IOSR Journal of Business and Management (IOSR-JBM)
e-ISSN:2278-487X, p-ISSN: 2319-7668. Volume 28, Issue 4. Ser. 1 (April. 2026), PP 47-60
www.iosrjournals.org

Factors Influencing Employment In The Agricultural Sector Under Inflation Shocks And Exchange Rate Volatility: The Mediating Effect Of Agricultural Investment In Iraq From 1990 – 2024

Rashid Bani Shannan, Mohammed Khaleel Jasim, Wadhah Raheem Rahi, Maha Kareem Ali, Sajid Nabeel Abdulazeez
Imam Al-Sadiq University/Dhi Qar Branch/Al-Rifai
Samarra University, College Of Education For Humanities
Muthanna University, College Of Administration And Economics
Muthanna University, College Of Administration And Economics
University Of Tikrit, College Of Agriculture

Abstract
This study aims to analyze the determinants of employment in the Iraqi agricultural sector in a turbulent economic environment, with a particular focus on the role of inflation shocks and exchange rate fluctuations, and the mediating role of agricultural investment for the period 1990-2024. To achieve the research objectives, a nonlinear time series methodology with distributed lag periods (NARDL) was applied to annual data. This model includes an analysis of the asymmetric effects of both positive and negative shocks. The empirical results demonstrate a long-run asymmetric equilibrium relationship between monetary variables and agricultural employment. showing that the negative impact of shocks (high inflation or devaluation of the dinar) is faster and deeper on employment and income levels than the positive effects of similar shocks. Agricultural employment is overly sensitive to inflationary pressures, with producers resorting to reducing labor costs as their first response to rising costs. The study recommends effective coordination between monetary and agricultural policies, and proposes the creation of a special financing window at the central bank to provide foreign currency at a preferential and stable exchange rate for basic agricultural inputs, and the redirection of investments towards value- added chains to enhance the sector's resilience to external crises.

Keyword: *inflation shocks, exchange rate, agricultural investment, employment in the agricultural, NARDL*

Date of Submission: 01-04-2026 Date of Acceptance: 10-04-2026

I. Introduction To The Study

The agricultural sector occupies a strategic position in the economic structure of developing countries, not only in its traditional role of securing food, but also as the main source of income, especially for groups at risk of poverty in society. This role is even more crucial in economies with weak economic diversification, where stable agricultural income and employment act as a safety valve against poverty and forced migration. However, this vital sector is currently operating in a highly turbulent macroeconomic environment, where monetary variables such as inflation and exchange rate fluctuations exert structural pressures that exceed the adaptive capacity of agricultural producers, reshaping the employment and income distribution landscape in ways that are often unfair and unfavorable to sustainable growth (FAO, 2023).

Inflationary shocks have a complicated effect on the agricultural sector. They don't just cause prices to go up; they also change the "terms of trade" between agriculture and other industries. During times of inflation, the prices of industrial and service inputs that are necessary for farming (like fuel, machinery, and fertilisers) usually go up faster than the prices of final agricultural products (at the farm gate). This lowers farmers' real incomes and makes it hard for them to keep making things.

Because of this financial burden, investors and farmers have to cut costs. Labour is often the first thing to go, which leads to widespread layoffs or wage stagnation and makes the economic gap in rural areas even bigger. (Chandio et al., 2023).

Exchange rate fluctuations also provide an existential threat to the agriculture sector in commercially open nations, as instability in the local currency's value engenders a state of "uncertainty" that hinders long-term investment planning. When the currency is exposed to sudden shocks, the cost of importing technology and improved seeds rises, which increases production costs and weakens the competitiveness of local products against cheap imports. Recent studies indicate that the response of real economy variables such as employment

and income to these monetary shocks is rarely linear or symmetrical, The negative effects of shocks occur quickly and deeply, while recovery requires a long time and double the effort, leading to permanent losses in economic welfare (Mishra & Mishra, 2024).

When comparing these studies with the Iraqi economy for the period 1990-2024, we find that we are dealing with a unique case study. The Iraqi agricultural sector has undergone many fluctuations, starting with the "economic embargo" in the 1990s, when the sector bore the burden of excess employment but with low productivity and income. This continued until after 2003, which was characterized by uncontrolled openness and the dominance of a rentier economy. Because oil prices were so important, the currency rate and inflation rates were based on them instead of being fully separate from monetary policy tools. This left Iraqi farmers open to shocks from outside sources. This situation made the area "repellent" to investment and made it harder for the sector to develop good jobs or make sure people had stable incomes (Eregha & Mesagan, 2022).

Given these issues, it is expected that agricultural investment will act as a "intermediary variable" that can lessen shocks and change their consequences from bad to good. Investing in modern infrastructure and advanced supply chains would make production more efficient, giving farmers more options for dealing with rising costs without putting their operations or income at risk. This position in Iraq is very questionable because the way investments are made and the way they are carried out are both unstable. If not handled carefully, investments could go from being a possible solution to the crisis to making the problem worse (Urgessa, 2024).

This study examines the determinants affecting employment and income within Iraq's agricultural sector, taking into account the effects of inflationary shocks and currency exchange rate volatility resulting from the previously described complex interrelations. To overcome the constraints of traditional standard models that assume stable interactions, the study utilises a nonlinear autoregressive distributed lag (NARDL) methodology. This methodological choice is important because it can break shocks down into positive and negative parts, which reveals asymmetric impacts. It gives a clear picture of how weak or strong the Iraqi agricultural sector is and gives decision- makers a data-driven framework to improve this important area.

II. Methodological Structure Of The Study Research Problem:

The study problem centers on the "structural paradox" in the Iraqi economy. Despite the agricultural potential that exists, the sector is very vulnerable to financial shocks when it comes to making money and staying in business. The main problem is that agricultural economic policies are often made with the purpose of achieving macroeconomic stability, without thinking about how they would affect small farmers. The problem shows up in the next important questions.

1. Do changes in the cost of living and the value of the dollar affect agricultural jobs and income rates in the same way and at the same speed when they go up and down?
2. Does investment in agriculture help Iraq deal with these shocks?

Research objective:

The main objectives of the research are:

- Measure the non-linear impact of positive and negative shocks of both inflation and exchange rates on agricultural income and employment.
- Determine the extent of asymmetry; that is, is the damage caused by negative shocks greater than the benefit resulting from positive shocks?

Assessing the effectiveness of agricultural investment as a mediating variable in modifying the relationship between monetary shocks and the real performance of the sector.

Significance of the research:

The significance of the research stems from the application of a modern standard methodology (NARDL) that goes beyond traditional linear assumptions, providing a more accurate understanding of the behavior of economic variables in turbulent environments. It also lies in providing quantitative evidence to decision-makers in Iraq that addressing unemployment and rural poverty cannot be done in isolation from monetary policy, which requires coordination between agricultural and monetary policy.

Research hypothesis:

The research is based on the hypothesis that:

There is a long-term equilibrium relationship and an asymmetric effect of inflation and exchange rate shocks on employment and agricultural income in Iraq, where the sector's response to negative shocks (rising costs/currency depreciation) is faster and stronger than its response to positive shocks, with agricultural investment playing a mediating (but limited) role in absorbing these shocks.

Research gap:

What distinguishes this study from previous ones:

1. Methodology: Most previous Iraqi studies have relied on linear models (OLS, ARDL) that assume homogeneity of effects, while this study relied on a NARDL model to reveal hidden effects (positive and negative shocks).
2. Variables: Most studies focused on "agricultural production" as a dependent variable, while this study focused on the socio-economic dimension represented by (employment and income), which are the most important for the well-being of rural families.
3. Time frame: Covers the latest available time series (1990-2024), including the effects of recent exchange rate changes and recent global crises.

III. Materials And Methods

In order to accurately diagnose the nature of the relationships between macroeconomic variables and real variables in the Iraqi agricultural sector for the years 1990–2024, this study uses an advanced quantitative analytical methodology. This study was designed to avoid superficial analysis by combining a modern statistical application that considers the structural specificity of the Iraqi economy with a theoretical study of the variables. Here are the specifics:

First, Delineation of model variables and theoretical framework

Based on a thorough analysis of recent economic research relating monetary imbalances to sectoral performance, the study variables were purposefully selected. Both theoretically and economically, the variables were categorised and defined as follows:

Dependent variables, or indicators of agricultural response:

A. Employment in agriculture: In developing nations, jobs in the agriculture sector are most likely to be impacted by economic issues. In addition to the typical supply and demand factors, a recent study reveals that "real wage shocks" have a significant impact on the agricultural labour market. A major shortage of skilled labour and a threat to the sustainability of output result from agricultural workers migrating to peripheral urban areas in search of higher income in an inflationary environment due to declining wage buying power (FAO, 2023; ILO, 2024). Agricultural jobs were once thought of as a way to protect people in difficult times, but this is changing due to rising operating costs brought on by fluctuations in exchange rates. Because of this, farmers are growing crops on less land or using cheaper technologies rather than human labour. This exacerbates rural poverty and causes long-term unemployment. Chandio et al. (2023) and the World Bank (2024).
B. The total value added by the industry at fixed prices is known as agricultural income. This variable encounters a significant obstacle in rentier economies known as "price decoupling," in which the costs of manufacturing inputs—which are typically imported—increase at rates higher than the rise in the selling prices of domestic goods, which compete with low-cost imports. Although data indicates that returns are increasing, this disparity reduces producers' actual revenue (Urgessa, 2024). Research indicates that agricultural income has a short-term memory for positive shocks and a long-term memory for negative shocks. This suggests that income declines brought on by unfavourable seasons or price shocks may require years to recover, while increases from exceptional seasons quickly fade because of ongoing inflationary pressures, resulting in a state of ongoing instability in agricultural income. (Mishra and Mishra, 2024; Khan and Wang, 2022). a continuous state of transformation (Khan & Wang, 2022; Mishra & Mishra, 2024).

Independent factors that contribute to financial shocks:

C. Inflation rate: Currently, inflation is measured using the consumer price index. This study examines inflation as a means of communicating "economic inefficiency" to the agricultural industry. Costs for necessities like transportation, fuel, fertilisers, and machinery rise as a result of the ongoing increase in the overall price level. According to research, inflation has two negative effects: it raises prices while also decreasing demand for non-essential agricultural products (Chandio et al., 2023). Furthermore, unpredictable inflation makes it difficult for farmers to make plans for the upcoming season. They decide to hold their money in safe assets like gold or foreign currency rather than reinvesting it in farming. This results in a long-term decline in productivity and a reduction in the sector's capital (Eregha & Mesagan, 2022; FAO, 2023).
D. Exchange rate: A "parallel exchange rate" (market) has been established as an independent variable since the Iraqi economy is reliant on imports and oil. This is the true standard by which products and services are priced. Prices in the area rise rapidly when the local currency depreciates; conversely, prices decline more slowly when the currency appreciates (Mishra & Mishra, 2024). Due to the unfairness of this situation, Iraqi farmers do not receive the same benefits when the dollar declines, but they must deal with the increased costs of imported goods when the dollar rises.

Consequently, fluctuations in the exchange rate reduce the competitiveness of businesses and make it more difficult for individuals to find employment and earn money (Urgessa, 2024; World Bank, 2024).

The intermediate variable, agricultural investment:

This is the sum of fixed capital formation in the agricultural sector. Because it is anticipated to function as a "automatic stabiliser" for shocks, this variable is significant. This is due to the fact that investments in cold chains, sophisticated irrigation systems, and infrastructure increase productivity and reduce waste. This allows farmers to manage growing expenses without having to reduce output or fire employees. A consistent flow of investment and the absence of government spending displacement are necessary for this role to be effective (Al-Hussaini et al., 2024; FAO, 2023).

Second: Data analysis and conventional techniques

1. Data description and study population: The annual time series from 1990 to 2024 is included in the study. This timeline was purposefully selected to encompass all structural shifts, from economic isolation and international sanctions in the 1990s to the political upheaval of 2003 and the ensuing trade liberalisation and oil issues. Reliable government sources provided the data, including the World Bank's global development indicators, the Central Statistical Organization's reports, and the Central Bank of Iraq's annual reports. These were employed to fill in the blanks and standardise base years.
2. Nonlinear Autoregressive Time Series Model (NARDL): Rather than using conventional linear models, data analysis was done using the NARDL methodology (Shin et al., 2014). Strong scientific justifications that align with the Iraqi data underpin this methodological decision.

According to the concept of asymmetry, dependent variables, such as employment and income, react differently to positive shocks than they do to negative ones. The independent variables (exchange rate and inflation) are divided into two sections: the first displays the partial sums of positive changes, and the second displays the partial sums of negative changes.

b. Cointegration and error correction: The model's "Bounds Test" enables the search for a long-term equilibrium relationship between variables, even when their integration levels fluctuate. Additionally, it has an error correction coefficient (ECM) that gauges how fast the system returns to equilibrium following a sudden change.

c. Wald Test: To confirm the nonlinearity hypothesis, this test serves as a crucial diagnostic tool. A more realistic explanation of the behaviour of economic variables in turbulent environments is provided if the results demonstrate statistical significance for the difference between the positive and negative shock coefficients. This validates the use of the NARDL model and disproves the theory of traditional linear models (Mishra & Mishra, 2024).

Materials And Methods

The data were analyzed using a nonlinear distributed interval autoregression (NARDL) model (27). The NARDL model combines long-term cointegration nonlinearity with error correction in an integrated manner. The NARDL model is an extension of the ARDL model. Assuming that a cointegration can be represented as a linear combination of instability may be too restrictive, as long- term cointegrations can be asymmetric or nonlinear (26). Researchers have argued that nonlinearity is a common phenomenon in the social sciences. For example, in advanced and self-sufficient economies, a negative change in agricultural economic growth may be more surprising than a positive one. This is common because their economic activity is elastic. Thus, positive and negative changes do not have the same power to influence, making them asymmetric or different, which falls under the category of nonlinearity (8). Therefore, NARDL models can contribute to a deeper understanding of asymmetry, given the common assumption that a cointegration involves a set of constant variables (15). The starting point of the model can be expressed as follows: where y is a function of the positive and negative values of the independent variable represented by (19) respectively.(Oginni &Other ,2024)

$$y = f(x_t^+, x_t^-) \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

model is chosen in the present investigation extending the linear approach of ARDL bounds testing. After considering the asymmetry in (2), the following equation is obtained:

$$y_t = \beta^+ x_t^+ + \beta^- x_t^- + \mu_t \ldots\ldots\ldots\ldots\ldots (2)$$

The $x_t$is a k × 1 vector of decomposed regressors as follows:

$$y_t = x_0 + x_t^+ + x_t^- \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

where x^+ and x^- are partial sum processes of positive and negative changes in x^t.

$$x_t^+ = \sum_{j=1}^{t} \Delta x_j^+ = \sum_{j=1}^{t} max(\Delta x_j, 0) \ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

$$x_t^- = \sum_{j=1}^{t} \Delta x_j^- = \sum_{j=1}^{t} min(\Delta x_j, 0) \ldots\ldots\ldots\ldots (5)$$

The equation comprising both the short and long estimates is specified as:

$$\Delta y_t = \alpha + \rho y_{t-1} + \theta^+ x_{t-1}^+ + \theta^- x_{t-1}^- + \sum_{j=1}^{p-1} \theta_j \Delta y_{t-j} + \sum_{j=0}^{q} \theta_j (\pi_j^+ \Delta x_{t-j}^+ + \pi_j^- \Delta x_{t-j}^-) +$$

$$\varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

Where$\beta^+ = -\theta^+ / \rho$ and$\beta^- = -\theta^- / \rho$ are the afore mentioned long run impacts of increase and reduction in x_t ony$_t$ respectively.

Table Description of the standard model

Variable Role	Variable Name	Abbreviation	Abbreviation
Independent	Inflation	INF	X_1
Independent	Exchange Rate	EXR	X_2
Mediating	Agricultural Investment	AGI / IN	X_3
Dependent	Agricultural Employment	AEMP	Y_1

The experimental NARDL model was used in the study to model the relationship between the dependent and independent variables shown in the table above. (25). :

$$\Delta y_t = \beta_0 + \beta_1 y_{t-1} + \beta_2 Ex_{t-1}^+ + \beta_3 Ex_{t-1}^- + \beta_4 Im_{t-1}^+ + \beta_5 Im_{t-1}^- + \beta_6 Gs_{t-1}^+ + \beta_7 Gs_{t-1}^- + \beta_8 I_{t-1}^+ + \beta_9 I_{t-1}^- + \sum_{i=1}^{p} \sigma_{10} \Delta y_{t-1} + \sum_{i=0}^{q} (\emptyset_i^- \Delta Ex_{t-i}^+ + \emptyset_i^+ \Delta Ex_{t-i}^-) + \sum_{i=0}^{n} (\emptyset_i^+ \Delta Im_{t-i}^+ + \emptyset_i^- \Delta Im_{t-i}^-) + \sum_{i=0}^{n} (\emptyset_i^+ \Delta Gs_{t-i}^+ + \emptyset_i^- \Delta Gs_{t-i}^-) + \sum_{i=0}^{a} (\emptyset_i^+ \Delta I_{t-i}^+ + \emptyset_i^- \Delta I_{t-i}^-) + \varepsilon_t \quad (7)$$

Where : $\Delta y_{t1} = Agricultural\ Employment$

INF (x1) = Inflation

EXR (x2) =Exchange Rate

AGI / IN (x3) = Agricultural Investment

P,q,h and n= Lag values

Δ= Difference operator

T= Time trend

	Y	X1	X2	X3
Mean	1586.574	821.826	48.514	272496.883
Median	1721.000	1190.000	12.600	148261.000
Maximum	2110.400	1836.000	448.500	1415608.000
Minimum	943.300	0.300	0.200	156.500
Std. Dev.	406.070	654.364	103.208	369970.001

Skewness	-0.238	-0.390	2.917	1.918
Kurtosis	1.456	1.382	10.621	5.947
Jarque-Bera	3.808	4.707	134.315	34.120
Probability	0.149	0.095	0.000	0.000
Sum	55530.100	28763.900	1698.000	9537390.900
Sum Sq. Dev.	5606354.667	14558550.507	362163.563	4653845266230.320
Observations	35.000	35.000	35.000	35.000

IV. Results And Discussion

Unit root tests

When he study utilized time series data, and it is important to examine stationarity variables before model estimation. While the ARDL test does not mandate unit root testing, it is crucial to conduct such tests to ensure data stationarity and confirm they are not integrated of order more than one, enabling the use of the ARDL approach Given the limitations of the Augmented Dickey-Fuller (ADF) test in terms of power and size properties, Phillips-Perron test was also employed alongside the ADF test to assess the unit root of the variables .The results of the stationarity tests indicated that some variables were nonstationary at the level but became stationary at the first difference. This transformation is essential for ensuring the validity of the ARDL model and the reliability of the subsequent analysis .

Table 1. Unit Root Test **(PP)**

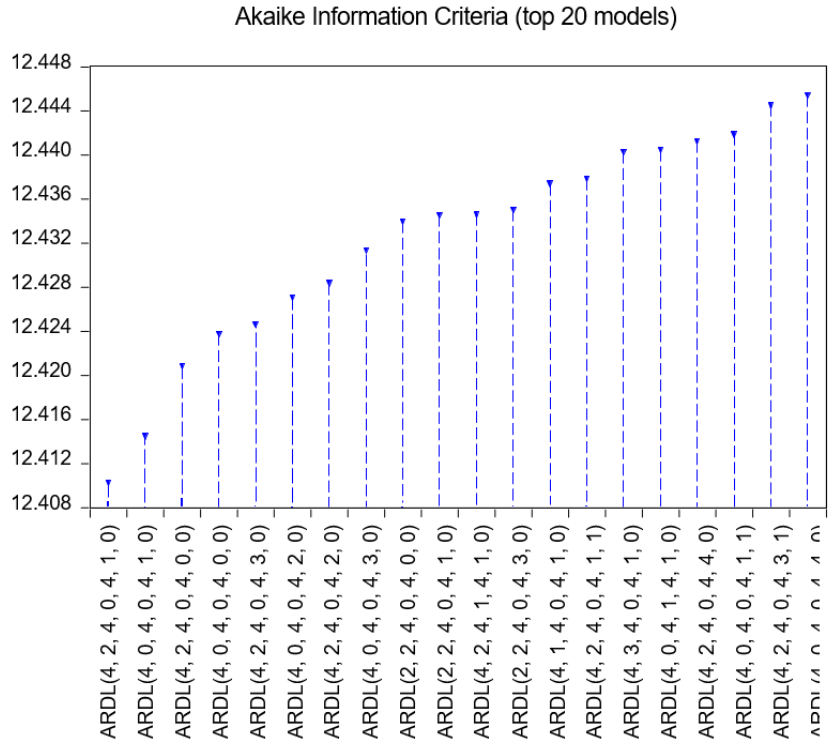
UNIT ROOT TEST TABLE (PP)

At Level		**Y1**	**X1**	**X2**	**X3**
	t-Statistic	-2.103	-1.666	-2.499	-2.771
With Constant	**Prob.**	0.245	0.439	0.125	0.073
		NO.	NO.	NO.	*
With Constant & Trend	**t-Statistic**	-4.198	-2.435	-3.205	-3.029
	Prob.	0.011	0.356	0.100	0.140
		**	NO.	NO.	NO.
Without Constant & Trend	**t-Statistic**	0.812	-0.486	-2.248	-1.979
	Prob.	0.883	0.498	0.026	0.047
		NO.	NO.	**	**
At First Difference					
		d(Y)	**d(X1)**	**d(X2)**	**d(X3)**
	t-Statistic	- 11.282	-6.896	-8.522	-13.753
With Constant					
	Prob.	0.000	0.000	0.000	0.000
		***	***	***	***
	t-Statistic	- 11.194	-6.818	-9.503	-13.923
With Constant & Trend	**Prob.**	0.000	0.000	0.000	0.000
		***	***	***	***
Without Constant & Trend	**t-Statistic**	- 10.872	-6.849	-7.606	-11.355
	Prob.	0.000	0.000	0.000	0.000
		***	***	***	***
UNIT ROOT TEST TABLE (ADF)					
At Level		**Y**	**X1**	**X2**	**X3**
	t-Statistic	-0.419	3.336	-1.666	-1.682
With Constant	**Prob.**	0.894	1.000	0.439	0.429
		NO.	NO.	NO.	NO.
With Constant & Trend	**t-Statistic**	-3.981	-1.477	-2.418	-4.868
	Prob.	0.019	0.818	0.364	0.003
		**	NO.	NO.	***
Without Constant & Trend	**t-Statistic**	1.114	3.843	-0.486	-2.301
	Prob.	0.928	1.000	0.498	0.023
		NO.	NO.	NO.	**
At First Difference		**d(Y)**	**d(X1)**	**d(X2)**	
	t-Statistic	-7.824	-6.806	-6.859	-4.031
With Constant	**Prob.**	0.000	0.000	0.000	0.005
		***	***	***	***
	t-Statistic	-7.742	-5.910	-6.778	-5.499
With Constant & Trend	**Prob.**	0.000	0.000	0.000	0.001
		***	***	***	***
	t-Statistic	-7.654	-6.469	-6.846	-4.071
Without Constant & Trend	**Prob.**	0.000	0.000	0.000	0.000
		***	***	***	

(*) Significant at the 10%; (**) Significant at the 5%; (***) Significant at the 1% and (no) Not Significant Authors .

Source : output program EViews 13 .

1-Testing optimal lag periods: The optimal lag period that gives the lowest value for the Akaike criterion



ARDL results table Dependent Variable: Y
Method: ARDL
Date: 02/08/26 Time: 19:19 Sample (adjusted): 1992S2 2024S2
Included observations: 65 after adjustments Maximum dependent lags: 4 (Automatic selection) Model selection method: Akaike info criterion (AIC)
Dynamic regressors (4 lags, automatic): X1_POS X1_NEG X2_POS X2_NEG X3_POS X3_NEG
Fixed regressors: C
Number of models evalulated: 62500 Selected Model: ARDL(4, 2, 4, 0, 4, 1, 0)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
Y(-1)	0.419376	0.120294	3.486261	0.0011
Y(-2)	-0.633376	0.133572	-4.741844	0.0000
Y(-3)	0.133435	0.113871	1.171814	0.2477
Y(-4)	-0.194882	0.099624	-1.956184	0.0570
X1_POS	0.278446	0.060260	4.620734	0.0000
X1_POS(-1)	-0.107685	0.085999	-1.252176	0.2173
X1_POS(-2)	0.144030	0.089938	1.601436	0.1166
X1_NEG	1.183771	0.391953	3.020186	0.0042
X1_NEG(-1)	-0.562173	0.373056	-1.506942	0.1391
X1_NEG(-2)	-0.716779	0.375460	-1.909071	0.0629
X1_NEG(-3)	0.404344	0.389136	1.039080	0.3046
X1_NEG(-4)	-1.137128	0.341364	-3.331133	0.0018
X2_POS	0.201499	0.291780	0.690586	0.4935
X2_NEG	-0.148783	0.319772	-0.465278	0.6441
X2_NEG(-1)	-0.006022	0.397225	-0.015161	0.9880
X2_NEG(-2)	0.254667	0.388929	0.654791	0.5161
X2_NEG(-3)	-0.157295	0.388984	-0.404374	0.6879
X2_NEG(-4)	0.828919	0.311017	2.665191	0.0108
X3_POS	0.000133	0.000113	1.180031	0.2445
X3_POS(-1)	-0.000150	0.000111	-1.348232	0.1846
X3_NEG	-4.65E-05	4.62E-05	-1.004703	0.3207
C	1605.966	260.2663	6.170471	0.0000
R-squared	0.954697	Mean dependent var		1612.117
Adjusted R-squared	0.932572	S.D. dependent var		404.5106

S.E. of regression	105.0391	Akaike info criterion	12.41028
Sum squared resid	474428.6	Schwarz criterion	13.14623
Log likelihood	-381.3341	Hannan-Quinn criter.	12.70066
F-statistic	43.15027	Durbin-Watson stat	1.448809
Prob(F-statistic)	0.000000		

*Note: p-values and any subsequent tests do not account for model selection.

Based on the results of the ARDL model

(0 ,1 ,4 ,0 ,4 ,2 ,4) that I reviewed, which examines the determinants of employment in the Iraqi agricultural sector under the influence of inflation shocks, exchange rate fluctuations, and the mediating role of agricultural investment

•Inflation or exchange rate shocks (X1): asymmetric effect (NARDL) Here we note a clear distinction between positive and negative shocks for

Positive shocks X1_POS have a positive coefficient (0.278) and high statistical significance. This means that an increase in this variable stimulates employment in the short term, possibly as a result of price increases that encourage producers to increase production and thus demand labor.

Negative shocks X2_NEG have a very high coefficient (1.183) and are statistically significant. What is notable here is the violent reverse effect at the fourth gap.

Agricultural employment in Iraq suffers from “excessive sensitivity” to negative shocks. Any decline in price incentives or exchange rate fluctuations leads to layoffs or a decline in employment levels that is much greater than similar increases .

•Exchange rate fluctuations (which mostly represent exchange rate volatility) did not have an immediate significant effect, but the effect appeared strongly at the fourth time lag with a coefficient of (0.828) and significance of.(0.01)

This indicates a time lag in the agricultural labor market's response to financial shocks. The real impact of today's exchange rate shock on employment may not appear until after four time periods, reflecting the slow production cycle in Iraq's agricultural sector .

1. The mediating role of agricultural investment It is noted that the coefficients (both positive and negative) have been very weak and statistically insignificant, indicating that agricultural investment in Iraq does not currently play an effective role in generating employment opportunities or mitigating shocks. This is due to the fact that investments are directed towards mechanization, which reduces dependence on labor, or that agricultural investments remain below the required level. This means that the volume of funds and technologies flowing into agriculture is still so small that it is unable to trigger a “chain reaction” that would change the face of the economy.

The determination coefficient *R*2=0.95 indicates that 95% of the variation in the dependent variable was explained by the independent variables, with the remainder attributable to other factors not included in the model and absorbed by the random variable.

Boundary test for the NARDL model

Null Hypothesis: No levels relationship

F-Bounds Test

I(1)	I(0)	Signif.	Value	Test Statistic
	Asymptotic: n=1000			
2.94	1.99	10%	7.882640	F-statistic
3.28	2.27	5%	6	k
3.61	2.55	2.5%		
3.99	2.88	1%		
	Finite Sample: n=65		65	Actual Sample Size
3.145	2.12	10%		
3.583	2.473	5%		
4.571	3.225	1%		

It can be seen from the table above that the calculated F-statistic is greater than the tabulated value for the upper limit at a confidence level of 1%, 2.5%, 5%, and 10%. Here, the alternative hypothesis is accepted. This means that there is a long-term equilibrium relationship between the variables.

Model quality test
Diagnostic tests for the NARDL model
Table test Heteroskedasticity Test: Breusch-Pagan-Godfrey

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	0.573988	Prob. F(21,43)	0.9142
Obs*R-squared	14.23144	Prob. Chi-Square(21)	0.8595
Scaled explained SS	13.05036	Prob. Chi-Square(21)	0.9068

It should be noted that the probability corresponding to the statistical value at 0.05 is greater than Obs*R-squared at a significance level of 5%.
Therefore, the null hypothesis, which states that the model is free of serial correlation, is accepted.

Testing for conditional heteroscedasticity with autocorrelation Heteroskedasticity Test: ARCH

F-statistic	0.004481	Prob. F(1,62)	0.9468
Obs*R-squared	0.004625	Prob. Chi-Square(1)	0.9458

It should be noted that the probability corresponding to the statistical value at 0.05 is greater than Obs*R-squared at a significance level of 5%.
Therefore, the null hypothesis stating that the model is free from the problem of heteroscedasticity is accepted.

Testing the adequacy of the specification and design of the estimated model in terms of the Ramsey functional form.

Ramsey RESET Test				
Equation: NARDL				
Specification: Y Y(-1) Y(-2) Y(-3) Y(-4) X1_POS X1_POS(-1) X1_POS(-2)				
X1_NEG X1_NEG(-1) X1_NEG(-2) X1_NEG(-3) X1_NEG(-4) X2_POS				
X2_NEG X2_NEG(-1) X2_NEG(-2) X2_NEG(-3) X2_NEG(-4) X3_POS				
X3_POS(-1) X3_NEG C				
Omitted Variables: Squares of fitted values				
	Value	df	Probability	
t-statistic	0.295549	42	0.7690	
F-statistic	0.087349	(1, 42)	0.7690	
F-test summary:				
	Sum of Sq.	df	Mean Squares	
Test SSR	984.6442	1	984.6442	
Restricted SSR	474428.6	43	11033.22	
Unrestricted SSR	473443.9	42	11272.47	

It is noted that the probability corresponding to the F-statistic value is greater than 0.05 at a significance level of 5%.
Therefore, the null hypothesis, which states that the model's spectral form is valid, is accepted.

Estimation Equation:
==========
D(Y) = C(1) + C(2)*Y(-1) + C(3)*X1_POS(-1) + C(4)*X1_NEG(-1) + C(5)*X2_POS +
C(6)*X2_NEG(-1) + C(7)*X3_POS(-1) + C(8)*X3_NEG + C(9)*D(Y(-1)) + C(10)*D(Y(-2)) +
C(11)*D(Y(-3)) + C(12)*D(X1_POS) + C(13)*D(X1_POS(-1)) + C(14)*D(X1_NEG) +
C(15)*D(X1_NEG(-1)) + C(16)*D(X1_NEG(-2)) + C(17)*D(X1_NEG(-3)) + C(18)*D(X2_NEG) +
C(19)*D(X2_NEG(-1)) + C(20)*D(X2_NEG(-2)) + C(21)*D(X2_NEG(-3)) + C(22)*D(X3_POS)

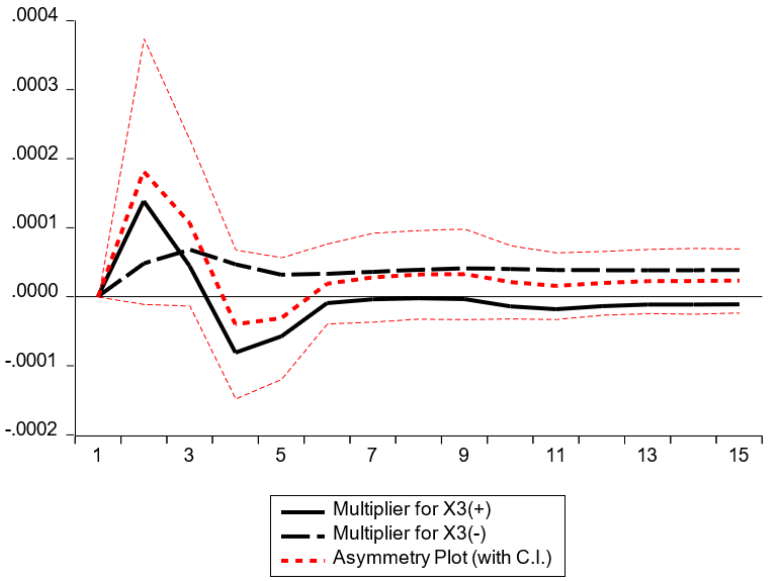
Long-run Dynamics
Inflation INF: The effect of lower inflation. If the values are different, it means that the agricultural labor market responds differently to price increases than it does to price stability.
Exchange rate EXR: Measures the impact of currency fluctuations. Typically, a higher exchange rate may increase the cost of imported agricultural machinery, which may force farmers to rely more on manual labor (substitution), or vice versa.

Agricultural investment (AGI): This is the most important part related to "critical mass": it measures the impact of increased investment. If the coefficient is small, this confirms your hypothesis that investment has not reached the critical mass to bring about structural change.

Second: Short-run dynamics

These are transactions associated with the difference sign, meaning that agricultural employment in the current month or year is affected by what it was in the previous three years (employment continuity). **Inflation shocks:** These measure how the agricultural labor market reacts to sudden jumps in inflation. Exchange rate shocks: These reflect the speed with which farmers respond to currency fluctuations (immediately reducing employment when input costs rise).

This measures the immediate and direct impact of new investment on the creation of agricultural jobs in the very short term.



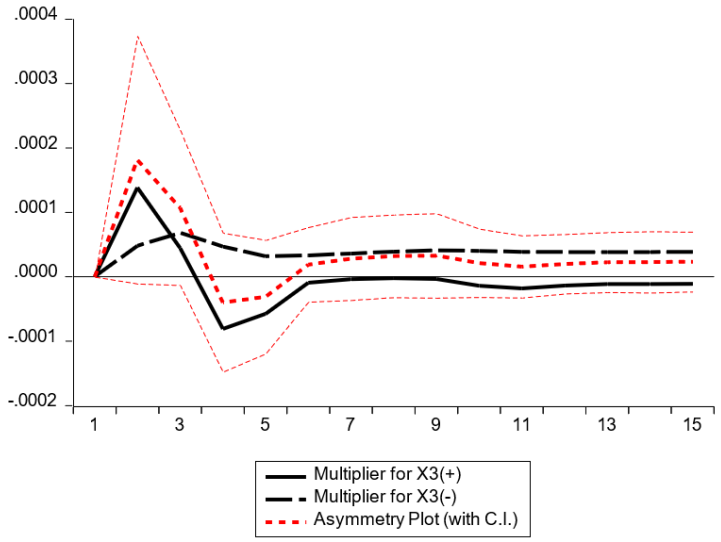
This figure shows the cumulative multiplier graph (Dynamic Multiplier Graph) resulting from the NARDL model, which represents the "cornerstone" of critical mass and asymmetry in the impact of agricultural investment (on agricultural employment).

The three curves explain:

1. The continuous curve (Multiplier for) Positive investment shock represents the agricultural employment response to increased agricultural investment. We observe an initial rise, but it fluctuates and then stabilizes at a level very close to the zero line (or slightly above it). This supports your claim that employment is "below the critical mass" required for genuine structural change by confirming that increased investment results in a minor and transient improvement in employment but fails to raise it to high and sustainable levels.
2. The long intermittent curve (Multiplier for) Negative investment shock represents the response of employment to a decline in agricultural investment, and the curve shows different behavior; it moves more slowly and steadily above the zero line, This indicates "rigidity" in the agricultural labor market, as a lack of investment may not lead to immediate layoffs (perhaps because they depend on agriculture as their primary livelihood), but it keeps employment stagnant.
3. The dotted red curve (Asymmetry Plot) - This asymmetry curve is the most important curve, representing the difference between the response of employment to an increase and its response to a decrease in investment. The thin red lines (C.I.): represent the 95% confidence interval. Since the zero line falls within the range of the dotted red lines in most periods (especially after period 6), this means statistically that asymmetry in the long term may not be strong, while in the early periods (2-4), the curve deviates from zero, indicating asymmetry in the short term.

The figure clearly shows that the agricultural response to agricultural investment shocks is very weak. Note that the values on the vertical axis are very small.

This figure is "incriminating evidence" for current investment policies; it proves mathematically that investment movements (whether upward or downward) do not significantly affect the employment structure, which means that current investments are dissipated before they reach the "critical mass" effect.



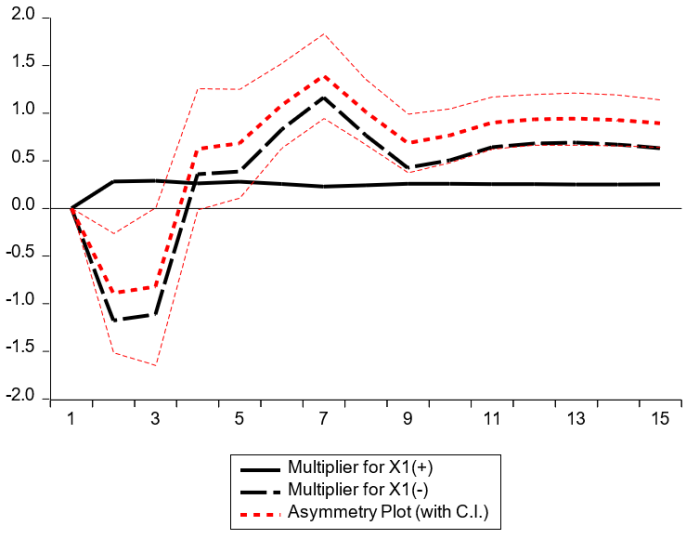
The cumulative dynamic multiplier graph illustrates the response of agricultural employment (Y) to positive and negative shocks in agricultural investment (X3) and supports your hypothesis about the "critical mass" as follows:

1. Response to positive stimuli (Multiplier for X3+) The continuous curve shows that more investment has a positive but little influence on agricultural employment (note that the figures on the vertical axis are quite small, about 0.0001). This influence quickly fades after the fourth period, which means that current investments aren't sustainable and don't move fast enough to cause lasting changes in the labour market.
2. Reaction to unfavourable shock (Multiplier for X3-) The discontinuous curve shows that when investment goes down, employment goes down a little bit, but then it stays above the zero line. This shows that the employment framework is stable, meaning that job growth doesn't go up a lot when investment goes up or down a lot when it goes down. This means that the sector is in a "survival mode" that is separate from modern capitalistic forces.
3. Asymmetry Plot Analysis

Short term (periods 1-5): The dotted red curve clearly deviates from the zero line, confirming the existence of a significant asymmetry; that is, the response of employment to an increase in investment differs in speed and strength from its response to a decrease at the beginning.

Long term (after period 6): We note that the zero line falls completely within the confidence intervals (thin red lines), which means that there is no asymmetry in the long term.

The figure confirms that agricultural investments remain "below critical mass," as the overall (cumulative) impact on employment is almost negligible and statistically insignificant in the long term. Current investments are not succeeding in transforming the agricultural sector into an engine for absorbing unemployment.



This figure represents the dynamic multiplier scheme for the inflation variable and its impact on agricultural employment .

Compared to the previous investment graph, we find here more severe and clear results regarding the impact of inflationary pressures to increase inflation .

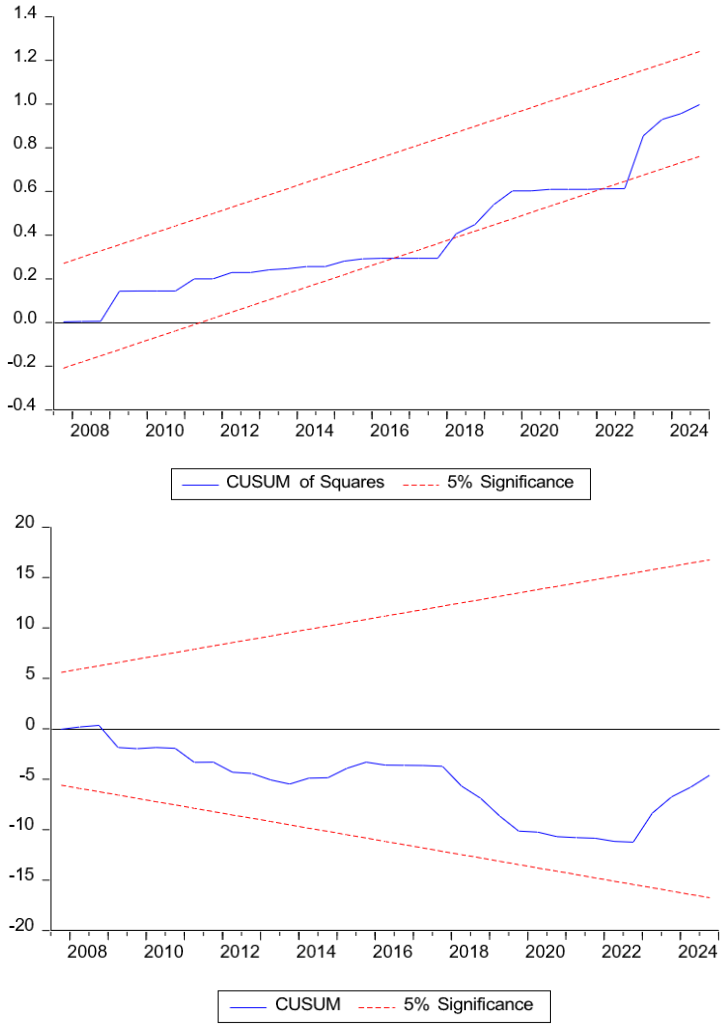
The continuous curve shows that a positive inflationary shock (price increase) leads to a slight and stable positive response in agricultural employment. Agricultural producers may resort to increasing their reliance on labor (especially cheap or seasonal labor) as a substitute for capital inputs whose prices have risen due to inflation, or this may be the result of an increase in agricultural product prices, which encourages a slight increase in activity .

Response to lower inflation: The broken curve shows violent and volatile behavior, with agricultural employment falling sharply in the early periods (1-3) in response to lower inflation (or price slowdown), then rebounding to rise significantly above the zero line. This indicates that the agricultural labor market is very sensitive to recessions or price declines; as soon as a negative price shock occurs, employment is immediately and strongly affected, reflecting the fragility of the employment structure .

Asymmetry Plot Analysis

- Short term: We note that the dotted red curve deviates significantly from the zero line (towards the negative), and the zero line falls outside the confidence intervals (thin red lines) in the early periods. This confirms the existence of a very significant asymmetry in the short term; that is, the effect of "deflation" on agricultural employment differs completely in strength and direction from the effect of "inflation".
- Long term: The red curve stabilizes above the zero line, and since the zero line remains outside the confidence interval in most periods, this indicates that the asymmetry continues even in the long term .

This means that agricultural employment is more affected by monetary variables (prices) and macroeconomic conditions than by direct investment policies, which reinforces the idea that current investments are insufficient to strengthen the sector's resilience to external shocks.



V. Conclusions And Recommendations

Conclusions

- The results of the standard estimation using the NARDL model proved the existence of a long- term equilibrium relationship characterized by asymmetry between monetary shocks and agricultural variables, as it was found that the negative impact of shocks (such as high inflation or a decline in the exchange rate) has a deeper and faster impact on employment and income levels than the positive impact, reflecting the vulnerability of the Iraqi agricultural sector to crises and its slow recovery from them.
- The results revealed excessive sensitivity of agricultural employment rates to inflationary pressures, as rising overall prices erode producers' real income, prompting them to cut labor costs and lay off workers as a first line of defense to reduce costs. This explains the strong inverse relationship between inflation and employment stability in rural Iraq.
- The analysis showed that parallel exchange rate fluctuations have a more direct impact on value added and agricultural income than on physical production quantities. Due to Iraqi agriculture's substantial structural reliance on imported inputs, any drop in the dinar's value is immediately deducted as a "cost tax" from farmers' real incomes and profit margins.
- The findings demonstrated that agricultural investment has not been totally successful in acting as a "stabilising buffer" to absorb monetary shocks, despite its positive moral impact. This is caused by the low allocative efficiency of investments and the predominance of operating costs over investments in cutting-edge technology, which lowers production costs and improves resistance to price swings.
- Standard diagnostic tests (such as the Ramsey RESET test for stationarity and the heteroskedasticity test) confirmed the robustness of the model used and its absence of structural errors, giving high credibility to the results obtained, which accurately reflect the dynamic relationship between monetary variables and the agricultural reality in Iraq for the period-1990). (2024

Recommendations

1- The necessity to establish a dedicated financing mechanism within the Central Bank of Iraq to supply foreign currency at a favourable and stable exchange rate for the importation of essential agricultural inputs (fertilisers, seeds, irrigation technologies), aimed at insulating agricultural production costs from fluctuations in the parallel market and safeguarding producers' real income from imported inflation.

2- Redirect agricultural investments, both public and private, towards value chain initiatives and food processing industries, rather than confining them to primary agriculture, to ensure the absorption of surplus labour during seasonal downturns and to generate added value that safeguards agricultural income from price declines of raw crops. To compensate farmers for losses brought on by abrupt price fluctuations and growing operating expenses, establish a national agricultural hedging and insurance fund. In times of economic crisis, not just natural disasters, this will maintain employment stability and productivity.

3. Encourage a change from fixed daily wage structures that are susceptible to inflation to partnership contracts that link wages to productivity in order to improve the agricultural job market. This will enhance rural income stability and performance efficiency while safeguarding workers' purchasing power.

4. Facilitate the coordination of agricultural and monetary policies. Ensure that the Central Bank considers the disparate impacts on the agriculture sector when making decisions about interest rates and exchange. Additionally, offer easily accessible credit packages to mitigate any potential deflationary effects of measures to stabilise the overall economy.

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