability because much is known in isolation (different regimes) rather than when the full sample is studied at one time.

Materials and Methods

Data Set

This study investigated the asymmetrical relationship between food inflation and oil prices in MENA nations. Using 240 cross-sectional time-series data from December 2021 to July 2022, the dependent variable was food inflation, while oil prices were used as independent variables. Table 1 provided sources and definitions for each variable.

Table 1

Data Set

Parameter	Description	Source
Food inflation (FD)	The consumer price index (CPI) for MENA countries includes the food price index.	MENA nation Monetary Authority
Price of oil (OP)	The cost of oil is the amount of US dollars that is used to trade crude oil on the world market at the Brent oil market.	The International Energy Agency (IEA)

Method

This section explained the econometric technique for estimating the non-linear Panel-ARDL models for the asymmetrical influence of changes in oil prices on food inflation for MENA countries. The linear ARDL model of Pesaran et al. (1999) and Pesaran et al. (2004) served as the foundation for the nonlinear

r ARDL (NARDL) framework presented by Shin et al. (2014) used the Granger and Yoon (2002) techniques to separate any variable (stationary) into its positive and negative variations. We also utilised Panel NARDL estimates to investigate the potential non-linear relationship between food inflation in the MENA region and fluctuations in oil prices. An example of a suggested Panel NARDL Model is as follows:

$$\Delta FD_{it} = \alpha_0 + \alpha_1 FD_{it-1} + \alpha_2^{+} OP_{it-1}^{+} + \alpha_2^{-} OP_{it-1}^{-} + \sum_{k=1}^{p} \beta_k \Delta FD_{it-k} + \sum_{k=0}^{q} \left(\delta_k^{+} \Delta OP_{it-k}^{+} + \delta_k^{-} \Delta OP_{it-k}^{-} \right) + \varepsilon_i \text{......................} (01)$$

$$\Delta \mathrm{FD}_{\mathrm{it}} = \alpha_{\mathrm{i0}} + \Omega_{1i}^{+} \Psi_{it-1}^{+} + \Omega_{1i}^{-} \Psi_{it-1}^{-} + \sum_{j=1}^{p} \theta_{ij}^{+} \Delta FD_{it-j}^{+} + \sum_{j=1}^{p} \theta_{ij}^{-} \Delta FD_{it-j}^{-} + \sum_{j=1}^{p} \gamma_{ij}^{+} \Delta OP_{it-j}^{+} + \sum_{j=1}^{p} \gamma_{ij}^{-} \Delta OP_{it-j}^{-} + \nu_i + \varepsilon_{\mathrm{i}} \text{......................} (02)$$

By breaking down changes in food inflation (FD) and oil prices (OP) into their corresponding positive and negative shocks, Eqs. 01 and 02 showed that the technique was intended (Shin et al., 2014).

The fluctuations in food inflation (FD) and oil prices (OP) were divided into positive and negative indicators using the following techniques:

$$OP_{it}^{+} = \sum_{k=1}^{t} \Delta X_{ik}^{+} = \sum_{k=1}^{t} Max(\Delta a_{ik}, 0) \ldots\ldots\ldots\ldots\ldots\ldots\ldots (03)$$

$$OP_{it}^{-} = \sum_{k=1}^{t} \Delta X_{ik}^{-} = \sum_{k=1}^{t} Min(\Delta i_{ik}, 0) \ldots\ldots\ldots\ldots\ldots\ldots\ldots (04)$$

$$FD_{it}^{+} = \sum_{k=1}^{t} \Delta Y_{ik}^{+} = \sum_{k=1}^{t} Max(\Delta a_{ik}, 0) \ldots\ldots\ldots\ldots\ldots\ldots\ldots (05)$$

$$FD_{it}^{-} = \sum_{k=1}^{t} \Delta Y_{ik}^{-} = \sum_{k=1}^{t} Min(\Delta i_{ik}, 0) \ldots\ldots\ldots\ldots\ldots\ldots\ldots (06)$$

In the end, the asymmetric panel causality test recommended by Hatemi-j (2011; 2012) was used in order to show the causal relationships between the price of oil and food inflation. According to Hatemi-j (2011; 2012), cumulative sums of the positive and negative components of the underlying variables should be utilized to test for causation and account for asymmetry. The Hatemi panel causality test was run within an apparently unrelated order P vector autoregressive regression model:

$$\begin{bmatrix} OP_{1,t}^{+} \\ OP_{2,t}^{+} \end{bmatrix} = \begin{bmatrix} \vartheta_{i,0} \\ \tau_{i,0} \end{bmatrix} + \begin{bmatrix} \sum_{i=1}^{P} \vartheta_{1,i} & \sum_{r=1}^{P} \vartheta_{2,i} \\ \sum_{i=1}^{P} \tau_{1,i} & \sum_{i=1}^{P} \tau_{2,i} \end{bmatrix} \cdot \begin{bmatrix} OP_{1,t-i}^{+} \\ OP_{2,t-i}^{+} \end{bmatrix} + \begin{bmatrix} \mu_{1,k}^{+} \\ \mu_{2,k}^{+} \end{bmatrix} \qquad (07)$$

$H_0 : \vartheta_{2,i} = 0$ where i = 1……..P, this hypothesis suggested that $OP_{2,t}^{+}$ did not cause $OP_{1,t}^{+}$ for the cross sectional unit K in the panel and this hypothesis was tested by using a wald test according to Hatemi-j (2011; 2012). In addition other combinations of ($OP_{1,t}^{-}$; $OP_{2,t}^{+}$), ($OP_{1,t}^{+}$; $OP_{2,t}^{-}$), or ($OP_{1,t}^{-}$; $OP_{2,t}^{-}$) were constructed by a similar way.

Results

Result of Descriptive Statistics

Table 2 shows a similarity between mean and median food and oil prices, indicating nearly equivalent distributions. The food prices are positively skewed, while crude oil prices are negatively skewed. Jarque-Beta probabilities are less than 0.05, disproving the null hypothesis of normal distribution. This may be due to cross-sectional and heterogeneous data.

Table 2

Statistical Data

Varibles	Mean	Median	Max	Min	St-De	Skewness	Kurtosis	J-Berra	Prob
LFD_t	0.32	0.46	1.23	0.84	0.78	1.02	0.84	14.20	0.00
LOP_t	0.84	0.45	1.25	1.03	0.31	-0.34	0.45	12.34	0.00

Table 03 shows how Pesaran's cross-sectional dependence test identified the series' cross-sectional dependence. The Panel NARDL model can still be estimated even when neither the regressor nor the regressand is present. The DGCS test and enhanced IPS Panel unit root test confirm cross-sectional dependence and seasonality effects.

Table 3

The Diagnostic Test for General Cross-Section Dependence

Variables	Test	Stat	Prob
Whole sample period (December 2021 to July 2022)			
LFD_t	Pesaran' s GCSDD test	16.33	0,012
LOP_t	Pesaran' s GCSDD test	18.67	0,003
Pre- Ukraine-Russia War regime (December 2021 to January 2022)			
LFD_t	Pesaran' s GCSDD test	22.01	0,000
LOP_t	Pesaran' s GCSDD test	17.84	0,023
Post – Ukraine-Russia War regime (June 2022 to July 2022)			
LFD_t	Pesaran' s GCSDD test	16.81	0,0014
LO_t	Pesaran' s GCSDD test	21.07	0,0000

Note. At the 5% level significant.

It is crucial to look at the stationary of the variables because the cross-sectional dependency does in fact imply that countries share some characteristics. Table 04 shows the outcomes of Pesaran's GCSDD-ADF test and CIPS second generation unit root test.

Result of Panel-Unit Root Test

In order to assess the stationarity of the series, the Cross-sectional Augmented IPS unit root test proposed by Pesaran in 2007 is applied, along with panel unit root tests conducted on each individual series. According to Table 4, which displays the results of the test for stationary behaviour, the series of food inflation (LFD) and oil prices (LOP) are non stationary at the level but stationary at the 1st difference I(1) with a 5% significant level. The table also demonstrates that at the second differencing, neither the volatility in food prices nor the oil prices of MENA nations become stationary. This shows that the Panel N-ARDL model is an effective choice for analysing the symmetrical and asymmetrical effects of changes in oil prices on food prices in MENA nations.

Table 4

Panel Unit Root Tests

Variables	Levels				First difference				Result
	« cips1 »	« cips2 »	« cips3 »	« Critical value (5%) »	« cips1 »	« cips2 »	« cips3 »	« critical value (5%) »	
Whole sample period (December 2021 to July 2022)									
LOP_t	-0.56	-0.66	-0.18	-1.88	-4.02	-4.67	-4.64	-4.95	I(1)
$LFDP_t$	-1.20	-0.33	-076	-1.95	-4.21	-4.17	-3.21	-4.87	I(1)
Pre- Ukraine-Russia Conflict regime (December 2021 to January 2022)									
LOP_t	-0.64	-0.24	-0.17	-1.88	-4.31	-4.05	-4.31	-4.95	I(1)
$LFDP_t$	-1.37	-0.75	-0.54	-1.95	-3.56	-4.02	-4.37	-4.88	I(1)
Post – Ukraine-Russia Conflict regime (June 2022 to July 2022)									
LOP_t	-0.41	-0.94	-1.32	-1.88	-2.33	-3.34	-4.04	-5.56	I(1)
$LFDP_t$	-0.68	-0.94	-0.34	-1.95	-4.02	-4.27	-4.81	-5.23	I(1)

Note. The Pesaran (2007) panel unit root test results are shown in the first section for the entire sample period, and the panel-based CIPS unit root test findings are shown in the second and third portions for the pre- and post-crisis regimes.

Results of Co-integration Test

The third element of the current empirical investigation involved looking at the long-term relationship between food inflation and oil prices. Because of Pedroni (2004), the panel co-integration method is being used. Table 5 displays the results of the seven (7) Pedroni cointegration statistics. The cointegration of the variables is determined by the size of the probability associated with each statistic. It is evident from the results of the Pedroni cointegration test that only four out of the seven statistics have probability values less than one percent.For the inter-individual tests "Pedroni (1999)", we have (Group PP-Statistic) and (ADF-Statistic Group), and for the intra-individual tests "Pedroni (1999), Pedroni (2004) (Weighted statistic)," they are mainly (Panel pp-Statistic) and (Panel ADF-Statistic). Consequently, a cointegration relationship is found to exist in each of these experiments.

Table 5

Results of Panel Cointegration Tests for MENA Tations

Pedroni (2004) test	Whole sample period (December 2021 to July 2022)		Pre- Ukraine-Russia Conflict regime (December 2021 to January 2022)		Post – Ukraine-Russia Conflict regime (June 2022 to July 2022)	
Within dimension	Stat-test	Prob	Stat-test	Prob.	Stat-test	Prob.
Panel-v-Statistic	-0,214	0,66	-1,324	0,33	-0,369	0,57
Panel-rho-Statistic	-1,152	0,72	-0,715	0,25	-1,294	0,34
Panel-PP-Statistic	-3,201*	0,00	-5,801*	0,00	-5,284*	0,01
Panel-ADF-Statistic	-4,264*	0,00	-5.351*	0,00	-5.309*	0,00
Between-dimension						
Group-rho-Statistic	-0,327	0,28	-1,78	0,95	0,398	0,95
Group-PP-Statistic	-7,563*	0,00	-5,648*	0,01	-5,448*	0,00
Group-ADF-Statistic	-6,574*	0,00	-5,015*	0,01	-4,587*	0,00
Decision	Cointegration		Cointegration		Cointegration	

Note. Demonstrates that there is a 1% chance that the computed parameters will reject the null hypothesis that there is no cointegration.

Results of Panel-NARDL

Table 6 shows the long-term results of the asymmetrical Panel ARDL model for three different types of regimes: before the Ukraine-Russia war, after the Ukraine-Russia war, and when the complete sample was selected. The long run coefficients for the Panel ARDL models, which are shown in Table 06, point to an asymmetric long-run relationship between shocks to oil prices and food inflation before the war between Russia and Ukraine. The asymmetries showed that positive adjustments had no discernible impact on food inflation, but negative shocks to oil prices had a negative and considerable impact. According to estimates, food inflation drops by 19% for every dollar increase in oil costs. Following the war between Russia and Ukraine, there seems to be an unbalanced long-term link between oil price shocks and food inflation.

The ARDL models' long run coefficients, displayed in Table 06. The asymmetries suggested that positive changes in oil prices had a significant and favourable impact on food inflation, whereas negative changes had little or no effect. Calculations showed that a dollar increase in oil costs causes food inflation to rise by 21%.The long run coefficients of the ARDL models reported in Table 06 indicated that when the complete sample was considered, there appeared to be an unbalanced long-run link between oil price shocks and food inflation. According to the results of the nonlinear panel-based ARDL model, only positive shocks to changes in the price of oil were indirectly affecting food inflation, while negative shocks to these changes were still statistically insignificant. According to this viewpoint, it can be claimed that a 1% increased in the real price of oil results in an 18% increased (at the 1% level) in food inflation.

In addition, with the help of table 06, which displays the Short Run Coefficient of the Panel-NARDL model, it is visible that the sign of the lagged error correction representation (ECM-1) is statistically significant when applied to three different types of regimes, including those that existed prior to the Ukraine-Russia Conflict, following the Ukraine-Russia Conflict, and when the entire sample is chosen. This gives evidence of cointegration's existence before the crisis between Ukraine and Russia. 14.3%, 51.5%, and 43.25% of the short-run deviation in MENA nations from equilibrium are managed monthly to restore the equilibrium in this connection, and (ecmt-1) is extremely significant (at 1%) in this regard.

Table 6

Results of Panel-NARDL

Variables	ΔFDt is an endogenous variable in the ECM form.					
	Pre- Ukraine-Russia war regime		Post – Ukraine-Russia war regime		Whole sample period	
	Coeff	Prob	Prob	Coeff	t-stat	Prob
	Short-Run Equation					
ΔLFD_{t-1}	0.034651	0.0000	0.195874	0.0000	0.478952	0.0000
ΔLOP_t^+	0.000237	0.0000	0.013256	0.0000	0.023652	0.0000
ΔLOP_{t-1}^+	-0.012302	0.0000	-0.000078	0.0000	-0.000794	0.0000
ECT_{t-1}	-0.143024	0.0000	-0.515623	0.0000	-0.432501	0.0000
	Long-Run Equation					
LOP_t^+	0.000025	0.0000	0.210568	0.0000	0.180587	0.0000
LOP_t^-	-0.194628	0.0000	-0.000120	0.0000	-0.001362	0.0000
Constant	9.302681	0.0000	10.251354	0.0000	14.357629	0.0000

Results of Panel Asymmetric Granger Causality Test

The results for panel asymmetric Granger causality are displayed in Table 7. for three distinct regime types: pre-Ukraine-Russian war, post-Ukraine-Russian war, and when the entire sample was selected. When the entire sample is taken into account, the panel asymmetric Granger causality result shows that there is a unidirectional causal relationship between oil prices and food inflation. Positive and negative shocks to food prices as well as positive and negative shocks to oil prices are causally related to the war between Russia and Ukraine. However, prior to the Ukraine-Russia war, Granger causality did not demonstrate an imbalanced link between positive and negative shocks to oil prices and positive and negative shocks to food inflation.

Table 7

Granger Causality test in panel asymmetry

Hatemi-j (2012) test	Pre- Ukraine-Russia war regime		Post – Ukraine-Russia war regime		Whole sample period	
	Null hypothesis					
	Stat	Proba	Stat	Proba	Stat	Proba
OP does not Granger Cause FD	2,302	0,5628	1,265*	0,0000	1,369*	0,0000
FD does not Granger Cause OP	1,187	0,7598	1,450*	0,0000	0,387	0,2560

Note. * Indicates a 5% level of significance.

Discussion

In this research, the symmetric or asymmetric impact of oil prices on food prices in MENA countries during the Russia-Ukraine war using a nonlinear panel ARDL and an asymmetrical Granger causality test were simulated.

Regarding the hypothesis that food costs fluctuate in response to changes in oil prices, the results of this study indicate that there is an asymmetric long-run relationship between oil price shocks and food inflation. This conclusion is based on the long run coefficients of the Panel ARDL models, as detailed in Table 7. The financialisation of commodities, driven by institutional investors diversifying into future markets, can impact the energy and food market, as it primarily impacts commodity prices due to shocks in the economy's demand and supply fundamentals. These results are consistent with Baumeister and Kilian (2014); Khan and Ahmed (2011); Olayungbo (2021). They reached the same results, meaning that there is strong evidence on how changes in crude oil prices affect the pricing of agricultural commodities. According to the asymmetries, whereas negative changes in oil prices have little to no impact on food inflation, positive changes have a big and positive impact. Given the many disagreements that exist in the literature regarding the causal relationship between oil price and food inflation, this study also established that the movement of causality between oil price and food inflation is a bi-directional one, with causality originating from oil price to food inflation. In this situation, the energy markets have a considerable impact on the agriculture sectors in the sample countries. As a result, this research expands our understanding of how the price of food relates to the price of oil in developing countries that export oil while importing food. The finding suggests that the use of biofuels as an alternative to traditional energy sources plays a role in influencing oil prices, along with other factors such as global economic conditions. These results are consistent with Adeosun et al. (2023), Demirtaş et al. (2023), Köse and Ünal (2022). Oil and gas are seen as inputs for the agricultural industry, affecting output and inflation due to increased crude oil costs.

As for the hypothesis that states that in the context of the war between Russia and Ukraine, is it possible to conduct an empirical test of symmetry or asymmetry and cointegration between oil prices and food price inflation in the countries of the Middle East and North Africa; In the applied aspect, we were able to test this hypothesis in Table 07. for three distinct regime types: pre-Ukraine-Russian war, post-Ukraine-Russian war, and when the entire sample was selected. When the entire sample was taken into account, the panel asymmetric Granger causality result showed that there was a unidirectional causal relationship between oil prices and food inflation. Positive and negative shocks to food prices as well as positive and negative shocks to oil prices were causally related to the war between Russia and Ukraine. However, prior to the Ukraine-Russia war, Granger causality did not demonstrate an imbalanced link between positive and negative shocks to oil prices and positive and negative shocks to food inflation. This results are consistent with Abay et al. (2023), Al-Rousan et al. (2024), Bagchi & Paul, 2023; Hanif et al., 2024; He et al., 2023; Hamulczuk et al., 2023; Headey & Hirvonen, 2023; Kilfoyle, 2023; Lin et al., 2023; Raga et al., 2024; Rashad et al., 2023; Tass et al., 2024; Zhang et al., 2024. According to Al-Rousan et al. (2024), El Bilali and Ben Hassen (2024), Kim (2022), and Paudel et al. (2023) explain that the war is between Russia and Ukraine significantly correlated with food, cereals, meat, and oils prices, with WTI and Brent crude showing a strong relationship.

The last hypothesis states that changes the changes in oil prices affect the MENA region's food inflation, and Are the impacts of the oil prices shocks on food inflation substantial or weak, more specifically, how symmetrical or asymmetrical it is.According to the results of this study, the long run coefficients of the Panel ARDL models, which are shown in Table 06 and 07, there is a unidirectional causal relationship between oil prices and food inflation. Positive and negative shocks to food prices as well as positive and negative shocks to oil prices are causally related to the conflict between Russia and Ukraine in MENA region. The ongoing war between Russia and Ukraine has caused significant human suffering and raised concerns about the global economy. In the same context, the study by Ben Hassen and El Bilali (2024) concluded that there is an effect of the war in Ukraine has significantly impacted North Africa's food systems, affecting global economy, trade dynamics, and food prices. High fertilizer prices have led to decreased yields and increased food prices. Wealthy countries have the means to alleviate these impacts, whereas nations with limited financial resources or unstable governance may find it challenging to safeguard food security. In a connected study by Kozielec et al. (2024), discussed how the war between Russia and Ukraine has had a significant effect on food security in the Middle East and North Africa (MENA) region, with Ukraine being a key global producer and exporter of grains. Transportation routes being disrupted, infrastructure being harmed, and logistics being hindered by the conflict all contribute to a decrease in export volume. Geopolitical tensions have damaged the confidence of MENA grain importers, which affects global supply chains, prices, and the availability of agricultural products. Urbanisation, population growth, obesity, and malnutrition rates all have an effect on food security. The region's increasing reliance on imports makes it increasingly vulnerable to disruptions in the global supply chain.

Moreover, Middle East and North Africa Countries, heavily relies on agricultural imports from both countries, making it susceptible to market shocks through two points: The Russia-Ukraine war significantly impacted crude oil prices, increasing WTI and Brent prices by 52.33% and 56.33% respectively. This shift in long-term trends was influenced by high-frequency IMF fluctuations and the use of crude oil in manufacturing, transportation, and biofuels. The conventional view suggests that oil prices lead to higher food commodity prices due to increased production costs. The emphasis on agricultural biofuel production as a result of increasing oil prices has shifted the traditional connection between energy and agriculture. The cost of energy is expected to increase by over 50% in 2022, with Brent crude oil prices reaching $100 per barrel. Coal and natural gas prices are also expected to reach all-time highs in 2022 in the time of Ukraine-Russia war. Ukraine is a key cereal supplier to the MENA region, exporting 95% of its grains through the Black Sea basin. The Ukrainian-Russian conflict could disrupt agricultural trade and lead to a food crisis. Variations in Ukrainian cereal imports could impact food stability, necessitating further analysis. Annual variability in cereal import volumes may reflect production, global prices, trade policy, and internal demand (Kozielec et al., 2024; Mottaleb et al., 2022).

Conclusions and Implications

In this work, the symmetric or asymmetric influence of Natural Gas and Oil Prices on Industrial Production in MENA nation were evaluated in Times of Russia-Ukraine war using non-linear panel ARDL and asymmetrical Granger Causality test.

- The research examined the effects of energy price shocks (increases in the price of natural gas and oil) on food inflation, and it revealed that these price increases had some effect on food inflation.
- The study's findings indicated that over the long run, there was a non-linear relationship between the variables.
- The short- and long-term asymmetries in the prices of food and oil were revealed by the empirical evidence, and the favourable effects of oil price shocks on food inflation predominated. The results also demonstrated that rising oil prices caused food prices to rise in both time periods (after the conflict between Ukraine and Russia and when the entire sample is chosen).
- Asymmetric Granger Causality stated that there was a two-way causative relationship between positive and negative shocks, the price of oil, and the price of food.
- Finally, it was shown that it was more efficient to use a non-linear panel-based technique to evaluate asymmetrical linkages between changes in oil prices and changes in food inflation.

Suggestions for Future Research

The Suggestions from the Oil Price Shochs'S Asymmetric Responses on Food Inflation in Middle East and North Africa Countries in the time of Ukraine-Russia war suggest that a combination of achieving self-sufficiency in some basic agricultural materials and market adjustments can resolve commodity market challenges. The key steps include promoting energy efficiency, reducing food waste, and easing biofuel mandates, while focusing on reliable low-carbon energy sources. Future research must take into account more food indices in addition to other independent factors (such as air pollution, global stock indices, inflation rate, and so on). Furthermore, it is recommended to employ Multiple Threshold NARDL forecasting models in order to verify and improve future projections. To delve deeper into the diversity and geographic variations of global food safety, the research could be expanded to include information from additional countries and regions, particularly those involved in the export of food products.

The study's limitations include excluding other macroeconomic variables and limiting its time to 240 observations. Future research should include a longer period and significant macroeconomic variables to better understand Oil Price Shifts' Asymmetric Responses to Food Inflation.

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Conflict of Interest

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