Business, Management and Economics Engineering
ISSN: 2669-2481 / eISSN: 2669-249X 2026
Volume 24 Issue 1: 1–8
DOI: https://doie.org/10.10399/BMEE.2026849644

Exploring the Energy–Agriculture Price Nexus: Evidence of Cross Market Linkages and Volatility Spillover Effects

[1]Janani A, [2]Jansirani K , [3]Dr. Vijayakumari Joseph

[1]M. com, Research Scholar, Department of Commerce, Madras Christian College, Tambaram, Chennai, India.
[2]M. com, M.Phil., Research Scholar, Department of Commerce, Madras Christian College, Tambaram, Chennai, India.
[3]M. Com, B.Ed., Ph.D. Associate Professor & Research Supervisor, Department of Commerce, Tambaram, Chennai, India.

ABSTRACT

Energy and agriculture are critical areas for the global economy, impacting economic development, food security, inflation, and trade dynamics. Their interconnectedness is significant since agriculture is significantly reliant on energy inputs like gasoline, electricity, and fertilisers. This study investigates the relationship between energy and agricultural commodity prices in India, with an emphasis on cross-market linkages and volatility spillover effects. Using monthly Wholesale Price Index (WPI) data from 2013 to 2025 for crude oil, natural gas, paddy, and wheat, the study employs econometric approaches such as the Augmented Dickey-Fuller test, Johansen cointegration test, Vector Error Correction Model (VECM), and DCC-GARCH model. The results show that all variables are integrated to order one and have strong long-run connections. Findings reveal that energy prices drive agricultural prices, confirming unidirectional causality. Major volatility spillovers and time-varying correlations are also noted, indicating robust market integration and major policy and risk management implications.

Keywords: Energy Prices, Agricultural Commodities, Wholesale Price Index (WPI), Cointegration, Time Series Analysis.

1. Introduction

Global trade patterns, food security, inflation, and economic growth are all impacted by these markets' performance. Energy inputs like gasoline for machinery, electricity for irrigation, fertilisers made from petroleum products, and transportation for the distribution of agricultural products are crucial to agricultural production. As a result, changes in energy prices can have a substantial impact on the cost structure of agricultural production, which in turn can have an impact on food prices (Gohin & Chantret 2010). The interdependence of asset classes has increased in recent decades due to the growing integration of the global financial and commodity markets, creating important cross-market connections and volatility spillover effects. In practical economics and commodities market research, these processes have garnered significant attention, especially in light of financialisation, globalisation, and recurrent economic crises. Volatility spillovers describe the transfer of risk and uncertainty from one market to another, whereas cross-market connections describe the co-movement and interdependence of prices across many markets. Investors, policymakers, and researchers must comprehend these phenomena since they have a direct impact on market stability, risk management, and portfolio diversification.

Strong empirical proof of these connections is provided by the increasing interdependence of the energy and agricultural commodity markets. The link between crude oil and agricultural commodities like corn, soybeans, and sugar has been reinforced by the increase in energy prices

Business, Management and Economics Engineering
ISSN: 2669-2481 / eISSN: 2669-249X 2026
Volume 24 Issue 1: 1–8
DOI: https://doie.org/10.10399/BMEE.2026849644

since the mid-2000s and the growth of biofuel production. The relationship between the energy and agricultural markets has grown over time, as noted by Dahl et al. (2020), with evidence of asymmetric and bidirectional volatility transmission, especially during times of financial and economic instability. The energy-intensive nature of agricultural production, where changes in oil prices have a direct impact on input costs, transportation, and overall food prices, further reinforces this interdependence.

Furthermore, during times of crisis, volatility spillovers typically worsen due to increased uncertainty and market contagion. Geopolitical conflicts, the COVID-19 pandemic, and the global financial crisis of 2008 have all greatly increased the spread of shocks throughout markets. For example, research like Umar et al. (2021) demonstrates that supply chain disruptions and investor emotion greatly increase the volatility connection between the energy and agricultural markets when there is a crisis.

The significance of comprehending the connections between energy and agricultural pricing has been further reinforced by the rising volatility seen in international commodity markets. because of financial market integration, geopolitical tensions, economic crises, and climate change (Braun & Tadesse 2012). The growth of biofuel production is another significant aspect in the expanding link between the energy and agricultural industries. Corn, sugarcane, and soybean oil are among the agricultural products used to make biofuels like ethanol and biodiesel. Therefore, the demand for agricultural commodities can be significantly impacted by energy policies that support renewable fuels (Beckman et al., 2013). By looking at cross-market connections and volatility spillover effects, this study aims to evaluate the relationship between energy prices and agricultural commodity prices. Policymakers must comprehend these relationships.

By looking at cross-market connections and volatility spillover effects, this study aims to evaluate the relationship between energy prices and agricultural commodity prices. Policymakers, researchers, and market participants who want to reduce the risks associated with commodity price volatility must comprehend these relationships.

1.2 Objectives of the study

- To examine the relationship between energy and agricultural commodity prices in India.
- To analyse the presence of cross-market linkages between energy and agricultural markets.
- To investigate volatility spillover effects between selected commodities.

2. Review of Literature

The literature has extensively examined the relationship between the energy and agricultural commodity markets, especially in relation to cross-market connections and volatility spillover effects. Researchers have concentrated on comprehending how shocks originating in one market, particularly crude oil, are transferred to agricultural commodities due to the growing globalisation and financialisaton of commodity markets. The cost-push impact of energy prices on agricultural production was the main focus of early studies. costs for agricultural commodities rise as a result of rising oil costs, which also raise the cost of transportation, machinery, and fertilisers (Baffes 2007). This viewpoint has been broadened by recent research that takes financial market integration and volatility transmission into account. Research employing econometric models like VAR and GARCH has shown that energy market volatility can affect agricultural commodity markets (Shahani & Taneja 2022).

The relationship between both markets has been further reinforced by the expansion of biofuel production (Barbaglia et al., 2017). The demand for maize and sugarcane has increased as a result of policies encouraging the manufacture of ethanol, increasing the connection between agricultural prices and the dynamics of the energy market (Etienne et al., 2017). According to empirical data, crude oil prices frequently serve as a leading indication for changes in the pricing of agricultural commodities, especially during times of unstable global economies (Hung 2021).

The VAR-GARCH model was used by Nazlioglu et al. (2013) to investigate the transmission of volatility between agricultural commodities and oil. The results show unmistakable evidence of volatility spillovers, suggesting that shocks to the oil market have a major impact on the volatility patterns of agricultural commodity prices. Due to agriculture's reliance on energy inputs including gasoline, fertiliser, and transportation, this study emphasises how energy markets are a significant source of volatility for agricultural industries. Pal & Mitra (2017) used wavelet analysis, the Toda–Yamamoto causality test, and the Johansen cointegration test to examine the long-term and short-term correlations between crude oil and world food prices. The findings imply that, especially in the short term, changes in oil prices might anticipate the prices of agricultural commodities. The authors were also able to emphasise the multi-scale character of market links by using wavelet analysis to break down interactions over several time periods. The VARMA-BEKK-GARCH model with permanent-transitory decomposition were employed by Hanet et al. (2020). Strong bidirectional volatility links between energy and agricultural futures markets are found in the study, indicating that agricultural markets can transfer shocks back to energy markets in addition to the energy market's influence on agriculture. The study by Umar et al. (2021), which uses the spillover index approach to investigate dynamic connection among commodities markets, goes into great detail about how crisis situations exacerbate volatility spillovers.

Overall, the literature consistently demonstrates that energy and agricultural markets are closely linked through both price and volatility channels. A common finding across studies is that crude oil acts as a dominant transmitter of volatility, while agricultural commodities often serve as receivers, although bidirectional relationships are also observed. Results verify that oil shocks are a significant source of volatility for food commodities, especially in times of increased uncertainty like the COVID-19 pandemic. It illustrates how volatility spillovers are not constant but rather tend to worsen during times of crisis, reflecting increased market integration and investor response to shocks around the world. This emphasises how crucial it is to use time-varying frameworks when examining market linkages. Using sophisticated econometric models, Adeosun et al. (2024) investigated market integration and discovered substantial comovement between the food and energy markets. The findings show that the connections between these markets have been strengthened by globalisation, financialisation, and increasing speculative trading, which has diminished the advantages of diversification. In a similar vein, Mishra et al. (2025) captured the dynamic nature of market linkages using a Time-Varying Parameter Vector Autoregression (TVP-VAR) framework. According to their research, there is a significant time-varying relationship between the prices of agricultural commodities and crude oil, with short-term volatility spillovers being the most common.

3. Research Methodology

To investigate the volatility spillover effects and cross-market connections between the energy and agricultural commodity markets. It outlines the study's variables, econometric methods, data sources, and research strategy. Using sophisticated time-series models, the methodology

Business, Management and Economics Engineering
ISSN: 2669-2481 / eISSN: 2669-249X 2026
Volume 24 Issue 1: 1–8
DOI: https://doie.org/10.10399/BMEE.2026849644

is designed to capture both the interdependence and dynamic transmission of volatility across markets.

3.1 Research Design:

Time-series econometric methods are used in this study's quantitative research design. It focuses on examining how the prices of agricultural commodities and energy interact dynamically over time.

3.2 Data Sources and Description

The secondary data included in the study was gathered from reputable and legitimate sources. The WPI index of energy and agricultural commodities is chosen from the Indian Economic Advisor's office. The analysis ensures that there are enough observations for time-series analysis by covering monthly data from January 2013 to December 2025.

3.3 Variables of the Study

The study includes the following variables:

- Energy Commodities: Crude oil and Natural gas.
- Agricultural Commodities: Paddy and Wheat.

3.4 Econometric techniques

- **Augmented Dickey Fuller (ADF Test):** Used to check whether the time series is stationary or has a unit root.
- **Johansen Cointegration Test:** Used to determine whether multiple non-stationary variables have a long-run equilibrium relationship.
- **VAR Model:** Used to capture the interdependence and dynamic relationships among multiple time series variables.
- **VECM Model:** Used to analyse both short-run adjustments and long-run equilibrium when variables are cointegrated.
- **DCC-GARCH Model:** Used to measure time-varying volatility and dynamic correlations between multiple series.

4. Analysis and Interpretation

Table 4.1: ADF Test at Level

Variable	ADF	p-value	Result
WPI_Paddy	-2.134	0.231	Non-stationary
WPI_Wheat	-1.876	0.342	Non-stationary
WPI_ Crude Petroleum	-1.765	0.398	Non-stationary
WPI_ Natural Gas	-2.556	0.102	Non-stationary

All variables are non-stationary at level as p-values exceed 0.05.

Business, Management and Economics Engineering
ISSN: 2669-2481 / eISSN: 2669-249X 2026
Volume 24 Issue 1: 1–8
DOI: https://doie.org/10.10399/BMEE.2026849644

Table 4.2: ADF Test at First Difference

Variable	ADF	p-value	Result
WPI_Paddy	-5.842	0.000	Stationary
WPI_Wheat	-6.114	0.000	Stationary
WPI_ Crude Petroleum	-5.671	0.000	Stationary
WPI_ Natural Gas	-6.203	0.000	Stationary

All variables become stationary after first differencing, confirming I(1).

The stationarity characteristics of the monthly Whole-sale Price Index (WPI) series were investigated using the ADF test. Since the unit root null hypothesis could not be rejected at standard significance levels, the results show that all variables are non-stationary at levels. All series are stationary at first difference, according to the ADF statistics, which become highly significant ($p < 0.01$) after taking initial differences. As a result, the variables meet the requirement for cointegration analysis because they are integrated of order one, I(1).

Table 4.3: Johansen Cointegration Test

Hypothesis (r)	Trace Statistic	5% Critical Value	Result
$r = 0$	58.34	47.85	Reject
$r \leq 1$	30.92	29.79	Reject
$r \leq 2$	14.22	15.49	Not Reject
$r \leq 3$	0.004	3.84	Not Reject

At the 5% significance level, the trace statistics show that the null hypothesis of no cointegration ($r = 0$) and at most one cointegrating vector ($r \leq 1$) are rejected. Nonetheless, the existence of two cointegrating links is confirmed since the null hypothesis for $r \leq 2$ cannot be rejected. This finding suggests that energy commodities (natural gas and crude petroleum) and agricultural commodities (wheat and paddy) are integrated across time, indicating that changes in energy market prices have a major impact on agriculture prices. Market connections and long-term equilibrium dynamics between the two sectors are supported by cointegration.

VECM Error Correction Term

Table 4.4: Error Correction Term (ECT) Results

Dependent Variable	ECT_1 Coefficient	t-Statistic	ECT_2 Coefficient	t-Statistic	Interpretation
ΔPaddy	-0.42	-3.21	-0.18	-2.05	Significant
ΔWheat	-0.36	-2.89	-0.22	-2.34	Significant
ΔCrude Oil	-0.15	-1.45	-0.08	-0.92	Not Significant

Business, Management and Economics Engineering
ISSN: 2669-2481 / eISSN: 2669-249X 2026
Volume 24 Issue 1: 1–8
DOI: https://doie.org/10.10399/BMEE.2026849644

ΔNatural Gas	-0.12	-1.21	-0.05	-0.67	Not Significant

Table 4.5: Short-Run Dynamics (Lagged Differences)

Dependent Variable	ΔPaddy(-1)	ΔWheat(-1)	ΔCrude(-1)	ΔGas(-1)	Key Finding
ΔPaddy	0.21	0.18	0.32	0.11	Energy → Agriculture
ΔWheat	0.25	0.29	0.27	0.14	Strong own + energy effect
ΔCrude Oil	0.05	0.08	0.41	0.22	Own dominance
ΔNatural Gas	0.03	0.06	0.19	0.38	Energy internal linkage

In order to account for both short-term dynamics and long-term equilibrium adjustments between agricultural and energy commodity prices, the Vector Error Correction Model (VECM) was estimated. For agricultural commodities (wheat and paddy), the error correction term coefficients are statistically significant and negative, suggesting that long-term equilibrium deviations are gradually rectified. In particular, wheat and paddy adjust at rates of 36% and 42%, respectively, indicating rapid convergence toward equilibrium.
Energy commodities, such as natural gas and crude oil, on the other hand, have statistically insignificant adjustment coefficients, indicating that they are weakly exogenous and mainly function as system drivers. The short-run dynamics also show that agricultural prices are greatly impacted by energy price shocks, but there are still little feedback effects from agriculture to energy markets. Overall, the findings corroborate the theory of cross-market connections and price transmission mechanisms by confirming the existence of long-run integration and unidirectional causality from energy to agriculture.

DCC-GARCH Correlation

Table 4.6: Volatility Estimates

Variable	ω (Constant)	α (ARCH)	β (GARCH)	α+β	Volatility Persistence
Paddy	0.0021	0.18	0.76	0.94	High
Wheat	0.0018	0.21	0.73	0.94	High
Crude Oil	0.0035	0.26	0.70	0.96	Very High
Natural Gas	0.0042	0.29	0.68	0.97	Very High

All variables show **high volatility persistence (α + β ≈ 1)**. Energy markets exhibit **higher volatility clustering**. Confirms suitability for DCC-GARCH modeling

Table 4.7: DCC Parameters

Parameter	Value	Interpretation
α (DCC)	0.042	Short-run shock effect

Business, Management and Economics Engineering
ISSN: 2669-2481 / eISSN: 2669-249X 2026
Volume 24 Issue 1: 1–8
DOI: https://doie.org/10.10399/BMEE.2026849644

β (DCC)	0.931	Long-run persistence
α + β	0.973	Highly persistent correlation

Table 4.8: Dynamic Conditional Correlation (DCC) Results

Pair	Average Correlation	Nature of Relationship
Paddy – Crude Oil	0.62	Strong Positive
Wheat – Crude Oil	0.68	Strong Positive
Paddy – Natural Gas	0.48	Moderate Positive
Wheat – Natural Gas	0.52	Moderate Positive

The dynamic correlations and volatility spillover between the energy and agricultural commodity markets were investigated using the DCC-GARCH model. High volatility persistence is seen in all series, especially in energy commodities like natural gas and crude oil, according to the univariate GARCH results. Conditional correlations appear to be quite persistent and react slowly to market shocks, according to the estimated DCC parameters ($\alpha = 0.042$, $\beta = 0.931$). The results of the dynamic correlation show that energy and agricultural commodities have a substantial positive link, particularly between wheat and crude oil. These results demonstrate that there is substantial volatility spillover from energy to agricultural markets, suggesting that changes in energy prices are a major factor in determining the stability of agricultural prices. Further evidence that market integration gets stronger during uncertain economic times comes from the correlations' time-varying character.

Results and Conclusion

The empirical findings show that after first differencing, all of the chosen variables—crude oil, natural gas, wheat, and paddy—become stationary and are integrated of order one, I(1). The Johansen cointegration test demonstrates a robust and stable relationship between energy and agricultural commodity prices in India by confirming the existence of two long-run equilibrium relationships. Additionally, the Vector Error Correction Model (VECM) demonstrates that agricultural commodities considerably shift toward long-run equilibrium, with wheat and paddy correcting deviations at comparatively fast rates. Energy commodities, on the other hand, exhibit poor exogenous variable behaviour, suggesting that they serve as the system's main drivers. This conclusion is further supported by the short-run dynamics, which show that while feedback effects are still minimal, changes in energy costs have a substantial impact on agricultural prices.

Strong volatility persistence is shown across all variables, especially in energy markets, which show stronger volatility clustering, according to the DCC-GARCH study. The computed dynamic conditional correlations show moderate correlations with natural gas and a high positive link between crude oil and agricultural commodities, particularly wheat. Significant volatility spillover effects from energy to agricultural markets are confirmed by these findings. Additionally, the correlations' time-varying nature implies that these connections get stronger during uncertain economic times, suggesting greater market integration and the spread of shocks across industries.

The concludes that India's energy and agricultural commodity markets are strongly and consistently interdependent. While the VECM results show that agricultural prices considerably change to restore equilibrium when deviations occur, the existence of long-run cointegration demonstrates that these markets move together over time. Energy commodities, especially

natural gas and crude oil, are found to be important motivators that have a big impact on changes in agricultural prices. Energy costs play a crucial role in setting agricultural production expenses and overall pricing behaviour, as demonstrated by the evidence of unidirectional causality from energy to agriculture.

Additionally, the DCC-GARCH results show that there are significant and long-lasting volatility spillovers from energy to agriculture markets, with dynamic correlations become stronger during uncertain economic times. This suggests that energy market shocks might transfer risk and instability to the agricultural sector, decreasing the efficacy of diversification tactics. Overall, the study highlights how crucial it is to keep a careful eye on changes in energy prices while developing agricultural policies and managing risks. It recommends that in order to maintain stability in agriculture markets and the overall economy, authorities and market players should implement measures to lessen the negative consequences of energy price volatility.

References

Baffes, J. (2007). Oil spills on other commodities. Resources Policy, 32(3), 126–134.

Barbaglia, L., Croux, C., & Wilms, I. (2020). Volatility spillovers in commodity markets: A large t-vector autoregressive approach. Energy Economics, 85, 104555. https://doi.org/10.1016/j.eneco.2019.104555

Dahl, R. E., Oglend, A., & Yahya, M. (2020). Volatility spillovers in commodity markets: New evidence from energy and agricultural sectors. Energy Economics, 85, 104559. https://doi.org/10.1016/j.eneco.2019.104559

Diebold, F. X., & Yilmaz, K. (2012). Better to give than to receive: Predictive directional measurement of volatility spillovers. International Journal of Forecasting, 28(1), 57–66. https://doi.org/10.1016/j.ijforecast.2011.02.006

Diebold, F. X., & Yilmaz, K. (2014). On the network topology of variance decompositions: Measuring the connectedness of financial firms. Journal of Econometrics, 182(1), 119–134. https://doi.org/10.1016/j.jeconom.2014.04.012

Etienne, X. L., Trujillo-Barrera, A., & Hoffman, L. A. (2017). Volatility Spillover and Time-Varying Conditional Correlation Between DDGS, Corn, and Soybean Meal Markets. Agricultural and Resource Economics Review, 46(3), 529–554. https://doi.org/10.1017/age.2016.44

Gohin, A., & Chantret, F. (2010). The long-run impact of energy prices on world agricultural markets: The role of macro-economic linkages. Energy Policy, 38(1), 333-339.

Han, L., Jin, J., Wu, L., & Zeng, H. (2020). The volatility linkage between energy and agricultural futures markets with external shocks. International Review of Financial Analysis, 68, 101317.

Hung, N. T. (2021). Oil prices and agricultural commodity markets: Evidence from pre and during COVID-19 outbreak. Resources policy, 73, 102236.

Mishra, A. K., Mishra, A. K., Anand, K., & Ranjan, S. (2025). Risk spillovers between crude oil and agricultural commodities in India: Insights from two major global disruptions. European Review of Agricultural Economics, 52(3), 494-530.

Pal, D., & Mitra, S. K. (2017). Time-frequency contained co-movement of crude oil and world food prices: A wavelet-based analysis. Energy Economics, 62, 230-239.

Shahani, R., & Taneja, A. (2022). Dynamics of volatility behaviour and spillover from crude to energy crops: Empirical evidence from India. Energy Nexus, 8, 100152. https://doi.org/10.1016/j.nexus.2022.100152

Umar, Z., Jareño, F., & Escribano, A. (2021). Dynamic return and volatility connectedness for dominant agricultural commodity markets during the COVID-19 pandemic. Research in International Business and Finance, 56, 101314. https://doi.org/10.1016/j.ribaf.2020.101314

Von Braun, J., & Tadesse, G. (2012). Global food price volatility and spikes: an overview of costs, causes, and solutions.

Zhang, Y. J., & Qu, F. (2015). The impact of oil price shocks on China's agricultural commodity markets. Energy Economics, 51, 149–160. https://doi.org/10.1016/j.eneco.2015.06.013