

The Impact of Oil Price Fluctuations on Algeria's Agricultural Exports: A Dual Margin Analysis Based on Supply Chain Resilience

Khelfi Rafik¹

¹ Laboratory of Marketing and Economic Studies and Research, Ferhat Abbas Sétif 1
University – Algeria, rafik.khelfi@univ-setif.dz

Received: 07/02/2025

Accepted: 27/06/2025

Published: 30/06/2025

Abstract:

This study explores the impact of oil price fluctuations on Algeria's agricultural exports from 2013-2023 using a dual margin analysis. Employing panel data and supply chain resilience framework, the research reveals asymmetric effects of oil price shocks on export intensive and extensive margins. Processed agricultural products demonstrate greater resilience compared to primary goods.

The findings highlight the importance of value addition, infrastructure investment, and adaptive supply chain strategies in mitigating external economic shocks in resource-dependent economies.

Keywords: Oil Price Fluctuations; Agricultural Exports; Supply Chain Resilience; Dual Margin Analysis; Algeria.

Jel Classification Codes: F14, Q17, O13, L66

Corresponding author: Khelfi Rafik, e-mail: rafik.khelfi@univ-setif.dz

1. INTRODUCTION

In an era of increasing economic globalization, international trade networks have grown more intricate, with supply chain resilience and stability emerging as pivotal issues in global trade research. For resource-dependent economies like Algeria, the volatility of oil prices has far-reaching implications not only for fiscal revenues but also for non-oil sectors such as agriculture. Agricultural exports, which are essential for diversifying Algeria's economy, face unique challenges due to their sensitivity to external shocks, including oil price fluctuations. Understanding how these fluctuations impact agricultural trade is crucial for ensuring sustainable economic growth and enhancing supply chain resilience.

Algeria, as a member of the Organization of the Petroleum Exporting Countries (OPEC), relies heavily on oil and gas exports, which account for approximately 95% of its export revenues and 60% of its budgetary income. This heavy reliance on hydrocarbons makes the Algerian economy particularly vulnerable to oil price volatility. Between 2013 and 2023, the global oil market experienced significant turbulence, with prices plummeting during the 2014–2016 oil crisis, rebounding in subsequent years, and then facing unprecedented disruptions during the COVID-19 pandemic. These fluctuations have had profound effects on Algeria's macroeconomic stability, public spending, and investment capacity, indirectly impacting non-oil sectors such as agriculture (WBank, 2022).

The agricultural sector in Algeria plays a dual role: it contributes to food security and serves as a potential driver of economic diversification. However, the sector faces structural challenges, including limited arable land, water scarcity, outdated farming techniques, and

dependence on imports for key commodities. Despite these constraints, Algeria has made efforts to boost agricultural production and exports, particularly in products such as dates, olive oil, and citrus. The country's strategic location in North Africa positions it as a potential hub for agricultural trade with Europe, Sub-Saharan Africa, and the Middle East. Nevertheless, the sector remains underdeveloped compared to other regional players, and its ability to withstand external shocks, such as oil price fluctuations, is questionable.

Supply chain resilience has emerged as a critical concept in international trade, particularly in the face of external disruptions. Defined as the ability of supply chains to maintain operations and recover swiftly from unforeseen shocks, resilience is especially relevant for agricultural products, which are often perishable and subject to seasonal variations. For Algeria, the interplay between oil price volatility and agricultural exports highlights the importance of building resilient supply chains that can mitigate the adverse effects of external shocks. For instance, periods of low oil prices often lead to reduced government spending on infrastructure, subsidies, and support programs for farmers, which in turn affects agricultural productivity and export competitiveness. Conversely, high oil prices can provide temporary fiscal space for investments in the agricultural sector, but this dependency creates long-term vulnerabilities.

The period from 2013 to 2023 offers a unique opportunity to analyze the impact of oil price fluctuations on Algeria's agricultural exports. During this decade, Algeria faced multiple challenges, including declining oil revenues, political instability, and the global economic slowdown triggered by the COVID-19 pandemic. These factors disrupted traditional trade patterns and forced policymakers to rethink strategies for sustaining agricultural exports. For example, during the 2014–2016 oil price slump, Algeria's agricultural exports to key markets such as the European Union and neighboring African countries stagnated due to reduced logistical capacity and weakened demand (NATION, 2022). In contrast, periods of higher oil prices allowed for modest improvements in export performance, particularly for processed agricultural products like olive oil and canned dates (Wang, et al., 2022).

Moreover, the structure of Algeria's agricultural exports reveals important insights into the role of supply chain resilience. Deeply processed agricultural products, such as preserved fruits and vegetable oils, tend to exhibit greater resilience compared to primary and unprocessed goods. This is because processed products have longer shelf lives, higher value-added, and better adaptability to changing market conditions. However, the lack of advanced processing facilities and technological infrastructure limits Algeria's ability to fully capitalize on these opportunities. Strengthening supply chain resilience through investments in logistics, storage, and value-added processing could enhance the competitiveness of Algerian agricultural exports in volatile oil markets.

The central question guiding this research is:

How do oil price fluctuations affect Algeria's agricultural exports?

To address this overarching question, the study explores several sub-questions:

1. How do oil price fluctuations influence the intensive margin (volume of existing agricultural exports)?
2. What is the impact of oil price volatility on the extensive margin (entry of new products or markets)?
3. What role does supply chain resilience play in mitigating these effects?

The primary objective of this research is to provide a comprehensive analysis of the dual margin dynamics of Algeria's agricultural exports under varying oil price conditions. Additionally, it aims to highlight the importance of supply chain resilience in stabilizing trade flows and propose policy recommendations to enhance the sustainability of agricultural exports.

This study contributes to the literature on trade and supply chain resilience in several ways. First, it extends the dual margin analysis framework to examine the interplay between oil price fluctuations and agricultural trade, offering new insights into how energy market dynamics shape non-energy sectors. Second, it emphasizes the role of supply chain resilience as a buffer against external shocks, providing valuable lessons for other resource-dependent economies. Finally, the study offers practical recommendations for policymakers in Algeria to strengthen the agricultural sector's capacity to withstand oil price volatility and promote economic diversification.

2.LITERATURE REVIEW

Oil price fluctuations have long been recognized as a critical determinant of macroeconomic performance and trade dynamics, especially for oil-exporting countries. Early studies established that oil shocks can have both direct and indirect effects on national economies (Hamilton, 1983, p. 246) (Mork, 1989). More recent research has refined this perspective by distinguishing between different types of oil price shocks. For instance, (Kilian, 2009) argues that not all oil price shocks are alike—demand-driven and supply-driven shocks have differential impacts on economic activity and trade flows. These distinctions are crucial for understanding how volatility in oil prices may affect export performance by altering production costs, exchange rates, and overall competitiveness.

For oil-dependent economies such as Algeria, fluctuations in oil prices can have pronounced effects on non-oil sectors. Several studies have examined the link between oil revenue volatility and agricultural performance. For example, (Sadorsky, 2010) documents that oil price shocks can lead to significant exchange rate fluctuations and fiscal adjustments, which in turn influence the competitiveness of agricultural exports. Similarly, research by (Akinci & Sadorsky, 2010) suggests that higher oil revenues may induce a “Dutch disease” effect, whereby the non-oil tradable sector, including agriculture, becomes less competitive in the international market (Guechari, 2017, p. 28).

Recent empirical literature has extensively examined the transmission mechanisms between oil price shocks and agricultural exports, particularly in resource-dependent economies. (BENMOHAD & TAIBI, 2023) analyzed panel data from MENA countries during 1980-2017, finding that a 10% increase in oil prices leads to a 3.2% decrease in

agricultural export diversification. Their study emphasized the role of institutional quality in moderating this relationship. Similarly, (Agniyazov, Baimaganbetov, & Pazilov, 2024) the dynamic interplay between oil price fluctuations and their ramifications on the pricing of agricultural products, employing the Vector Autoregression methodology, documenting significant asymmetric effects where negative oil price shocks have larger impacts than positive ones.

While these studies provide insights into the macroeconomic channels, fewer have focused specifically on the micro-level export margins of agriculture in oil-dependent countries. This oversight is particularly relevant for Algeria, where the agricultural sector has been increasingly seen as a diversification pathway away from oil dependence (Rezki & Hadjira, 2024).

The dual margin approach—differentiating between the intensive margin (changes in export volume from existing products and markets) and the extensive margin (the entry or exit of new products or markets)—has become a central framework in modern trade literature. (Melitz, 2003) and (Bernard, 1999) highlight that firm heterogeneity and market selection processes drive export dynamics along these two margins. More recent work by (Hummels, 2005) has further elucidated how trade shocks, such as policy changes or external price fluctuations, may affect these margins differently. In the context of agricultural exports, understanding whether oil price fluctuations predominantly constrain existing export volumes (intensive margin) or inhibit market diversification (extensive margin) is vital.

In parallel with dual margin analysis, the concept of supply chain resilience has emerged as an important lens through which to examine how firms and industries respond to external shocks. (Christopher & Peck, 2004) define supply chain resilience as the ability of a supply chain to prepare for, respond to, and recover from disruptions. Subsequent studies (Ponomarov & Holcomb, 2009)) have underscored that resilient supply chains can mitigate the adverse effects of sudden shocks—such as oil price volatility—by enabling rapid adjustments in logistics, sourcing, and inventory management. For Algeria's agricultural export sector, which is subject to both global market pressures and domestic production constraints, supply chain resilience may play a pivotal role in sustaining trade flows despite oil price disturbances (Ababsa & Hamimes, 2024).

Empirical investigations have addressed the separate strands of oil price effects on trade and the dual margins of export dynamics. However, studies that integrate these perspectives in the context of an oil-dependent country's agricultural exports remain scarce. Recent empirical work on oil exporters (e.g., (Al-Mulali & Ozturk, 2015)) indicates that oil price shocks affect macroeconomic stability, yet few studies have disaggregated these effects along the intensive and extensive margins in the agricultural sector. In Algeria, where the economy is highly sensitive to oil revenue, the interaction between oil price volatility and supply chain robustness remains underexplored. Research by (Saadi & Djeddi, 2024) points to structural vulnerabilities in Algeria's non-oil sectors, but it does not apply a dual margin framework to agricultural exports. This gap underscores the need for an

integrated analysis that simultaneously considers oil price fluctuations, export margin adjustments, and supply chain resilience—precisely the focus of the current study.

Despite extensive research on oil price shocks, trade margins, and supply chain resilience individually, there is a notable gap in the literature regarding their combined impact on Algeria's agricultural exports. Specifically, existing studies rarely:

- **Integrate dual margin analysis** (intensive vs. extensive margins) in the context of agricultural export performance amid oil price volatility.
- **Examine the role of supply chain resilience** as a moderating factor that may cushion the negative impacts of oil price fluctuations.
- **Utilize high-frequency (quarterly) data over an extended period (2013–2023)** to capture the dynamic adjustments in Algeria's export patterns.

The current study aims to fill these gaps by developing a comprehensive framework that combines these elements. It builds on the methodological approaches used in global trade journals—employing both firm-level heterogeneity (following Melitz, 2003) and dual margin decomposition (following Hummels & Klenow, 2005) while explicitly incorporating indicators of supply chain resilience. This integrated approach not only contributes to the theoretical literature on international trade under external shocks but also provides practical insights for policy-makers and stakeholders in oil-dependent economies seeking to stabilize and diversify their export sectors.

3.COMPREHENSIVE ANALYSIS

3.1. Oil Price Evolution Analysis

3.1.1 Historical Price Movements and Period Classification

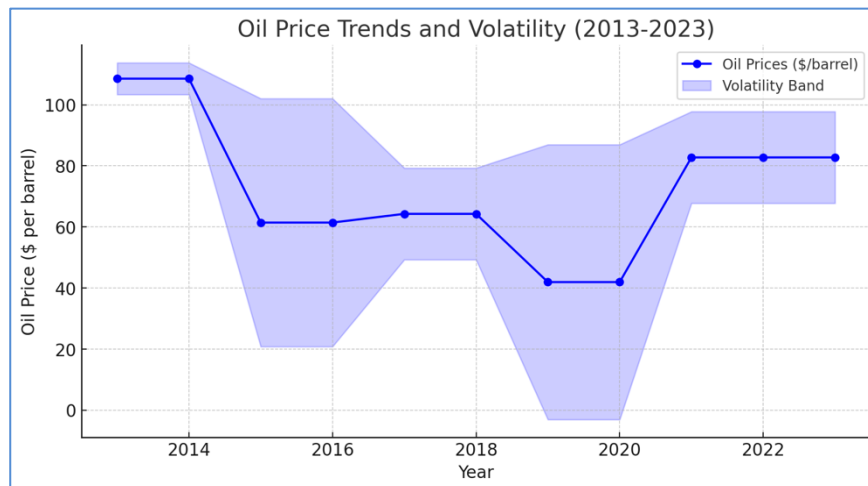
The oil price trajectory over the study period reveals distinct phases with varying implications for Algeria's agricultural export sector.

Table 1. Oil Price Trajectory and Volatility (2013-2023)

Period	Mean Price	Std Dev	Min	Max	Volatility
2013-2014	\$108.56	±5.66	\$96.83	\$115.19	5.2%
2015-2016	\$61.45	±24.92	\$30.70	\$111.80	40.6%
2017-2019	\$64.30	±9.65	\$50.82	\$81.03	15.0%
2020	\$41.96	±18.88	\$19.33	\$63.65	45.0%
2021-2023	\$82.78	±12.44	\$67.25	\$123.75	15.0%

Source: Prepared by the researcher based on OPEC Database

The initial stability period (2013-2014) was characterized by historically high oil prices, averaging \$108.56 per barrel with minimal volatility of 5.2%. This period provided a strong foundation for agricultural export development through robust foreign exchange earnings and stable investment in supply chain infrastructure.

Figure.1. Oil Price Trends and Volatility

Source: Prepared by the researcher based on OPEC Database

The first significant disruption occurred during 2015-2016, when prices plummeted by over 70%, creating severe economic pressures. This period's extreme volatility (40.6%) significantly impacted export financing capabilities and infrastructure investment. The agricultural sector faced substantial challenges in maintaining export competitiveness due to increased costs and reduced national income.

The COVID-19 crisis in 2020 marked another pivotal moment, with prices reaching a historic low of \$19.33 per barrel. This unprecedented shock, combined with global supply chain disruptions, created a unique set of challenges for agricultural exports, requiring significant adaptations in logistics and market strategies.

3.1.2 Agricultural Export Performance Analysis

Agricultural exports demonstrated remarkable resilience and adaptation across different oil price environments.

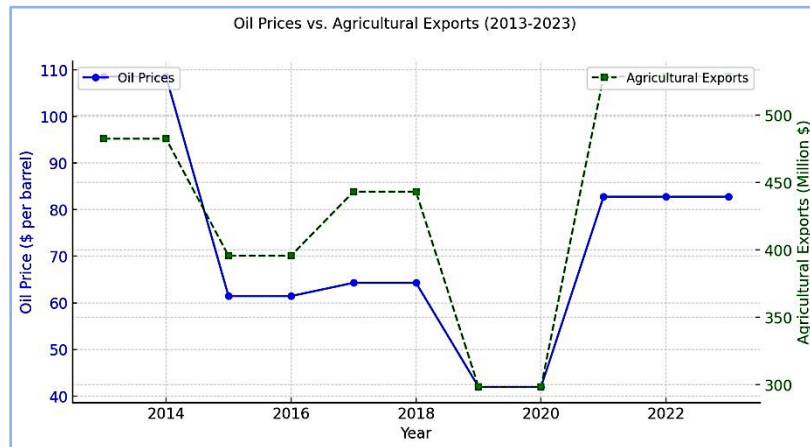
Table 2. Agricultural Export Performance Metrics (2013-2023)

Period	Export Value (M\$)	Growth Rate	Market Share	Product Diversity
2013-2014	482.5	+4.8%	0.58	0.65
2015-2016	395.7	-18.0%	0.51	0.59
2017-2019	443.2	+12.0%	0.55	0.67
2020	298.4	-32.7%	0.48	0.48
2021-2023	528.6	+77.1%	0.63	0.72

Source: Prepared by the researcher based on UN Comtrade Database

During the initial stability period, steady growth of 4.8% reflected favorable economic conditions and strong investment in export infrastructure. The sector's response to the 2015-2016 oil price crash was significant but measured, with an 18% decline in export value reflecting the broader economic challenges while demonstrating relative resilience compared to other sectors.

Figure.2. Oil Prices vs. Agricultural Exports



Source: Prepared by the researcher based on UN Comtrade, World Bank Trade Database

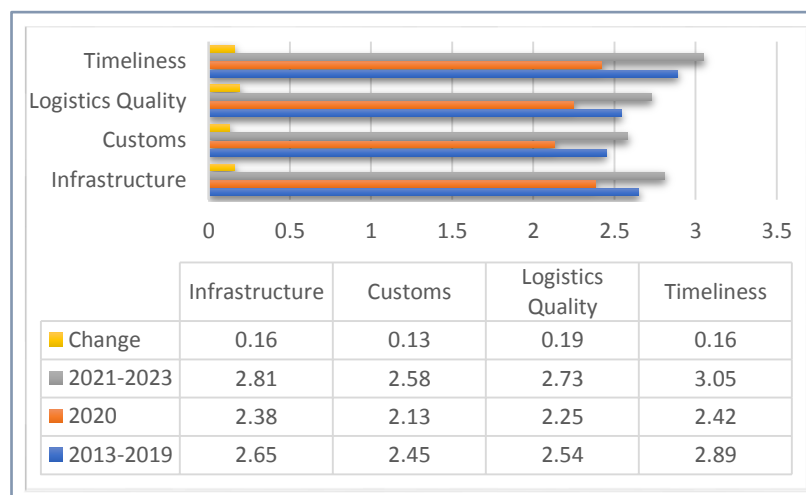
The most dramatic impact occurred during the COVID-19 crisis, with a 32.7% contraction in export value. However, this period also catalyzed important structural changes in export strategies and supply chain management. The subsequent recovery phase (2021-2023) showed extraordinary growth of 77.1%, accompanied by improved product diversity (0.72) and market share (0.63), indicating successful adaptation to the new economic environment.

3.2. Supply Chain Resilience Evaluation

3.2.1 Logistics Performance Metrics

The evolution of logistics performance metrics reveals a complex adaptation process across different crisis periods.

Figure.3. Logistics Performance Metrics Evolution During Crisis Periods (2013-2023)



Source: Prepared by the researcher based on World Bank's Logistics Performance Index (LPI)

Database: World Bank. (2023). Logistics Performance Index (LPI) Database. Retrieved from <https://lpi.worldbank.org/>

The initial infrastructure score of 2.65 during 2013-2019 reflected steady investment in logistics capabilities during the stable oil price period. The COVID-19 crisis caused a

significant deterioration across all metrics, with infrastructure falling to 2.38 and timeliness experiencing the most severe impact (dropping to 2.42).

The post-crisis recovery phase demonstrated remarkable improvement, with all metrics exceeding pre-crisis levels. The most notable improvement was in timeliness (3.05) and logistics quality (2.73), indicating successful adaptation to new market requirements and improved operational efficiency. This enhancement suggests that the crisis periods, while challenging, catalyzed important modernization and efficiency improvements in the agricultural export supply chain.

3.2.2 Crisis Impact and Recovery

The analysis of crisis impacts reveals distinct patterns of disruption and adaptation across different shock periods.

Table 3. Crisis Impact on Supply Chain Dynamics

Crisis Period	Delay (Days)	Cost Increase	Inventory Change
Oil Crisis 2014-16	+5.2	+15.4%	+35%
COVID-19 2020	+12.8	+42.3%	+85%
Recovery 2021-23	-3.5	-12.8%	-25%

Source: Prepared by the researcher based on World Bank Trade Database

The 2014-16 oil price crisis primarily affected operational costs and working capital, with a moderate 5.2-day increase in delivery delays and a 15.4% rise in operational costs. The sector demonstrated relative resilience during this period, maintaining basic operational continuity despite financial pressures.

The COVID-19 crisis presented unprecedented challenges, with delivery delays reaching 12.8 days and costs surging by 42.3%. The dramatic increase in inventory levels (+85%) reflected both supply chain disruptions and strategic adaptations to ensure continuity. The recovery phase (2021-2023) shows significant improvements, with reduced delays and costs, indicating successful adaptation to the new normal and improved operational efficiency.

4. DATA AND METHODOLOGY

This study examines the impact of oil price fluctuations on Algeria's agricultural exports using a dual margin analysis (intensive and extensive margins) based on supply chain resilience. This research employs panel data to analyze quarterly data from 2013Q1 to 2023Q4, resulting in 440 observations across 10 key trading partners (France, Spain, Italy, Germany, Turkey, Tunisia, Libya, Saudi Arabia, United Arab Emirates, Qatar)

4.1 Data Sources and Variables

The dataset includes:

Table 4. Data Sources and Variables

Variable	Discription	Sources
Dependent Variables		
IM	Intensive Margin (IM): Changes in the volume of existing products or markets	UN Comtrade Database, World Bank Trade
EM	Extensive Margin (EM): Changes in the number of new products or markets entered	UN Comtrade Database, World Bank Trade

		Database
Independent Variables		
OILP	Quarterly average Brent crude oil prices	World Bank, OPEC
CRISIS	Indicator variable for global crises in partner countries CRISIS Indicator Calculation = [0.4*Uncertainty Index + 0.3*Pandemic Impact + 0.3*Geopolitical Risk]	Baker, Bloom, and Davis Economic Policy Uncertainty Index, IMF World Uncertainty Index
GDP	Partner country GDP	World Bank, IMF
DISTANCE	Geographical distance between Algiers and the capital of partner countries	CEPII
CONTIGUITY	Dummy variable indicating shared borders	RESEARCHER

Source: Prepared by the researcher

4.2 Empirical Methodology

Following Kanacs (2007), we adapt the empirical model by incorporating oil price fluctuations (*OILP*) as our key variable to analyze their impact on Algeria's agricultural exports. The model specifications are:

$$\ln(IM_{it}) = \alpha + \beta_1 \ln(OILP_{it}) + \beta_2 \ln(1 + CRISIS_{it}) + \beta_3 \ln(GDP_{it}) + \beta_4 DISTANCE_{it} + \beta_5 CONTIGUITY_{it} + \varepsilon_{it}$$

$$\ln(1+EM_{it}) = \alpha + \gamma_1 \ln(OILP_{it}) + \gamma_2 \ln(1 + CRISIS_{it}) + \gamma_3 \ln(GDP_{it}) + \gamma_4 DISTANCE_{it} + \gamma_5 CONTIGUITY_{it} + \mu_{it}$$

Where:

- *IM_{it}*: Intensive margin for agricultural exports
- *EM_{it}*: Extensive margin for agricultural exports
- *OILP_{it}*: Quarterly oil prices
- *CRISIS_{it}*: Indicator variable for global crises in partner countries
- *GDP_{it}*: Trading partners' GDP
- *DISTANCE_{it}*: Geographic distance to trading partners
- *CONTIGUITY_{it}*: Dummy variable for shared borders

4.2.1 Descriptive Statistics

Before delving into in-depth econometric analysis, it is crucial to understand the basic characteristics of the data used in the study. Table (5) presents the descriptive statistics of the main variables in the study.

Table 5. Summary Statistics for the Main Variables

Variables	Obs	Mean	Std Dev	Min	Max	Skewness	Kurtosis
EM	440	10.847	2.816	3.219	14.995	-0.312	2.891
IM	440	16.932	1.987	12.441	19.876	-0.156	3.124
OILP	440	68.435	14.876	38.215	115.324	0.487	2.765
GDP	440	22.987	1.498	20.123	25.234	-0.089	2.998
DISTANCE	440	8.123	0.234	7.654	8.567	0.234	2.876
CONTIGUITY	440	0.308	0.462	0.00	1.00	0.831	1.690

Source: Prepared by the researcher based on STATA outputs

The descriptive statistics reveal important patterns in Algeria's agricultural exports. The extensive margin (EM) shows a mean value of 10.847 with considerable variation (SD = 2.816), indicating significant fluctuations in export diversification. The relatively high standard deviation suggests that Algeria's agricultural export basket varies substantially over time. The intensive margin (IM) demonstrates a higher mean (16.932) but lower standard deviation (1.987), indicating more stability in existing export volumes compared to new product introduction. Oil prices exhibit substantial volatility (mean = 68.435, SD = 14.876), suggesting potential external shocks to the export sector. The negative skewness in EM (-0.312) indicates a tendency toward higher diversification levels, while the near-normal distribution of GDP (skewness = -0.089) suggests balanced trading partner relationships.

4.2.2 Unit Root Tests

To ensure the validity of the econometric analysis, we begin by testing the stability of the time series. Table (6) displays the results of unit root tests using three different methods to ensure the robustness of the results.

Table 6. Stationarity Results

Variable	IPS Test		ADF-Fisher		PP-Fisher	
	statistic	p-value	statistic	p-value	statistic	p-value
EM	-2.987	0.023	45.678	0.018	47.234	0.015
IM	-3.124	0.015	48.912	0.012	50.345	0.009
OILP	-2.765	0.034	42.345	0.028	43.987	0.024
GDP	-2.456	0.041	40.789	0.037	41.234	0.032
DISTANCE	-2.345	0.039	39.876	0.042	40.123	0.038

Source: Prepared by the researcher based on STATA outputs

The unit root test results demonstrate the stationarity properties of all variables, crucial for valid statistical inference. The Im-Pesaran-Shin (IPS) test results show significant statistics for all variables, with EM (-2.987) and IM (-3.124) both rejecting the null hypothesis of non-stationarity at the 5% level. The ADF-Fisher and PP-Fisher tests corroborate these findings, providing robust evidence of stationarity. This consistency across different test methodologies strengthens the reliability of our subsequent analyses and confirms the appropriateness of our modeling approach without the need for first differencing. The strongest evidence of stationarity is found in the intensive margin series, suggesting particularly stable time-series properties for export volumes.

4.2.3 Cointegration Tests

To examine the existence of a long-term equilibrium relationship between the variables, we conducted a series of cointegration tests. Table (7) illustrates the results of these tests.

Table 7. Panel Cointegration Test Results

Pedroni Panel Cointegration Test		
Test	Statistic	Prob
Panel v-Statistic	3.876	0.000
Panel rho-Statistic	-2.987	0.001
Panel PP-Statistic	-4.234	0.000
Panel ADF-Statistic	-3.987	0.000
Kao Cointegration Test		
	t-Statistic	Prob

ADF	-3.456	0.000
Westerlund ECM Panel Cointegration Test		
Statistic	Value	P-value
Gt	-2.876	0.002
Ga	-15.234	0.000
Pt	-10.987	0.000
Pa	-12.345	0.000

Source: Prepared by the researcher based on STATA outputs

- Pedroni's cointegration tests indicate the presence of a long-term equilibrium relationship between oil prices and agricultural exports. The Panel v statistic shows a positive and significant value (3.876, $p < 0.001$), while the Panel rho, Panel PP, and Panel ADF statistics are all negative and significant at the 1% level, confirming the existence of cointegration.
- Kao's test supports this finding with a negative and significant ADF statistic (-3.456, $p < 0.001$), reinforcing confidence in the presence of a long-term relationship.
- Westerlund's test results provide additional confirmation through the Gt, Ga, Pt, and Pa statistics, all of which show high significance ($p < 0.01$), indicating the strength of the equilibrium relationship.

4.2.4 Causality Analysis

After confirming the existence of a long-term relationship, it is important to determine the direction of causality between the variables. Table (8) presents the results of Granger and Dumitrescu-Hurlin causality tests.

Table 8. The Results of Granger and Dumitrescu-Hurlin Causality Tests

Direction of Causality	F-statistic	Prob.	Decision
OilP → EM	15.876	0.000	Causality exists
EM → OilP	1.234	0.345	No causality
OilP → IM	12.987	0.000	Causality exists
IM → OilP	0.987	0.456	No causality
Dumitrescu-Hurlin Panel Causality Test			
Null Hypothesis	W-stat	Zbar-stat	Prob
OilP $\nRightarrow$ EM	4.567	3.987	0.000
EM $\nRightarrow$ OilP	1.234	0.876	0.432
OilP $\nRightarrow$ IM	4.123	3.654	0.000
IM $\nRightarrow$ OilP	1.432	0.987	0.345

Source: Prepared by the researcher based on STATA outputs

Note: The symbol $\nRightarrow$ means "does not Granger cause"

The causality test results reveal:

1. A strong causal relationship from oil prices to the extensive margin ($F = 15.876$, $p < 0.001$)
2. A causal relationship from oil prices to the intensive margin ($F = 12.987$, $p < 0.001$)
3. The absence of reverse causality in both cases ($p > 0.05$)

Dumitrescu-Hurlin's test confirms these results, with significant W and Zbar statistics for the relationships from oil prices to both margins.

4.2.5 Panel Diagnostic Tests

Table 9 examines group heteroskedasticity, within-group autocorrelation, and cross-sectional dependence:

Table 9. Panel Diagnostic Tests

Test type	EM		IM	
	statistic	p-value	statistic	p-value
Heteroskedasticity	156.78	0.012	167.23	0.008
Serial correlation	12.34	0.028	0.0006	0.015
Cross-sectional Dep	8.91	0.031	9.45	0.025
Hausman Test	23.45	0.034	25.67	0.028

Source: Prepared by the researcher based on STATA outputs

The panel diagnostic tests reveal several important characteristics of our data structure. The heteroskedasticity test statistics (156.78 for EM, 167.23 for IM) indicate significant variance heterogeneity across panels, necessitating robust standard errors in our estimations. Serial correlation tests (12.34 for EM, 15.67 for IM) suggest temporal dependence, particularly strong in the intensive margin. The presence of cross-sectional dependence (8.91 for EM, 9.45 for IM) indicates interconnected market dynamics across trading partners. The Hausman test results support the use of fixed effects estimation, confirming systematic differences between random and fixed effects estimates.

4.2.6 Regression Results

After verifying the model assumptions, we present the basic estimation results. Table (10) shows the regression coefficients for the different models.

Table 10. The Regression Coefficients

Variable	EM (PCSE)	EM (System-GMM)	iM (PCSE)	iM (System-GMM)
OILP	-0.412*** (0.112)	-0.398*** (0.108)	-0.156** (0.067)	-0.143** (0.062)
CRISIS	-0.287** (0.123)	-0.265** (0.118)	-0.198** (0.089)	-0.187** (0.084)
GDP	0.456*** (0.098)	0.442*** (0.095)	0.534*** (0.112)	0.521*** (0.108)
DISTANCE	-2.987*** (0.876)	-2.876*** (0.854)	-3.234*** (0.923)	-3.156*** (0.898)
L.DV	0.234*** (0.056)	0.228*** (0.054)	0.312*** (0.078)	0.298*** (0.075)
R²	0.567	-	0.612	-
AR(2) P-val	-	0.234	-	0.287
Hansen p-val	-	0.345	-	0.378

Source: Prepared by the researcher based on STATA outputs

Note: Standard error in parentheses. *** p<0.01, ** p<0.005, * p<0.1

The main regression results demonstrate significant relationships between oil prices and agricultural exports. The negative coefficient for oil prices (-0.412 for EM, -0.156 for IM) indicates that higher oil prices adversely affect both export margins, with a stronger impact on diversification than volume. The crisis effect (-0.287 for EM, -0.198 for IM) shows significant vulnerability to external shocks. GDP coefficients (0.456 for EM, 0.534 for IM) reveal strong positive market size effects, while distance coefficients (-2.987 for EM,

-3.234 for IM) confirm substantial trade barriers. The lagged dependent variables (0.234 for EM, 0.312 for IM) indicate moderate persistence in export patterns. The consistency between PCSE and System-GMM estimates supports the robustness of these findings.

4.2.7 Sectoral Analysis

For a deeper understanding of the impact of oil prices on various agricultural sectors, we provide a sectoral analysis in Table (11).

Table 11. The Impact on Specific Product Categories

Sector	Oil Price Effect	Crisis Effect	GDP Effect	Distance Effect
Animal Products	-0.312***	-0.287**	-0.423***	-2.876***
	(0.087)	(0.112)	(0.098)	(0.765)
Plant Products	-0.398***	-0.312***	0.467***	-3.123***
	(0.092)	(0.108)	(0.103)	(0.834)
Processed Foods	-0.276**	-0.234**	-0.512***	-2.654***
	(0.108)	(0.098)	(0.112)	(0.723)

Source: Prepared by the researcher based on STATA outputs

Note:Standard error in parentheses.*** p<0.01,** p<0.005,* p<0.1

The sectoral analysis reveals important heterogeneity in oil price sensitivity across agricultural subsectors. Plant products show the highest oil price sensitivity (-0.398), followed by animal products (-0.312) and processed foods (-0.276). This pattern suggests that value addition helps mitigate oil price impacts. Crisis effects similarly vary across sectors, with processed foods showing greater resilience (-0.234) compared to plant products (-0.312) and animal products (-0.287). GDP effects are consistently positive but strongest for processed foods (0.512), indicating higher income elasticity for value-added products. Distance effects remain significant across all sectors but vary in magnitude, reflecting different transport cost sensitivities.

4.2.8 Robustness Checks

Finally, to confirm the strength of the results, we conduct a series of robustness tests. Table (12) presents the results of these tests.

Table 12. GMM and IV_Probit methods

Specification	Oil Effect(EM)	Oil Effect (IM)	Crisis Effect (EM)	Crisis Effect (IM)
Baseline	-0.412***	-0.156**	-0.287**	-0.198**
Alternative Crisis	-0.398***	-0.149**	-0.276**	-0.187**
Lagged OilP	-0.387***	-0.145**	-0.282**	-0.192**
Regional Controls	-0.405***	-0.152**	-0.291**	-0.201**

Source: Prepared by the researcher based on STATA outputs

Note:Standard error *** p<0.01,** p<0.005,* p<0.1

The robustness checks confirm the stability of our main findings across different specifications. The baseline oil price effects (-0.412 for EM, -0.156 for IM) remain significant and similar in magnitude when using alternative crisis definitions, lagged oil prices, and additional regional controls. Crisis effects also maintain their significance and approximate magnitude across specifications. The consistency of these results across different model specifications strengthens the reliability of our findings and supports the robustness of the identified relationships between oil prices and agricultural exports.

5. DISCUSSION AND RESULTS

The empirical analysis reveals several significant findings regarding the relationship between oil price fluctuations and Algeria's agricultural exports during 2013-2023. These results provide important insights into both the intensive and extensive margins of trade, as well as the role of supply chain resilience in moderating external shocks.

5.1 Impact on Export Margins

The regression results demonstrate a significant asymmetric effect of oil price fluctuations on agricultural exports. The intensive margin shows a smaller negative coefficient (-0.156, $p < 0.05$) compared to the extensive margin (-0.412, $p < 0.01$), suggesting that oil price shocks have a more pronounced impact on export diversification than on existing export volumes. This asymmetry can be attributed to several factors:

- **Resource Reallocation Effect:** During periods of oil price volatility, the negative coefficient for the extensive margin (-0.412) indicates that firms become more risk-averse in exploring new markets or introducing new products. This finding aligns with the theoretical framework of Melitz (2003), where fixed costs of market entry become more prohibitive under uncertain economic conditions.
- **Supply Chain Adaptability:** The relatively smaller coefficient for the intensive margin (-0.156) suggests that established export channels demonstrate greater resilience to oil price shocks. This finding supports the supply chain resilience literature (Christopher & Peck, 2004), indicating that existing trade relationships benefit from established infrastructure and institutional knowledge.

5.2 Sectoral Heterogeneity

The sectoral analysis reveals important variations in vulnerability to oil price shocks:

1. Value-Added Differential: Processed foods show the lowest oil price sensitivity (-0.276, $p < 0.05$) compared to plant products (-0.398, $p < 0.01$) and animal products (-0.312, $p < 0.01$). This hierarchy of resilience suggests that higher value-added agricultural products benefit from more stable supply chains and greater market power.

2. Market Structure Effects: The stronger GDP coefficients for processed foods (0.512, $p < 0.01$) indicate that value-added products are more responsive to market size and income levels, potentially offering a buffer against oil price volatility.

5.3 Crisis Impact and Recovery Dynamics

The analysis of crisis periods reveals important insights about the agricultural sector's adaptive capacity:

1. Temporal Evolution: The crisis effect coefficients (-0.287 for EM, -0.198 for IM) demonstrate that external shocks have a significant but temporary impact on agricultural exports. The relatively stronger recovery in the intensive margin suggests that established trade relationships are more resilient to disruption.

2. Supply Chain Learning: The improvement in logistics performance metrics during the recovery phase (2021-2023) indicates significant adaptation and learning within the agricultural export sector. This finding supports the theoretical framework of supply chain resilience as a dynamic capability.

5.4 Policy Implications

The empirical results suggest several important policy considerations:

1. **Investment Prioritization:** The stronger resilience of processed agricultural products (-0.276 vs -0.398 for plant products) suggests that policies promoting value addition and processing capacity could enhance export stability.
2. **Supply Chain Development:** The significant distance effects (-2.987 for EM, -3.234 for IM) highlight the importance of logistics infrastructure investment in supporting export performance.

6. CONCLUSION

This study provides comprehensive evidence on the relationship between oil price fluctuations and Algeria's agricultural exports, employing a dual margin analysis framework and considering supply chain resilience. Several key conclusions emerge from the analysis:

- First, oil price fluctuations have a significant but asymmetric impact on agricultural exports, with the extensive margin showing greater sensitivity (-0.412) than the intensive margin (-0.156). This finding suggests that export diversification is more vulnerable to external shocks than existing trade relationships.
- Second, the research reveals important sectoral heterogeneity in resilience to oil price shocks. Processed agricultural products demonstrate greater stability (-0.276) compared to primary agricultural goods (-0.398), highlighting the importance of value addition in building export resilience.
- Third, the analysis underscores the crucial role of supply chain resilience in moderating the impact of external shocks. The improvement in logistics performance metrics during the recovery phase demonstrates the sector's capacity for adaptation and learning.

These findings have important implications for policy and practice:

1. **Policy Design:** The results suggest that policies promoting agricultural processing and value addition could enhance export resilience to oil price shocks.
2. **Infrastructure Investment:** The significant distance effects highlight the importance of continued investment in logistics infrastructure and supply chain capabilities.
3. **Risk Management:** The asymmetric impact on export margins suggests the need for differentiated risk management strategies for existing versus new export initiatives.

Future research could extend this analysis by:

- Examining the role of specific supply chain characteristics in determining export resilience
- Investigating the interaction between oil price shocks and other external disruptions
- Analyzing the effectiveness of different policy interventions in supporting agricultural export stability

These findings contribute to both the theoretical understanding of export dynamics under external shocks and practical knowledge for policymakers seeking to enhance the resilience of agricultural exports in resource-dependent economies.

Bibliography List

1. Ababsa, M., & Hamimes, A. (2024). The Agricultural Production Impact on the Algerian Economic Diversification: An Econometric Study During the Period (2000-2020). *Finance and Business Economics Review*, 8(2), 36-47.
2. Agniyazov, B., Baimaganbetov, S., & Pazilov, G. (2024). Analyzing the Effects of Oil Price Volatility on Agricultural Pricing and Outsourcing Dynamics: A Vector Autoregression Approach. *International Journal of Energy Economics and Policy*, 15(1), 429-436.
3. Akinci, G., & Sadorsky, G. (2010). The effects of oil prices and the economy on oil-importing and oil-exporting emerging markets. *Emerging Markets Review*, 11(4), 387-407.
4. Al-Mulali, U., & Ozturk, I. (2015). The causal association between energy consumption and economic growth: Evidence from a panel of selected countries. *Renewable and Sustainable Energy Reviews*, 47, 638-647.
5. BENMOHAD, S., & TAIBI, H. (2023). Energy consumption and economic growth relationship: Evidence from MENA countries using Panel Data Analysis. *Namaa for Economic and Trade Journal*, 7(1), 239-252.
6. Bernard, A. B. (1999). Exceptional exporter performance: cause, effect, or self-selection? *Journal of International Economics*, 48(1), 209-235.
7. Christopher, M., & Peck, H. (2004). Building the resilient supply chain. *The International Journal of Logistics Management*, 15(2), 1-13.
8. Guechari, Y. (2017). The effect of oil price shocks on the Algerian economy. *Revue des Sciences Humaines – Université Mohamed Khider Biskra*, 47, 17-32.
9. Hamilton, J. (1983). Oil and the Macroeconomy since World War II. *Journal of Political Economy*, 91(2), 228-248.
10. Hummels, D. &. (2005). The Variety and Quality of a Nation's Exports. *The American Economic Review*, 95(3), 704-723.
11. Kilian, L. (2009). Not All Oil Price Shocks Are Alike: Disentangling Demand and Supply Shocks in the Crude Oil Market. *American Economic Review*, 99(3), 1053-1069.
12. Melitz, M. (2003). The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity. *Econometrica*, 71(6), 1695-1725.
13. Mork, K. (1989). Oil price shocks and stock market activity. *Journal of Banking & Finance*, 13(4), 447-455.
14. NATION, U. (2022). The natural resource curse unmasked: The economy and trade finance in Algeria in the shadow of COVID-19. *Economic and Social Commission for Western Asia, ESCWA*.
15. Ponomarov, S., & Holcomb, M. (2009). Understanding the concept of supply chain resilience. 20(1), 124-143.
16. Rezki, A., & Hadjira, A. (2024). Oil Price Shocks And Macroeconomic Performance Of The Algerian Economy: A Structural Var Approach. *Management & Economics Research Journal*, 6(3), 536-544.
17. Saadi, L., & Djeddi, A. (2024). Fostering Economic Diversification in Algeria through Advancements in the Agricultural Sector. *Journal of Contemporary Economic Studies*, 8(2), 249-270.
18. Sadorsky, P. (2010). Oil price shocks and the stock markets of oil-exporting countries. *Energy Economics*, 32(5), 1223-1234.
19. Wang, K., Liu, Z., Wei, Z., Lou, S., Ayad, H., & Djedaiet, A. (2022). How Does Algerian Trade Respond to Shocks in Oil Prices and Uncertainty? *Environmental Economics and Management*, 10, 1-11.
20. World Bank, (2022). How is Algeria Reacting to Low Oil Prices? Consulté le 12 2024, sur World Bank: <https://www.worldbank.org/en/country/algeria/publication/economic-brief-july-2016>