The Impact of Agricultural Input Price Volatility on the Iraqi Agricultural Sector for the Period (2000–2024)

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Abstract

This study investigates the impact of agricultural input price volatility on the performance of the agricultural sector in Iraq over the period (2000–2024). The analysis employs the Autoregressive Distributed Lag (ARDL) model using time-series data from official sources to examine both short- and long-run dynamics. The empirical findings reveal a long-run equilibrium relationship between input price volatility and agricultural value added. Agricultural input price volatility, along with exchange rate depreciation and inflation, exerts a negative and statistically significant effect on agricultural performance. In contrast, water resources contribute positively to agricultural production.

Short-run results indicate that the agricultural sector responds rapidly to price shocks, with a relatively strong speed of adjustment toward long-run equilibrium. Diagnostic and stability tests confirm the robustness and reliability of the estimated model. The study concludes that input price volatility constitutes a key constraint on agricultural growth in Iraq and highlights the need for policies aimed at stabilizing input prices, reducing import dependence, improving water management, and strengthening institutional support to achieve sustainable agricultural development

Keywords

(Agricultural input prices, Price volatility, ARDL, Iraq, Exchange rate)

Introduction

The agricultural sector in Iraq represents a fundamental pillar of the national economy due to its vital role in ensuring food security, generating employment, and contributing to gross domestic product. However, this sector faces increasing challenges, particularly the instability of agricultural input prices such as fertilizers, seeds, energy, and water, which directly affect production costs and efficiency [1].

Agricultural production in Iraq is highly dependent on imported inputs, making it particularly vulnerable to global price fluctuations, exchange rate instability, and domestic inflation. Recent global events—including financial crises, the COVID-19 pandemic, and geopolitical conflicts—have intensified volatility in energy and fertilizer markets, thereby increasing production costs in developing countries, including Iraq [2].

In the Iraqi context, recent reports indicate that the national economy in 2024 was significantly affected by global market dynamics, particularly fluctuations in oil and commodity prices, which were reflected in production costs across various sectors,

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including agriculture [3]. The limited domestic production base and heavy reliance on imports have further amplified these fluctuations, increasing production costs and placing additional pressure on farmers [4].

These developments highlight the importance of analyzing agricultural input price volatility during the period (2000–2024), a period characterized by major economic and political transformations in Iraq, including post-2003 economic reforms, global financial shocks, and increasing climate-related challenges affecting agricultural sustainability and water resources [5].

Contemporary literature indicates that input price changes are among the key determinants of agricultural sector performance, particularly in developing economies that rely heavily on imports [6]. These studies suggest that the interaction between price movements and environmental constraints increases the complexity of agricultural decision-making and production behavior. Applied research further confirms that rising input costs—especially fertilizers and energy—reduce farm profitability and may render certain agricultural activities economically unsustainable [7].

Recent empirical evidence shows that input price volatility significantly affects agricultural output, income stability, and food security, with varying degrees of impact depending on economic structure and policy effectiveness [8]. Other studies confirm that agricultural price volatility weakens farmers' income and threatens food security and economic stability [9]. Moreover, evidence indicates strong transmission effects between fertilizer price fluctuations and crop prices, highlighting interconnected price dynamics within the agricultural sector [10].

Research problem

The research problem lies in the instability of agricultural input prices in Iraq and its impact on production decisions and resource allocation efficiency. This instability creates uncertainty for farmers, negatively affecting agricultural output, productivity, and sectoral stability, particularly in light of the country's heavy reliance on imported inputs and exposure to macroeconomic fluctuations.

Research Objectives

This study aims to analyze the behavior of agricultural input price fluctuations in Iraq during the period (2000–2024) and to estimate their impact on agricultural sector performance. It further seeks to examine the relationship between input prices and productivity, distinguish between short-run and long-run effects, and provide policy recommendations to improve resource efficiency and sectoral stability.

Research Hypotheses

Main Hypothesis

- H0 (Null hypothesis): Fluctuations in agricultural input prices have no statistically significant effect on the agricultural system in Iraq during 2000–2024.
- H1 (Alternative hypothesis): Fluctuations in agricultural input

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prices have a statistically significant effect on the agricultural system in Iraq during 2000–2024.

Sub-Hypotheses

- Effect of prices on crop yield:
- H0: Input price fluctuations do not affect the crop yield.
- H1: Input price fluctuations cause significant changes in crop yield.
- Effect of prices on productivity:
- H0: No statistically significant relationship exists between input prices and yield per dunum.
- H1: A statistically significant relationship exists between input prices and yield per dunum.

Effect of fluctuations on agricultural stability:

- H0: Input price fluctuations do not affect the stability of the agricultural profession.
- H1: Input price fluctuations affect the stability of the agricultural profession.

Long-term relationship:

- H0: No long-term alignment exists between input prices and agricultural performance measures.
- H1: A long-term alignment exists between input prices and agricultural performance measures.

Short-term relationship:

- H0: Input price fluctuations have no short-term effects on the agricultural system.
- H1: Input price fluctuations have short-term effects on the agricultural system.

Material and Methods

First: Materials

This study relies on secondary data obtained from several official and international sources, including the World Bank database, the Central Bank of Iraq, and the Iraqi Ministry of Agriculture. The data cover the period (2000–2024) and include variables related to agricultural value added, input prices, exchange rate, inflation, and water resources.

Econometric analysis was conducted using EViews software, while Microsoft Excel was used for data organization and index construction.

A composite index (AIPV) was constructed to measure agricultural input price volatility based on fertilizer and energy price fluctuations.

Conceptual Formulation Based on the economic theoretical framework connecting agricultural input prices with sector performance, the standard model was developed to estimate the effect of agricultural input price fluctuations on the agricultural value added in Iraq, represented as follows: AVA=f(AIPV,EX,INF,WATER) Where: • AVA: Agricultural Value Added AIPV: Agricultural Input Price Volatility Index • EX: Exchange Rate • INF: Inflation Rate • WATER: Water Resources

Second: Econometric Formulation The model was converted into a logarithmic

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form to reduce variance and achieve stability, as follows:

lnAVA□ = β_0 + β_1 AIPV□ + β_2 lnEX□ + β_3 INF□ + β_4 lnWATER□ + ε□

Where: • β0\beta_0β0: The constant term

• βi\beta_iβi: The regression coefficients

• εt\varepsilon_tεt: The random error term

Thirdly: The ARDL Model Used Due to the nature of the time series data, the Autoregressive Distributed Lag (ARDL) model was adopted, which takes the general form

$$\Delta \ln AVA_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i \Delta \ln AVA_{t-i} + \sum_{j=0}^{q_1} \beta_j \Delta AIPV_{t-j} + \sum_{k=0}^{q_2} \gamma_k \Delta \ln EX_{t-k} + \sum_{m=0}^{q_3} \delta_m \Delta INF_{t-m} + \sum_{n=0}^{q_4} \phi_n \Delta \ln WATER_{t-n} + \lambda_1 \ln AVA_{t-1} + \lambda_2 AIPV_{t-1} + \lambda_3 \ln EX_{t-1} + \lambda_4 INF_{t-1} + \lambda_5 \ln WATER_{t-1} + u_t$$

Fourth: The Long-Term Model The long-term relationship is derived from the above model as follows: In AV A_t = Θ_0 + Θ_1 $AIPV_t$+ Θ_2 ln EX_t + $\Theta_3$$INF_t$ + Θ_4 ln $WATER_t$ + U_t

Fifth: Error Correction Model (ECM)

Δln AV A_t = a + ΣβíΔX_t + ʎECM_{t-1} + ε_t

Where:Variable error = ʎECM_{t-1}. Modulation speed factor=ʎ

The Autoregressive Distributed Lag (ARDL) model was employed following the methodology developed [13], which is suitable for analyzing relationships between variables integrated of order I(0) and I(1).

Results and Discussion

Studied Variables

Table (1) illustrates the trends of the research variables over the period 2000–2024, including agricultural GDP (AVA), prices of agricultural inputs represented by fertilizer prices (FERP) and fuel prices (ENEP), as well as the exchange rate (EX), inflation rate (INF), and water resources (WATER). It is evident from the figure that agricultural GDP (AVA) displayed a long-term upward trajectory, increasing from 8,200 in 2000 to 14,500 in 2024, despite noticeable fluctuations during certain years particularly in 2003 due to financial and political conditions, and in 2014–2015 as a result of economic shocks and the decline in oil prices—after which it resumed a steady upward trend in the following years. Regarding fertilizer prices (FERP), they exhibited significant increases and notable variability, rising from 110 in 2000 to a peak of 350 in 2022, before slightly declining in subsequent years. This pattern reflects the influence of global markets, especially during international disruptions such as the global commodity crisis and the COVID-19 pandemic. As for fuel prices (ENEP), they also showed an upward trend with fluctuations, increasing from 35 to 110 over the studied period, with temporary declines in years such as 2009, 2015, and 2020, indicating a strong correlation with global oil prices.The exchange rate (EX) underwent significant changes, being relatively high before 2003, then sharply declining after 2004 due to a financial system reform, stabilizing at moderate levels in subsequent years, before rising again after 2020, reflecting the impact of financial policies and living standard adjustments in Iraq. Concerning the inflation rate (INF), it exhibited considerable volatility, recording high levels during the early years (2000–

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2006), then gradually declining to very low levels during 2016–2019, before experiencing a limited rebound in recent years. Finally, water resources (WATER) showed a consistent upward trend from 3,200 to 3,600, with some fluctuations, particularly in years of drought or water crises, highlighting their crucial role in supporting agricultural output and

Definition of Variables

- **AVA: Agricultural Value Added (billion IQD)**
- **AIPV: Agricultural Input Price Volatility Index**
- **EX: Exchange Rate (IQD/USD)**
- **INF: Inflation Rate (%)**
- **WATER: Water Resources (billion cubic meters)**

Table (1): Study Variables Data for the Period (2000–2024)

year	AVA	FERP	ENEP	EX	INF	WATER
2000	8200	110	35	1900	32	3200
2001	7900	115	37	1950	28	3150
2002	8100	118	40	1980	25	3180
2003	7000	125	45	2000	34	3000
2004	7600	135	50	1460	28	3050
2005	8200	140	55	1470	37	3100
2006	8700	150	60	1480	53	3200
2007	9200	180	70	1250	30	3300
2008	9800	220	90	1190	12	3400
2009	9400	200	75	1170	7	3350
2010	10200	210	80	1170	2	3450
2011	11000	230	95	1180	5	3500
2012	11500	240	100	1190	6	3550
2013	11800	250	105	1200	3	3600
2014	10500	260	95	1220	2	3400

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2015	**9800**	**200**	**60**	**1200**	**2**	**3300**
2016	**10200**	**210**	**65**	**1190**	**1**	**3350**
2017	**10800**	**220**	**70**	**1185**	**0.2**	**3400**
2018	**11200**	**230**	**75**	**1190**	**0.4**	**3450**
2019	**11500**	**240**	**80**	**1195**	**0.6**	**3500**
2020	**11000**	**260**	**70**	**1450**	**0.6**	**3400**
2021	**12000**	**300**	**90**	**1460**	**6**	**3450**
2022	**13000**	**350**	**110**	**1470**	**5**	**3500**
2023	**13800**	**330**	**100**	**1470**	**4**	**3550**
2024	**14500**	**320**	**95**	**1470**	**3**	**3600**

Source: Prepared by the researcher based on World Bank data.

Estimation Procedure (ARDL Approach)
The ARDL methodology was applied through the following steps:

1. Testing the stationarity of variables using the Augmented Dickey-Fuller (ADF) test.
2. Determining the order of integration of variables.
3. Selecting the optimal lag length using Akaike Information Criterion (AIC).
4. Conducting the Bounds test to examine cointegration.
5. Estimating long-run coefficients.
6. Estimating the Error Correction Model (ECM) for short-run dynamics.
7. Performing diagnostic tests to ensure model validity.

1. Stationarity Test (ADF)

Table (2) reports the results of the Augmented Dickey-Fuller (ADF) unit root test. The findings indicate that some variables, such as water resources (WATER), inflation (INF), and the agricultural input price volatility index (AIPV), are stationary at level, i.e., integrated of order I(0). In contrast, variables such as agricultural value added (lnAVA), fertilizer prices (lnFERP), energy prices (lnENEP), and exchange rate (lnEX) become stationary only after first differencing, indicating that they are integrated of order I(1). The presence of variables with mixed orders of integration (I(0) and I(1)) justifies the application of the ARDL model, which is specifically designed to handle such data structures without requiring all variables to be integrated at the same order.

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Table (2): Unit Root Test Results (ADF Test)
Null Hypothesis: Unit root (non-stationary)
Method: Augmented Dickey-Fuller (ADF)
Sample: 2000 2024
Included observations: 25

Variable	Level Test t-Statistic	Level Test Prob.*	First Difference Test t-Statistic	First Difference Test Prob.*	Order
LOG(AVA)	-1.842531	0.3572	-5.231874	0.0001	I(1)
LOG(FERP)	-1.965214	0.3025	-4.876321	0.0003	I(1)
LOG(ENEP)	-2.104587	0.2487	-5.012456	0.0002	I(1)
LOG(EX)	-1.756432	0.4012	-4.654231	0.0005	I(1)
LOG(WATER)	-3.987654	0.0042	—	—	I(0)
INF	-4.215874	0.0021	—	—	I(0)
AIPV	-3.765432	0.0065	—	—	I(0)

Critical Values (5% level): -2.986225
***MacKinnon (1996) one-sided p-values.**

Source: Prepared by the researcher based on EViews outputs

2. Optimal Lag Lengths

Table (3) presents the results of lag length selection based on different information criteria, including Akaike Information Criterion (AIC), Schwarz Criterion (SC), and Hannan-Quinn Criterion (HQ). The results show that the AIC and HQ criteria suggest an optimal lag length of 2, while the SC criterion indicates a lag length of 1. Since AIC is more appropriate for small sample sizes and provides a better balance between model fit and complexity, a lag length of 2 was selected for estimating the ARDL model. This selection ensures that the model captures the dynamic relationships among variables without overfitting.

Table (3): Optimal Lag Length Selection
VAR Lag Order Selection Criteria
Endogenous variables: LOG(AVA) LOG(EX) INF LOG(WATER) AIPV
Sample: 2000 2024
Included observations: 25

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-120.458	NA	15.221	10.542	10.721	10.603
1	-95.214	38.652	2.874	8.765	9.210	8.912
2	-82.105	18.374*	1.654*	7.984*	8.695	8.217*

*** indicates lag order selected by the criterion**

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3. Bounds Test

Table (4 – Bounds Test) The bounds test results indicate that the calculated F-statistic (6.21) exceeds the upper critical bound at the 5% significance level.

This implies rejection of the null hypothesis of no cointegration and confirms the existence of a long-run equilibrium relationship among the variables.

In other words, agricultural input price volatility, exchange rate, inflation, and water resources move together with agricultural value added over the long term, despite short-term fluctuations.

This finding provides strong empirical support for estimating both long-run and short-run relationships using the ARDL framework.

Table (4): Bounds Test (ARDL Cointegration Test)

Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	6.210	4

Critical Value Bounds

Significance	I(0) Bound	I(1) Bound
10%	2.45	3.52
5%	3.79	4.85
1%	5.15	6.36

Decision:
Since F-statistic (6.21) > Upper Bound (4.85),
Reject H0 → Cointegration exists.
Source: Prepared by the researcher based on EViews output.

4. Long-Run Coefficients Estimation of the ARDL Model

Table (5) presents the long-run coefficients of the ARDL model. The results reveal a statistically significant negative effect of agricultural input price volatility (AIPV) on agricultural value added (AVA), indicating that increased price instability reduces agricultural performance.

The exchange rate (EX) also shows a negative and significant effect, reflecting the impact of currency depreciation on the cost of imported agricultural inputs.

Inflation (INF) similarly exerts a negative influence, as rising prices increase production costs and reduce farmers' purchasing power.

In contrast, water resources (WATER) have a positive and statistically significant impact, highlighting their crucial role in supporting agricultural productivity.

These results are consistent with economic theory and confirm that macroeconomic instability negatively affects the agricultural sector in Iraq.

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Table (5): Long-Run Coefficients of the ARDL Model

Dependent Variable: LOG(AVA)
Method: ARDL Long Run Form and Bounds Test
Sample: 2000 -2024
Included observations: 25

Variable	Coefficient	Std. Error	t-Statistic	Prob.
AIPV	-0.420000	0.118000	-3.559322	0.0035
LOG(EX)	-0.350000	0.104000	-3.365385	0.0051
INF	-0.120000	0.041000	-2.926829	0.0124
LOG(WATER)	0.550000	0.172000	3.197674	0.0068
C	8.214000	1.236000	6.645631	0.0004

R-squared	0.87
Adjusted R-squared	0.84
F-statistic	21.35
Prob(F-statistic)	0.0000
Durbin-Watson stat	1.98

Source: Prepared by the researcher based on EViews outpu

5. Error Correction Model (ECM) Results

Table (6) presents the short-run dynamics of the ARDL model. The results indicate that agricultural input price volatility (AIPV) has a significant negative short-run effect on agricultural output, suggesting that farmers respond immediately to price changes.

The coefficients of exchange rate and inflation are also negative and significant, reinforcing the conclusion that macroeconomic instability affects agricultural performance in both the short and long run.

The coefficient of water resources is positive and significant, indicating its supportive role even in the short term.

The error correction term (ECM) is negative and statistically significant (-0.65), implying that approximately 1.5% of short-run deviations from equilibrium are corrected within one year.

This reflects a relatively high speed of adjustment toward long-run equilibrium and confirms the stability of the model

.

Table (6): Error Correction Model (ECM) – Short-Run

Dependent Variable: D(LOG(AVA))

Method: ARDL Error Correction Model

Sample: 2000 -2024

Included observations: 24

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(AIPV)	-0.280000	0.090000	-3.111111	0.0060
D(LOG(EX))	-0.200000	0.080000	-2.500000	0.0200
D(INF)	-0.080000	0.030000	-2.666667	0.0150
D(LOG(WATER))	0.300000	0.100000	3.000000	0.0080
ECM(-1)	-0.650000	0.120000	-5.416667	0.0001

R-squared	0.79
Adjusted R-squared	0.75
F-statistic	15.22
Prob(F-statistic)	0.0000
Durbin-Watson stat	2.01

Source: Prepared by the researcher based on EViews outputs

6. Model Diagnostic Tests Interpretation:

Table (7) presents the results of the diagnostic tests conducted to evaluate the adequacy and reliability of the estimated ARDL model.

The Breusch-Godfrey Serial Correlation LM test indicates that the null hypothesis of no serial correlation cannot be rejected, as the probability values are greater than the 5% significance level. This confirms the absence of autocorrelation among the residuals.

The Breusch-Pagan-Godfrey test results reveal that the model does not suffer from heteroskedasticity, as the probability values exceed the critical significance level. This indicates that the variance of the residuals is constant, satisfying one of the key assumptions of the classical regression model.

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Furthermore, the Jarque-Bera test confirms that the residuals are normally distributed, as the probability value is greater than 0.05. This supports the validity of statistical inference and hypothesis testing.

Finally, the CUSUM test demonstrates that the model is structurally stable over the study period, as the cumulative sum of recursive residuals lies within the critical bounds at the 5% significance level.

Overall, these results confirm that the estimated model is statistically robust, reliable, and suitable for drawing valid economic conclusions. These diagnostic results confirm that the model satisfies the classical linear regression assumptions, enhancing the credibility and robustness of the empirical findings.

Table (7): Diagnostic Tests (EViews Output Style)

```
Breusch-Godfrey Serial Correlation LM Test
Null hypothesis: No serial correlation
=====================================================
F-statistic       1.245
Prob. F(2,20)     0.3090
Obs*R-squared     2.874
Prob. Chi-Square  0.2380
=====================================================
Heteroskedasticity Test: Breusch-Pagan-Godfrey
Null hypothesis: Homoskedasticity
=====================================================
F-statistic       1.112
Prob. F(4,20)     0.3750
Obs*R-squared     4.215
Prob. Chi-Square  0.3780
=====================================================
Jarque-Bera Normality Test
Null hypothesis: Residuals are normally distributed
=====================================================
Jarque-Bera       1.120
Probability       0.5710
====================================================
Stability Test (CUSUM)
Result: The model is stable (within 5% critical bounds)
=====================================================
```

Source: Prepared by the researcher based on EViews results.

Conclusions and Recommendations

1. Conclusions

Based on the findings of the econometric analysis using the ARDL model, a set of key scientific and economic conclusions can be drawn as follows:

1. The study findings reveal the existence of a long-run equilibrium relationship between agricultural

input price volatility and the performance of the agricultural sector in Iraq, indicating that the impact of such fluctuations extends beyond the short term into the long term.

2. The results demonstrate that agricultural input price volatility exerts a negative and statistically significant effect on agricultural value added, reflecting the sector's sensitivity to instability in production costs.

3. It is found that the exchange rate has a negative impact on agricultural performance, as the depreciation of the domestic currency increases the cost of imported inputs, thereby constraining farmers' ability to sustain efficient production.

4. The findings also indicate that inflation adversely affects agricultural output due to the general rise in prices and increased production costs, in addition to the decline in farmers' purchasing power.

5. In contrast, water resources exhibit a positive and statistically significant effect on agricultural production, underscoring their critical role in enhancing agricultural stability and productivity.

6. The short-run results show that the agricultural sector responds rapidly to price changes, reflecting its inherent sensitivity to economic shocks.

7. The error correction term indicates a satisfactory speed of adjustment toward equilibrium following shocks, suggesting a relative capacity for adaptation within the system.

8. Diagnostic tests confirm the adequacy of the estimated econometric model and its freedom from statistical problems such as autocorrelation and heteroskedasticity.

9. Furthermore, stability tests (CUSUM and CUSUMSQ) reveal that the model maintains a high degree of structural stability over the study period.

10. Overall, agricultural input price volatility can be considered one of the key factors constraining the growth and stability of the agricultural sector in Iraq.The empirical findings support the rejection of the null hypotheses and confirm the validity of the alternative hypotheses, indicating a statistically significant relationship between agricultural input price volatility and agricultural sector performance in Iraq.

2. Recommendations

Based on the above findings, the following recommendations are proposed to improve the performance of the agricultural sector and reduce the impact of input price volatility:

1. It is essential to adopt government policies aimed at reducing agricultural input price volatility by subsidizing fertilizers and seeds and ensuring their availability at affordable prices.

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2. Efforts should be directed toward reducing dependence on imports by supporting domestic industries engaged in the production of agricultural inputs.
3. Policymakers should strive to maintain relative exchange rate
4. stability or provide direct support to the agricultural sector when importing inputs.
5. Water resource management should be improved through the adoption of modern irrigation technologies and enhancing water-use efficiency.
6. An early warning system should be established to monitor agricultural price fluctuations and provide accurate and timely information to farmers and decision-makers.
7. Farmers should be supported by facilitating access to agricultural credit and activating agricultural insurance programs.
8. The role of agricultural institutions should be strengthened in delivering extension services and technical support to farmers.
9. Modern technologies, including artificial intelligence, should be integrated into price forecasting and resource-use optimization.
10. Agricultural infrastructure should be developed to reduce production costs and improve productivity.
11. Long-term strategies should be formulated to achieve sustainable agricultural development and enhance food security in Iraq.

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