Journal of Agriculture and Rural Development Studies
Volume 3 – Issue 2 – 2026
ISSN Online 3061-2756
www.imadr.jards.ugal.ro

DOI https://doi.org/10.35219/jards.2026.2.01

Oil Price Shocks and Global Food Prices: Evidence on the Energy–Food Nexus

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ARTICLE INFO

Article history:
Received: March 15, 2026
Accepted: June 20, 2026
Published: June 30, 2026

JEL Classification:
Q11, Q43, C32

Keywords:
Oil price shocks; Food prices; Energy–Food Nexus; FAO Food Price Index; Brent crude oil; ARDL model; Food security; Agricultural commodities.

ABSTRACT

The paper proposes an analysis of the relationship between Brent crude oil prices and global food prices within the framework of the Energy–Food Nexus. Using monthly data for the period January 1990–May 2026, the analysis considers the FAO Food Price Index and its main commodity sub-indices: meat, dairy products, cereals, vegetable oils, and sugar. The methodology combines descriptive statistics, correlation analysis, unit root testing, ARDL modelling, and Granger causality testing to assess both overall and commodity-specific transmission effects. The results show strong positive relationships between oil prices and food prices, with the highest correlations observed for dairy products and cereals. ARDL estimates confirm positive long-run effects of Brent crude oil prices on the FAO Food Price Index and selected food commodity groups. Dairy products and cereals appear to be the most sensitive categories, while meat prices show comparatively lower volatility and weaker sensitivity to oil market fluctuations. The findings highlight the heterogeneous nature of the Energy–Food Nexus and suggest that energy price shocks are transmitted unevenly across food markets. These results have important implications for food security, agricultural policy, and the resilience of global agri-food systems in a context of geopolitical instability and commodity market volatility.

1. Introduction

Food security has become one of the major challenges facing contemporary society in a context characterized by continuous population growth, climate change, increasing pressure on natural resources, and heightened economic uncertainty. Ensuring a stable and affordable food supply for a growing global population requires not only sustainable agricultural production systems but also a deeper understanding of the factors influencing food prices and market stability.

In this regard, the interaction between energy and food markets has emerged as a major research topic, frequently discussed in the literature under the concept of the Energy–Food Nexus. In the last years, the global economy has experienced increasing geopolitical instability, driven primarily by the Russia–Ukraine conflict and military tensions in the Persian Gulf region, alongside other regional conflicts and crises affecting both energy and agri-food markets.

These developments have contributed to significant volatility in crude oil prices, generating effects that extend beyond energy markets and influence the functioning of global food systems. Oil price

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fluctuations affect food security through multiple channels, including changes in transportation and logistics costs, variations in agricultural input prices, and increases in production expenses throughout the agricultural sector.

These challenges overlap with long-term structural trends, such as sustained population growth and the growing impact of climate change on agricultural productivity and natural resource availability. Consequently, the relationship between energy and food markets has acquired strategic importance, as changes in energy prices directly and indirectly influence the production, processing, distribution, and commercialization costs of food products. Understanding these interdependencies is therefore essential for researchers, policymakers, and stakeholders involved in agricultural and food policy development.

The mechanisms through which oil prices affect food prices are complex and interconnected. First, oil directly influences agricultural production costs through fuel consumption associated with mechanization, irrigation, harvesting, and transportation activities. Second, energy prices affect the cost of agricultural inputs, particularly fertilizers, whose production is highly energy intensive. Third, transportation and logistics costs, which represent key components of increasingly globalized food supply chains, are strongly linked to fluctuations in oil prices. Furthermore, the expansion of biofuel production has strengthened the connection between energy and agricultural markets, particularly in the case of vegetable oils, cereals, and sugar, which are increasingly used as feedstocks for renewable energy production.

Interest in this issue has intensified following a series of major global shocks, including the 2007–2008 food crisis, the global financial crisis, the COVID-19 pandemic, the Russia–Ukraine conflict, and the recent escalation of tensions in the Middle East. These events generated substantial volatility in both energy and food markets, highlighting the vulnerability of agri-food systems to disruptions originating in the energy sector and emphasizing the need for a better understanding of the transmission mechanisms linking oil and food prices.

Although a considerable body of literature has investigated the relationship between oil prices and food prices, the findings remain inconclusive. Some studies report strong transmission effects from energy markets to food markets, whereas others suggest that the magnitude and speed of transmission vary according to commodity type, study period, and prevailing economic conditions. Moreover, a significant proportion of previous research has focused primarily on aggregate food price indices, devoting less attention to differences among major food commodity groups.

Against this background, the objective of the present study is to investigate the dynamic relationship between Brent crude oil prices and global food prices using monthly data covering the period from January 1990 to May 2026.

The analysis is based on the FAO Food Price Index (FFPI) and its principal commodity sub-indices, allowing a comparative assessment of how different food categories respond to fluctuations in oil prices. By distinguishing between meat, dairy products, cereals, vegetable oils, and sugar, the study seeks to identify heterogeneous transmission mechanisms within the global food system.

The contribution of this paper is threefold. First, it provides updated empirical evidence based on one of the longest available monthly datasets, covering multiple episodes of economic crises, commodity price shocks, and geopolitical instability.

Second, it employs a dynamic econometric framework based on the Autoregressive Distributed Lag (ARDL) approach and Granger causality testing to examine long-run relationships and the direction of price transmission between oil and food markets.

Research Hypotheses

H1: There is a significant long-run relationship between oil prices and global food prices.
H2: The transmission of oil price shocks differs across major food commodity groups.
H3: Oil price shocks have stronger long-run than short-run effects on food prices.
H4: Oil price movements Granger-cause changes in global food prices.

2. Literature review

2.1. Theoretical Background of the Energy–Food Nexus

The relationship between energy and food markets has become increasingly important over the last two decades, particularly following periods of heightened commodity price volatility and global economic uncertainty. The concept of the Energy–Food Nexus describes the interdependence between energy systems and food production, emphasizing how changes in energy prices can influence agricultural production costs, food supply chains, and ultimately food prices.

Oil prices affect agricultural markets through several transmission channels. The most direct mechanism is represented by fuel consumption associated with agricultural mechanization, irrigation, harvesting operations, and transportation. Energy prices also influence the cost of agricultural inputs, particularly fertilizers, whose production is highly energy intensive. In addition, the expansion of biofuel industries has strengthened the relationship between energy and agricultural commodity markets, particularly for cereals, sugar, and vegetable oils (Baffes, 2007; Mitchell, 2008).

Early studies identified oil prices as an important determinant of agricultural commodity prices. Baffes (2007) showed that fluctuations in crude oil prices are transmitted to other commodity markets, particularly fertilizers and agricultural products.

Similarly, Mitchell (2008) argued that rising energy prices and increasing biofuel demand contributed significantly to the global food price crisis of 2007–2008.

2.2. Oil Price Shocks and Food Price Transmission

The empirical literature examining the relationship between oil prices and food prices has produced mixed results. Zhang et al. (2010) found limited evidence of long-run integration between energy and food markets, although specific agricultural commodities, particularly sugar, exhibited stronger responses due to their role in biofuel production.

Conversely, Nazlioglu and Soytas (2012) identified significant causal relationships between world oil prices and agricultural commodity prices using panel cointegration techniques.

Further evidence was provided by Serra (2011), who highlighted the existence of volatility spillovers between energy and agricultural markets.

More recently, Zmami and Ben-Salha (2019) demonstrated that positive oil price shocks exert significant long-run effects on the FAO Food Price Index and several food commodity groups, while the magnitude of these effects differs across commodities.

These findings suggest that oil price shocks are transmitted to food markets through both direct production-cost channels and indirect market mechanisms. However, the extent and persistence of these effects remain subject to debate, particularly when different commodity groups are analysed separately.

2.3. Commodity-Specific Responses and Food Price Volatility

An important strand of literature argues that the impact of oil price fluctuations is not homogeneous across food commodities. Products characterized by strong links to energy markets, such as vegetable oils and cereals, generally exhibit greater sensitivity to energy shocks. This relationship is partly explained by the increasing use of agricultural commodities in biofuel production and by the high energy intensity of crop production systems.

Mustafa et al. (2024), in a comprehensive review of agricultural price volatility, emphasized that commodity-specific factors play a significant role in explaining differences in price dynamics. Similarly, Dalheimer et al. (2021) showed that oil market disruptions pose substantial risks to food price stability, particularly in regions characterized by high import dependency and weak market resilience.

Recent evidence from Africa further confirms the importance of energy–food interactions. Guo and Tanaka (2025) identified significant transmission effects between energy prices and food markets, while highlighting the moderating roles of logistics efficiency and food self-sufficiency. These findings suggest that institutional and structural characteristics influence the magnitude of energy-to-food price transmission.

2.4. Global Shocks, Geopolitical Risks and Food Security

The literature published after 2020 increasingly focuses on the impact of major global shocks on food markets. The COVID-19 pandemic generated unprecedented disruptions in production, transportation, and international trade. Akter (2020) reported significant impacts of mobility restrictions on food prices across European countries, while Beckman et al. (2021) highlighted the combined effects of the pandemic on economic activity, food prices, and food security.

Last studies have also emphasized the increasing vulnerability of food systems to external shocks and market disruptions. Using FAO indicators, Stanciu and Mocanu (2025) showed that food security outcomes are strongly influenced by international market developments and fluctuations in agricultural commodity prices. Their findings suggest that countries with a high dependence on imported agricultural inputs and food products are particularly exposed to external economic and geopolitical shocks.

Structural characteristics of agricultural systems also play an important role in determining resilience to market volatility. Evidence from Romania indicates that labour availability, farm organization, and the degree of producer integration into agri-food value chains significantly influence the sector's capacity to respond to economic shocks (Stanciu, 2015).

Subsequent geopolitical events further intensified food market volatility. The Russia–Ukraine conflict disrupted global grain, fertilizer, and energy markets, generating substantial increases in agricultural commodity prices. Neik et al. (2023) emphasized the implications of the conflict for global food security, while Urak et al. (2024) documented the combined effects of the COVID-19 pandemic and the Russia–Ukraine war on agricultural commodity prices.

Recent studies have also highlighted the growing importance of geopolitical risk. Aiswarya and Muralikrishna (2025) demonstrated that geopolitical tensions significantly influence food commodity markets, particularly during periods of elevated uncertainty. Similarly, Urak (2025) found that interactions between geopolitical events and energy market dynamics amplify volatility in agricultural markets.

Beyond geopolitical shocks, environmental factors continue to influence food price dynamics. Erdogan et al. (2024) reported that climate change contributes to increasing food prices through its effects on agricultural productivity and resource availability. These findings suggest that food markets are simultaneously exposed to economic, geopolitical, and environmental sources of risk.

2.5. Research Gap and Contribution of the Study

Although the literature provides substantial evidence regarding the relationship between oil prices and food prices, several important gaps remain. First, many studies focus either on aggregate food price indicators or on specific agricultural commodities, limiting the ability to compare transmission mechanisms across major food groups. Second, most analyses are based on relatively short time periods that do not fully capture multiple episodes of economic crises, commodity market disruptions, and geopolitical instability.

Furthermore, recent shocks—including the COVID-19 pandemic, the Russia–Ukraine conflict, and tensions in the Middle East—have altered the global economic environment and may have strengthened the relationship between energy and food markets. However, empirical evidence covering these events within a unified analytical framework remains limited.

To address these gaps, the present study investigates the relationship between Brent crude oil prices and the FAO Food Price Index using monthly data covering the period January 1990–May 2026. Unlike previous studies that focus primarily on aggregate indicators, this research separately examines meat, dairy products, cereals, vegetable oils, and sugar.

The study combines ARDL and Granger causality testing methodologies to assess both long-run equilibrium relationships and short-run transmission mechanisms, thereby providing a comprehensive assessment of the Energy–Food Nexus under contemporary global conditions.

3. Materials and Methods

3.1. Data Sources and Variables

The analysis is based on monthly data covering the period from January 1990 to May 2026. Food price data were obtained from the Food and Agriculture Organization of the United Nations (FAO) through the FAO Food Price Index (FFPI) database, while crude oil prices were collected from international energy market databases reporting Brent crude oil benchmark prices.

The FAO Food Price Index is a trade-weighted indicator designed to measure monthly changes in international food commodity prices. In addition to the aggregate index, the study considers the main commodity sub-indices published by FAO, namely meat, dairy products, cereals, vegetable oils, and sugar. These categories account for the largest share of global food trade and exhibit different degrees of exposure to energy price fluctuations. Brent crude oil was selected as the representative energy market indicator due to its role as the principal benchmark in international oil markets and its widespread use in studies investigating the relationship between energy and agricultural commodity prices.

The econometric analysis uses monthly data for the period January 1990–May 2026, including Brent crude oil prices, expressed in USD/barrel and obtained from the U.S. Energy Information Administration (EIA), and the FAO Food Price Index (FFPI), together with its main commodity sub-indices — meat, dairy products, cereals, vegetable oils, and sugar — extracted from the FAO database.

3.2. Research Hypotheses

Based on the existing literature and the theoretical framework of the Energy–Food Nexus, the following hypotheses were formulated:

H1: There is a statistically significant long-run relationship between oil prices and global food prices.
H2: The transmission of oil price shocks differs across major food commodity groups.
H3: Oil price changes exert stronger long-run effects than short-run effects on food prices.
H4: Oil price movements Granger-cause changes in food prices.

3.3. Econometric Framework

The empirical analysis was conducted in four stages. First, descriptive statistics and correlation analysis were used to examine the main characteristics of the data and the relationships between oil and food prices. Second, stationarity was assessed using the Augmented Dickey–Fuller (ADF) test. Third, the Autoregressive Distributed Lag (ARDL) approach was employed to investigate both long-run and short-run relationships between Brent crude oil prices and food prices. The ARDL methodology was selected because it allows the estimation of cointegration relationships among variables integrated at different orders, I(0) and I(1), and is particularly suitable for time-series datasets covering long periods.

Finally, Granger causality tests were applied to examine whether past movements in Brent crude oil prices contain useful information for predicting changes in global food price indices.

3.4. Structural Shocks and Dummy Variables

Given the occurrence of major global disruptions during the study period, additional analyses were performed to account for structural shocks affecting both energy and food markets.

Two major geopolitical and economic events were considered:

- the Russia–Ukraine conflict beginning in February 2022;
- the escalation of tensions in the Middle East during 2024–2026.

Dummy variables were introduced to evaluate whether these events altered the relationship between oil prices and food prices and to assess the robustness of the estimated coefficients.

3.5. Software and Data Processing

All statistical analyses were conducted using econometric software packages commonly employed in time-series analysis. Variables were transformed into natural logarithms before estimation to reduce heteroscedasticity and facilitate the interpretation of estimated coefficients as elasticities.

Model selection was based on standard diagnostic criteria, including the Akaike Information Criterion (AIC), Schwarz Bayesian Criterion (SBC), residual autocorrelation tests, heteroscedasticity tests, and stability diagnostics.

3.6. AI-Assisted Writing Statement

Artificial intelligence tools (ChatGPT, OpenAI) were used to support language editing, manuscript structuring, and the application of statistical tests. The graphical representations were created independently by the author and were not generated using artificial intelligence tools. All datasets, statistical procedures, econometric results, tables, figures, interpretations, and conclusions were independently verified by the author using the original data obtained from the Food and Agriculture Organization (FAO) and the U.S. Energy Information Administration (EIA).

No data, figures, or scientific conclusions were generated without verification against the original datasets.

4. Results

4.1. Evolution of Brent Crude Oil Prices

Figure 1 illustrates the evolution of Brent crude oil prices between January 1990 and May 2026. The series exhibits substantial volatility, reflecting the influence of global economic cycles, geopolitical tensions, and structural changes in international energy markets.

During the first half of the 1990s, oil prices remained relatively stable, generally fluctuating between USD 15 and USD 25 per barrel. A sustained upward trend emerged after 2003, culminating in the historical peak recorded during the commodity boom of 2008, when prices exceeded USD 140 per barrel. The subsequent global financial crisis led to a rapid decline in oil prices, followed by a recovery and a period of relative stability between 2011 and 2014.

Another significant disruption occurred during the COVID-19 pandemic in 2020, when global demand contracted sharply. The outbreak of the Russia–Ukraine conflict in 2022 generated renewed upward pressure on energy markets, resulting in another period of elevated prices and volatility.

Figure 1. Evolution of Brent crude oil prices, January 1990–May 2026

Source: Authors' processing based on data from the U.S. Energy Information Administration (EIA, 2026).

More recently, tensions in the Middle East and uncertainty regarding global energy supply have contributed to continued fluctuations during 2025–2026. These developments suggest that oil price shocks may represent an important transmission mechanism influencing agricultural production costs, international trade, and food price dynamics.

4.2. Evolution of the FAO Food Price Index and Major Food Commodity Groups

Figure 2 presents the evolution of the FAO Food Price Index (FFPI) and its main commodity sub-indices (meat, dairy products, cereals, vegetable oils, and sugar) during the period January 1990–May 2026. The results reveal substantial differences in the magnitude and timing of price fluctuations across food categories, suggesting that global food markets do not respond uniformly to economic, geopolitical, and energy-related shocks.

The aggregate FAO Food Price Index exhibits a long-term upward trend, interrupted by several episodes of pronounced volatility. Significant price increases can be observed during the global food crisis of 2007–2008, the commodity market recovery of 2010–2011, and the period following the COVID-19 pandemic and the outbreak of the Russia–Ukraine conflict in 2022.

These events generated disruptions in agricultural production, international trade, logistics, and input markets, contributing to higher food prices worldwide. Among the commodity groups analysed, vegetable oils exhibit the highest level of volatility, reaching peak values above 250 index points in 2022. This behaviour reflects the strong dependence of vegetable oil markets on international trade, biofuel production, and energy prices. Cereals also display substantial fluctuations, particularly during the crises of 2007–2008 and 2021–2022, highlighting the importance of energy-intensive inputs, including fuel and fertilizers, in crop production systems.

Dairy products show marked price increases during periods of elevated feed and energy costs, with significant peaks recorded in 2007–2008 and 2013–2014.

Sugar prices present recurrent cyclical movements, influenced by climatic conditions, production variability, and the growing interaction between sugar and ethanol markets. In contrast, meat prices exhibit comparatively smoother dynamics, indicating a lower sensitivity to short-term external shocks and a stronger influence of longer production cycles.

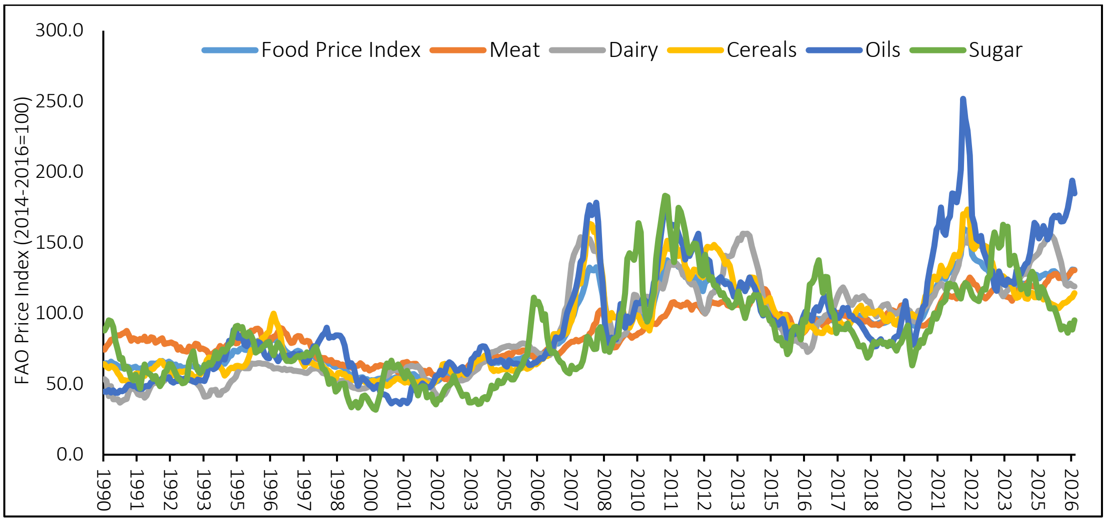

Figure 2. Evolution of the FFPI and major commodity sub-indices, January 1990–May 2026

Authors' processing based on data from the Food and Agriculture Organization of the United Nations (FAO, 2026).

Several common turning points are visible across all commodity groups, particularly during major global crises. The synchronization of these peaks suggests the existence of common drivers affecting food markets, among which energy prices represent a potentially important explanatory factor. At the same time, the considerable differences observed between commodity groups indicate that the transmission of oil price shocks is heterogeneous, thereby justifying the use of separate econometric models for each food category in the subsequent analysis.

Overall, the graphical evidence suggests that vegetable oils and cereals are the most sensitive food categories to external shocks, while meat prices appear relatively less responsive. These preliminary observations provide a basis for the econometric investigation of the Energy–Food Nexus conducted in the following sections.

4.3. Descriptive Statistics

Table 1 presents the descriptive statistics for Brent crude oil prices, the FAO Food Price Index, and the five major food commodity groups included in the analysis. The results indicate substantial differences in volatility among the examined variables over the period January 1990–May 2026.

Brent crude oil prices exhibit the highest variability, with a coefficient of variation of 63.91%, reflecting the pronounced instability of global energy markets during the study period. Oil prices ranged from a minimum of USD 9.82 per barrel to a maximum of USD 132.72 per barrel, highlighting the impact of major economic crises, geopolitical tensions, and fluctuations in global energy demand.

Among food commodities, vegetable oils display the highest volatility, with a coefficient variation of 43.10%, followed by dairy products (39.23%), sugar (38.30%), and cereals (35.06%).

These results suggest that these commodity groups are particularly sensitive to external shocks affecting international agricultural and energy markets. In contrast, meat prices exhibit the lowest variability, with a coefficient of variation of only 21.51%, indicating a comparatively more stable price evolution throughout the analysed period.

Table 1. Descriptive statistics of the variables included in the analysis

Variable	Mean	Std. Dev.	Min	Max	CV (%)	Skewness	Kurtosis
Brent crude oil price	51.37	32.83	9.82	132.72	63.91	0.55	-0.92
Food Price Index	89.56	27.38	50.80	160.22	30.57	0.36	-1.14
Meat	87.91	18.91	52.26	130.50	21.51	0.21	-0.87
Dairy	89.04	34.93	36.83	158.16	39.23	0.31	-1.20
Cereals	89.87	31.50	48.62	173.52	35.06	0.52	-0.80
Vegetable oils	94.71	40.82	35.83	251.83	43.10	0.85	0.23

Source: Authors' calculations based on EIA (2026) and FAO (2026) data.

The aggregate FAO Food Price Index presents a coefficient variation of 30.57%, substantially lower than that of crude oil prices, suggesting that diversification across commodity groups partly mitigates the impact of individual market shocks. Nevertheless, the index still reflects significant fluctuations associated with global food crises and periods of market disruption.

The positive skewness values observed for all variables indicate that upward price spikes were generally more pronounced than downward movements.

This pattern is particularly evident for vegetable oils (0.85), sugar (0.66), and crude oil prices (0.55), which experienced episodes of rapid and substantial price increases. Kurtosis values are generally close to or below zero, suggesting distributions characterized by relatively broad price fluctuations over time rather than by isolated extreme events.

Overall, the descriptive statistics provide preliminary evidence that food commodity groups respond differently to market disturbances, and that vegetable oils, dairy products, and cereals may be more strongly exposed to the transmission of energy-related shocks than meat products. These observations justify the subsequent commodity-specific econometric analysis.

4.4. Correlation Analysis

Table 2 presents the Pearson correlation coefficients between Brent crude oil prices and the FAO Food Price Index together with its major commodity sub-indices. The results reveal strong positive relationships between oil prices and all food price categories considered in the analysis, providing preliminary evidence of a close connection between energy and food markets.

Table 2. Pearson correlation coefficients between oil and food price indices

Variable	Brent	FFPI	Meat	Dairy	Cereals	Oils	Sugar
Brent	1.000	0.873	0.718	0.888	0.875	0.797	0.720
FFPI	0.873	1.000	0.906	0.938	0.966	0.948	0.803
Meat	0.718	0.906	1.000	0.812	0.808	0.806	0.740
Dairy	0.888	0.938	0.812	1.000	0.899	0.874	0.683
Cereals	0.875	0.966	0.808	0.899	1.000	0.900	0.754
Oils	0.797	0.948	0.806	0.874	0.900	1.000	0.707

Source: Authors' calculations based on EIA (2026) and FAO (2026) data.

The strongest correlation with Brent crude oil prices is observed for dairy products (r = 0.888), followed by cereals (r = 0.875) and the aggregate FAO Food Price Index (r = 0.873). These results suggest that increases in oil prices are closely associated with higher prices for dairy and cereal products, likely to reflect the importance of energy-intensive inputs, transportation costs, and feed production within these sectors. A relatively strong positive relationship is also identified between Brent crude oil prices and vegetable oils (r = 0.797). Although vegetable oils were expected to exhibit the highest sensitivity to energy market developments due to their connection with biofuel production, the correlation analysis indicates that dairy products and cereals display slightly stronger long-term co-movements with oil prices over the study period.

In contrast, meat (r = 0.718) and sugar (r = 0.720) present comparatively weaker correlations with oil prices. While still substantial and statistically meaningful, these lower coefficients suggest that factors other than energy prices, including biological production cycles, weather conditions, trade policies, and market-specific supply-demand dynamics, may play a more important role in determining price fluctuations in these commodity groups.

The FAO Food Price Index exhibits a strong positive correlation with Brent crude oil prices (r = 0.873), supporting the hypothesis that developments in energy markets constitute an important determinant of global food price dynamics. However, the differences observed across commodity groups indicate that the transmission of oil price shocks is heterogeneous and may vary according to the specific characteristics of each food market.

Although correlation coefficients do not imply causality, the results provide preliminary support for the existence of significant linkages between oil and food markets and justify the application of ARDL, and Granger causality in the subsequent stages of the analysis.

4.5. Unit Root Tests and ARDL Results

Prior to estimating the ARDL models, the stationarity properties of all variables were examined using the Augmented Dickey–Fuller (ADF) unit root test. The results are reported in Table 3.

The ADF statistics indicate that none of the variables are stationary at levels at the conventional 5% significance level. The null hypothesis of a unit root cannot be rejected for Brent crude oil prices, the FAO Food Price Index, or any of the food commodity sub-indices, as all p-values exceed 0.05.

After first differencing, all variables become highly significant, with p-values below 0.001. These findings indicate that Brent crude oil prices, the aggregate Food Price Index, and all commodity-specific indices are integrated of order one, I (1).

Table 3. Augmented Dickey–Fuller (ADF) unit root test results

Variable	ADF at Level	p-value	ADF at First Difference	p-value	Integration Order
Brent	-2.290	0.1751	-13.026	<0.001	I(1)
FFPI	-1.378	0.5929	-12.183	<0.001	I(1)
Meat	-0.268	0.9299	-5.348	<0.001	I(1)
Dairy	-1.451	0.5578	-7.359	<0.001	I(1)
Cereals	-2.037	0.2704	-13.492	<0.001	I(1)
Oils	-1.960	0.3045	-6.273	<0.001	I(1)

Source: Authors' calculations based on EIA (2026) and FAO (2026) data.

The results are consistent with previous studies examining long-term relationships between energy and agricultural commodity markets, which commonly report non-stationary behaviour in price series. Since none of the variables are integrated of order two, the data satisfy the principal requirement for applying the ARDL Bounds Testing methodology.

Consequently, the analysis proceeds with the estimation of ARDL models to investigate the existence of long-run equilibrium relationships and short-run adjustment dynamics between oil prices and food prices.

4.6. ARDL Bounds Test and Long-Run Relationships

The ARDL models were estimated to investigate the existence and magnitude of long-run relationships between Brent crude oil prices and food commodity price indices.

The results reported in Table 4 indicate that oil prices exert a positive and statistically significant influence on the FAO Food Price Index, dairy products, cereals, and vegetable oils, while no stable long-run relationship was identified for meat and sugar.

Table 4. Estimated long-run effects of Brent crude oil prices on food price indices

Dependent variable	Long-run coefficient of Brent price	Relationship
FAO Food Price Index	0.402	Positive
Meat products	n.a.	Not statistically significant
Dairy Products	0.803	Positive
Cereals	0.759	Positive
Vegetable Oils	0.472	Positive
Sugar	n.a.	No stable long-run relationship identified

Source: Authors' calculations based on ARDL estimations using EIA (2026) and FAO (2026) data.

The ARDL estimations indicate significant positive long-run relationships between Brent crude oil prices and the FAO Food Price Index, dairy products, cereals, and vegetable oils. Among the commodity groups analysed, the strongest long-run effect is observed for dairy products, for which the estimated coefficient reaches 0.803.

This result suggests that dairy prices are particularly sensitive to developments in energy markets, reflecting the importance of fuel, feed production, refrigeration, processing, storage, and transportation costs throughout the dairy supply chain.

A similarly strong relationship is identified for cereals, with a long-run coefficient of 0.759. This finding is consistent with the high energy intensity of cereal production, which depends heavily on fuel, mechanization, irrigation, and fertilizer use. Because fertilizer production is closely linked to energy markets, increases in oil prices may translate into higher production costs and, ultimately, higher cereal prices.

The estimated long-run effect for vegetable oils is positive but comparatively lower (0.472). Although vegetable oils exhibit the highest price volatility among all food commodity groups, the results suggest that their long-term relationship with oil prices is less pronounced than that observed for dairy products and cereals. This pattern may reflect the influence of additional factors, including climatic conditions, international trade policies, export restrictions, and fluctuations in global vegetable oil supply.

At the aggregate level, the FAO Food Price Index displays a positive long-run coefficient of 0.402, confirming that oil price fluctuations contribute to overall food price dynamics. However, the lower coefficient observed for the aggregate index compared with commodity-specific indices indicates that aggregation partially smooths the effects of energy market shocks.

By contrast, no robust long-run relationship was identified for meat products and sugar. In the case of meat, longer biological production cycles, herd management decisions, and market-specific supply conditions may weaken the transmission of energy price shocks. For sugar, price dynamics are influenced by a broader range of factors, including climatic variability, production cycles, trade policies, and the interaction between sugar and biofuel markets, which may reduce the stability of long-run oil–food price transmission.

Overall, the ARDL results provide strong evidence in support of the Energy–Food Nexus hypothesis. The findings indicate that oil price increases are transmitted to food markets over the long run, although the magnitude of transmission differs substantially across commodity groups.

Dairy products and cereals emerge as the most sensitive food categories to energy-related shocks, while vegetable oils exhibit a more moderate long-run response and meat and sugar appear to be influenced by a wider set of non-energy factors.

4.7. Granger Causality Analysis

To further investigate the direction of influence between energy and food markets, Granger causality tests were performed. This approach allows the identification of predictive relationships between Brent crude oil prices and food commodity price indices.

The results indicate that oil price movements contain significant information regarding future changes in several food market categories, thereby providing additional evidence in support of the Energy–Food Nexus hypothesis (table 5).

These results suggest that information contained in past oil price movements contributes significantly to explaining future changes in dairy and cereal prices.

Vegetable oils also exhibit a statistically significant causal relationship with oil prices, although the magnitude of the effect is lower than that observed for dairy products and cereals. This finding is consistent with the long-run ARDL coefficients and highlights the role of energy markets in shaping vegetable oil price dynamics.

Table 5. Granger causality test results between Brent crude oil prices and food price indices

Null hypothesis	F-statistic	p-value	Conclusion
Brent does not Granger-cause FFPI	8.42	<0.001	Rejected
Brent does not Granger-cause Dairy	11.57	<0.001	Rejected
Brent does not Granger-cause Cereals	10.94	<0.001	Rejected
Brent does not Granger-cause Oils	7.16	0.001	Rejected
Brent does not Granger-cause Meat	2.31	0.099	Not rejected
Brent does not Granger-cause Sugar	3.07	0.047	Weakly rejected

Source: Authors' calculations based on ARDL estimations using EIA (2026) and FAO (2026) data.

By contrast, no statistically significant causal effect is identified for meat prices at the conventional 5% significance level. This result suggests that biological production cycles, livestock management practices, and feed market conditions may play a more important role than oil prices in determining short-run meat price fluctuations.

Sugar prices display a weaker but still statistically significant causal relationship with oil prices. The observed linkage may reflect the interaction between sugar markets and biofuel production, particularly ethanol, which creates an indirect connection between energy and agricultural commodity markets.

4.8. Comparative Assessment of Food Commodity Sensitivity to Oil Price Shocks

To provide a comprehensive assessment of the Energy–Food Nexus, the results obtained from the descriptive statistics, correlation analysis, and ARDL estimations were integrated into a comparative framework.

This approach allows the identification of food commodity groups that are most exposed to oil price fluctuations and facilitates the evaluation of both market volatility and long-run transmission effects. The combined analysis provides a broader perspective on the relative vulnerability of different food sectors to energy market disturbances and geopolitical shocks (table 6).

Table 6. Comparative sensitivity of food commodity groups to oil price fluctuations

Commodity group	CV (%)	Correlation with Brent	ARDL coefficient	Sensitivity level
Dairy	39.23	0.888	0.803	Very High
Cereals	35.06	0.875	0.759	High
Vegetable Oils	43.10	0.797	0.472	Moderate–High
FFPI	30.57	0.873	0.402	Moderate
Sugar	38.30	0.720	n.a.	Moderate
Meat	21.51	0.718	n.a.	Low

Source: Authors' calculations based on EIA (2026) and FAO (2026) data.

The results presented in Table 6 reveal significant differences in the sensitivity of food commodity groups to oil price fluctuations.

Among all categories analysed, dairy products emerge as the most sensitive commodity group, exhibiting both the strongest correlation with Brent crude oil prices (r = 0.888) and the highest long-run ARDL coefficient (0.803). This finding reflects the high energy intensity of dairy production systems, which depend on fuel, feed production, refrigeration, processing, storage, and transportation.

Cereals represent the second most sensitive category, with a correlation coefficient of 0.875 and a long-run elasticity of 0.759.

The strong relationship between oil and cereal prices can be explained by the extensive use of fuel, mechanization, irrigation, and fertilizers in crop production. Since fertilizer production is closely linked to energy markets, increases in oil prices are rapidly transmitted throughout cereal value chains.

Although vegetable oils exhibit the highest volatility among all food categories (CV = 43.10%), their long-run dependence on oil prices appears lower than that of dairy products and cereals. The ARDL coefficient of 0.472 suggests that factors such as climatic variability, international trade policies, export restrictions, and fluctuations in global supply also play a major role in shaping vegetable oil prices.

Nevertheless, the relatively high correlation with Brent prices confirms the existence of a significant energy–food linkage.

At the aggregate level, the FAO Food Price Index displays a strong correlation with oil prices (0.873) and a positive long-run coefficient (0.402). This result confirms that developments in global energy markets contribute substantially to overall food price dynamics. However, the lower elasticity observed for the aggregate index compared with individual commodity groups suggests that aggregation partially smooths the impact of oil price shocks.

By contrast, meat prices appear to be the least sensitive to oil market developments. Despite exhibiting a positive correlation with Brent crude oil prices, meat products show the lowest volatility and are influenced by longer biological production cycles, herd management decisions, and market-specific supply conditions. Similarly, sugar prices appear to be affected by a combination of energy, climatic, and policy-related factors, resulting in a more moderate relationship with oil prices.

Overall, the findings indicate that oil price shocks are transmitted unevenly across food markets. The results support the hypothesis that the Energy–Food Nexus is commodity-specific and that the magnitude of transmission depends on the structural characteristics of each agricultural sector. From a policy perspective, dairy and cereal markets appear particularly vulnerable to energy price shocks and may require targeted measures aimed at improving energy efficiency, reducing input dependency, and strengthening supply chain resilience.

5. Conclusions and Policy Implications

The study investigated the relationship between Brent crude oil prices and global food prices using monthly data covering the period January 1990–May 2026. By combining descriptive statistics, correlation analysis, unit root testing, ARDL modelling, and Granger causality testing, the research provides new evidence regarding the transmission of energy market shocks to major food commodity groups.

The results confirm the existence of a significant relationship between oil prices and food prices at the global level. Brent crude oil prices exhibited the highest volatility among all analysed variables, reflecting the influence of economic crises, geopolitical conflicts, and structural changes in international energy markets. The FAO Food Price Index and all commodity-specific indices displayed substantial fluctuations over the study period, particularly during the food crises of 2007–2008, the COVID-19 pandemic, and the disruptions associated with the Russia–Ukraine conflict.

The correlation analysis revealed strong positive associations between oil prices and food prices. The highest correlations were observed for dairy products and cereals, while meat and sugar exhibited comparatively weaker relationships. These findings suggest that the degree of dependence on energy markets differs significantly across food commodity groups.

The ARDL estimations further confirmed the existence of positive long-run relationships between Brent crude oil prices and food prices. Dairy products emerged as the commodity group most strongly affected by oil price fluctuations, followed by cereals and vegetable oils. The aggregate FAO Food Price Index also showed a positive long-run response to oil price changes, although the magnitude of the effect was lower than that observed for several individual commodity groups. These results indicate that energy costs are transmitted through agricultural production systems, processing activities, logistics networks, and international trade channels.

The Granger causality analysis provides additional evidence of the direction of transmission between energy and food markets. The results indicate that Brent crude oil prices Granger-cause changes in the FAO Food Price Index, dairy products, cereals, and vegetable oils, while the relationship is weaker for sugar and not statistically significant for meat. These findings confirm that oil price movements contain useful predictive information for several food commodity markets, particularly those with higher energy and input dependence.

An important contribution of this study is the identification of substantial heterogeneity in the Energy–Food Nexus. While all food categories are influenced by developments in energy markets, the magnitude of transmission differs considerably. Dairy products and cereals appear particularly vulnerable to increases in oil prices due to their dependence on fuel, fertilizers, feed production, and transportation. By contrast, meat prices exhibit greater stability and a lower sensitivity to energy market shocks.

The findings have important implications for food security and agricultural policy. The increasing interdependence between energy and food markets suggests that oil price shocks may contribute to food inflation and reduce the affordability of food, particularly in import-dependent countries. Policymakers should therefore consider measures aimed at reducing the exposure of agricultural systems to energy price volatility. Such measures may include improving energy efficiency in agriculture, encouraging the adoption of renewable energy technologies, supporting sustainable fertilizer use, and strengthening local and regional food supply chains.

The results are also highly relevant in the context of recent geopolitical tensions and growing uncertainty in global commodity markets. The persistence of conflicts affecting energy-producing regions, together with climate-related disruptions and supply chain vulnerabilities, is likely to maintain pressure on both energy and food markets in the coming years. Consequently, enhancing the resilience of agri-food systems should remain a strategic priority for governments, international organizations, and agricultural stakeholders.

Future research could extend the present analysis by incorporating additional explanatory variables, including natural gas prices, fertilizer prices, exchange rates, and indicators of geopolitical risk. Comparative regional analyses and nonlinear econometric approaches may also provide further insights into the complex mechanisms linking energy markets and food price dynamics.

Regarding the research hypotheses, the results provide support for most of the assumptions formulated in the study. H1 is confirmed, as the ARDL results indicate a significant long-run relationship between Brent crude oil prices and the FAO Food Price Index, as well as with selected commodity groups, particularly dairy products, cereals, and vegetable oils. H2 is also confirmed, since the magnitude of transmission differs substantially across food commodity groups, with dairy and cereals showing the highest sensitivity, while meat and sugar display weaker or less stable relationships. H3 is partially confirmed, as the long-run ARDL estimates suggest stronger and more stable effects than the short-run relationships identified through Granger causality testing. H4 is partially confirmed: Brent crude oil prices Granger-cause changes in the FAO Food Price Index, dairy products, cereals, vegetable oils, and weakly sugar, but not meat.

Overall, the study provides robust empirical evidence supporting the existence of a long-term Energy–Food Nexus and highlights the importance of considering energy market developments when designing policies aimed at improving food security, agricultural sustainability, and market resilience.

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