Predictability of Stock Price Fluctuations with an Application of Agricultural Companies Data

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Abstract

The research aimed to predict the fluctuations in closing Stock Price of four agricultural companies listed on the Iraq Stock Exchange using daily closing Stock Price data from 11/3/2015 to 15/3/2025. The symmetric and asymmetric ARCH model was applied to the research data. The results of the GARCH models showed that the closing price behavior of the companies (Al-Ahliyah for Agricultural Production, Middle East for Fish, Iraqi for Meat Production and Marketing) achieved a GARCH (1,1) rank, indicating that the effect of past error variance (ARCH) was of rank 1, in addition to the conditional variance element GARCH also being of rank 1. Meanwhile, the results showed that the closing prices for the Iraqi Seed Production Company were of rank GARCH (1,2). The results indicated that the first-order variance parameter was greater than one for all agricultural companies, suggesting that the fluctuations in stock closing prices exhibit a slight upward trend, which aligns with the logic of financial behavior in financial markets.

Keywords: Forecasting; Agricultural companies; ARCH model; GARCH model; Stock Price fluctuations

1. Introduction

Agricultural companies play a pivotal role in achieving food security and enhancing the national economy, especially amid global economic fluctuations. The closing stock prices of these companies in financial markets are an important indicator reflecting their performance and financial stability [1]. Therefore, measuring the volatility of closing prices is crucial for understanding market dynamics and assessing the risks associated with financial investment in this sector [2].

The changes in the closing prices of agricultural companies listed on the Iraq Stock Exchange are a source of concern for investors, leading them to hesitate in deploying their investments in these companies, which in turn affects the necessary financing for those projects [3]. Thus, it is essential to seek an appropriate method for measuring volatility in financial indicators to hedge against the financial risks that these companies may face [4]. Since the changes occurring in the indicators of companies listed on the stock exchange are daily changes, their impacts on traded companies appear to be immediate, prompting us to use a standard model that simulates the instantaneous changes in financial indicators, enabling investors to make decisions closer to reality [5].

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The importance of this topic lies in its assistance to investors and decision-makers in the investment process when making appropriate financial decisions by referring to the results of the model used, which contributes to increasing profitability and reducing financial losses. Therefore, the research aims to measure the volatility occurring in the closing prices of agricultural companies listed on the Iraq Stock Exchange by using Generalized Autoregressive Conditional Heteroskedasticity models.

2. Previous Literature:

A study by Dum et al.[6] found that asymmetric GARCH models provided more accurate and suitable results than symmetric GARCH models in constructing an appropriate model for the fluctuations in Nigerian crude oil prices. This result aligns with the findings of Naik & Reddy 2021, which indicated that GARCH models yield more accurate results in measuring the fluctuations in the Indian stock market index (VIX) compared to other standard models like TGARCH and EGARCH for volatility[7]. Zakoian modified the classic ARCH model and developed it to be more effective and suitable for measuring the fluctuations in the French stock market index (CAC)[8]. Singh & Tripathi found that GARCH and PGARCH models proved effective in predicting future fluctuations in the Indian stock market index (S & P CNX Nifty) and that the response to shocks in volatility from good news was more pronounced than from bad news [9]. Samineni et al. 2020 found that bad news had a direct negative impact on the Nifty Bank index through the application of the EGARCH(1,1) model [10]. Amudha & Muthukamu concluded that asymmetric volatility models, namely EGARCH and TGARCH, are capable of measuring the fluctuations in stock prices, which showed that these prices react asymmetrically to good and bad news [11]. Kotishwar found that volatility had a significant effect on the Nifty index. The results of the ordinary least squares method indicated that one minute of high-frequency trading had a greater impact than other time intervals on the Bank Nifty index [12]. However, the study Battal & Hamad concluded that the best model for predicting closing price volatility in the Iraq Stock Exchange is the (3,1) EGARCH model, based on the statistical criteria used for model selection (Akaike Information Criterion, Schwarz Criterion), and these models can provide information to investors to reduce the risks resulting from fluctuations in stock prices in the Iraqi financial market [13]. The study by Xu et al aimed to predict the closing prices of airline stocks to assist investors in making better financial decisions, using the LASSO (Least Absolute Shrinkage and Selection Operator) model. The results showed that the closing price of an airline's stock is influenced by its closing price on previous days and the closing prices of other types of airlines, and it is closely related to the Shanghai Composite Index from the previous day and the three days prior[14]. The study by Sakamoto & Sengoku aimed to compare the effectiveness of predicting stock prices during normal periods versus the COVID-19 pandemic period, as well as to analyze the extent to which business relationships between companies affect stock price volatility. The Fama-French three-factor model was used, and two time periods were defined: the normal period (from June 1, 2015, to January 31, 2020) and the COVID-19 pandemic period (from February 1, 2020, to May 31, 2020). The study's results indicated that business relationships between companies are an effective indicator for predicting stock price volatility, especially during crises like the COVID-19 pandemic [15]. The study by Elshamy et al aimed to address the challenge of accurately predicting stock prices by using an ensemble regression approach that combines multiple data sources. The proposed approach was evaluated using Tesla's data over four years and proved effective in predicting stock closing prices. The results showed that the ensemble regression approach was capable of accurately predicting stock prices under various scenarios, handling volatility, anticipating sudden changes, and predicting both minor and radical changes in stock prices [16].

3. Methodology and Working Methods

A group from the ARCH family has been employed as follows:

3.1. ARCH Model

It is one of the most important ARCH models and is called autoregressive conditional heteroskedasticity. Engle proposed this model in 1982 as follows[17]:

$$y_t = \phi + e_t$$
$$e_t \mid I_{t-1} \sim N(0, h_t)$$
$$h_t = \alpha_0 + \alpha_1 e_{t-1}^2, \quad \alpha_0 > 0, \quad 0 \le \alpha_1 < 1$$

Since ϕ represents the average closing price, a0 and a1 represent the parameters of the variance equation of the closing price fluctuations.

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3.2. The General GARCH Model

It is one of the families of the ARCH model and is called the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model, referred to as conditional regression with non-constant general variance homogeneity [18], and is expressed in the following form[19]:

$$h_t = \delta + \alpha_1 e_{t-1}^2 + \beta_1 h_{t-1}$$

α1 + β1 are variance fluctuation parameters; if the sum of both parameters is less than one, it indicates stability in the fluctuations of closing prices. However, if the sum is greater than or equal to one, it is called the integrated GARCH process.

3.3. The Threshold ARCH Model

This is one of the ARCH family models and considers the effects of positive and negative news shocks, which may have asymmetric effects on stock price volatility. The formula for this model is as follows[20]:

$$h_t = \delta + \alpha_1 e_{t-1}^2 + \gamma d_{t-1} e_{t-1}^2 + \beta_1 h_{t-1}$$

$$d_t = \begin{cases} 1 & e_t < 0 \text{ (bad news)} \\ 0 & e_t \geq 0 \text{ (good news)} \end{cases}$$

Where γ represents the asymmetry or leverage parameter. If it equals zero, it means the model does not include asymmetry and approaches the general GARCH model[21]. If it is positive, it represents a positive shock (good news), and the effect on stock price volatility is through the parameter α1. If it is a negative shock (bad news), the effect on stock price volatility is through (α1 + γ). If the leverage parameter γ is positive and large, and significant, it means that the negative news shock was greater than the positive news shock[22].

3.4. GARCH-in-Mean Model

This is one of the ARCH family models; however, it takes into account the risk premium for stock price volatility and takes the following form[23]:

$$y_t = \beta_0 + \theta h_t + e_t$$

$$e_t \mid I_{t-1} \sim N(0, h_t)$$

$$h_t = \delta + \alpha_1 e_{t-1}^2 + \beta_1 h_{t-1},$$

$$\delta > 0,\ 0 \leq \alpha_1 < 1,\ 0 \leq \beta_1 < 1$$

The ɵ represents the risk premium in the estimated model, and should be greater than zero, as well as the values of α1 + β1 ranging between zero and one[24].

4. Results and Discussion

The agricultural sector accounts for (7.8%) of the total number of companies listed on the Iraq Stock Exchange, which has a total of 135 companies as of 2024. The number of agricultural companies listed in the market is 8, with the number of shares traded in 2023 reaching approximately (43,590,657) shares and a trading value of (463,665,817) dinars. Investing in this sector is considered a successful investment, as it provides a fertile environment for the growth of agricultural investment due to its investment components that contribute to achieving long-term economic development[25].

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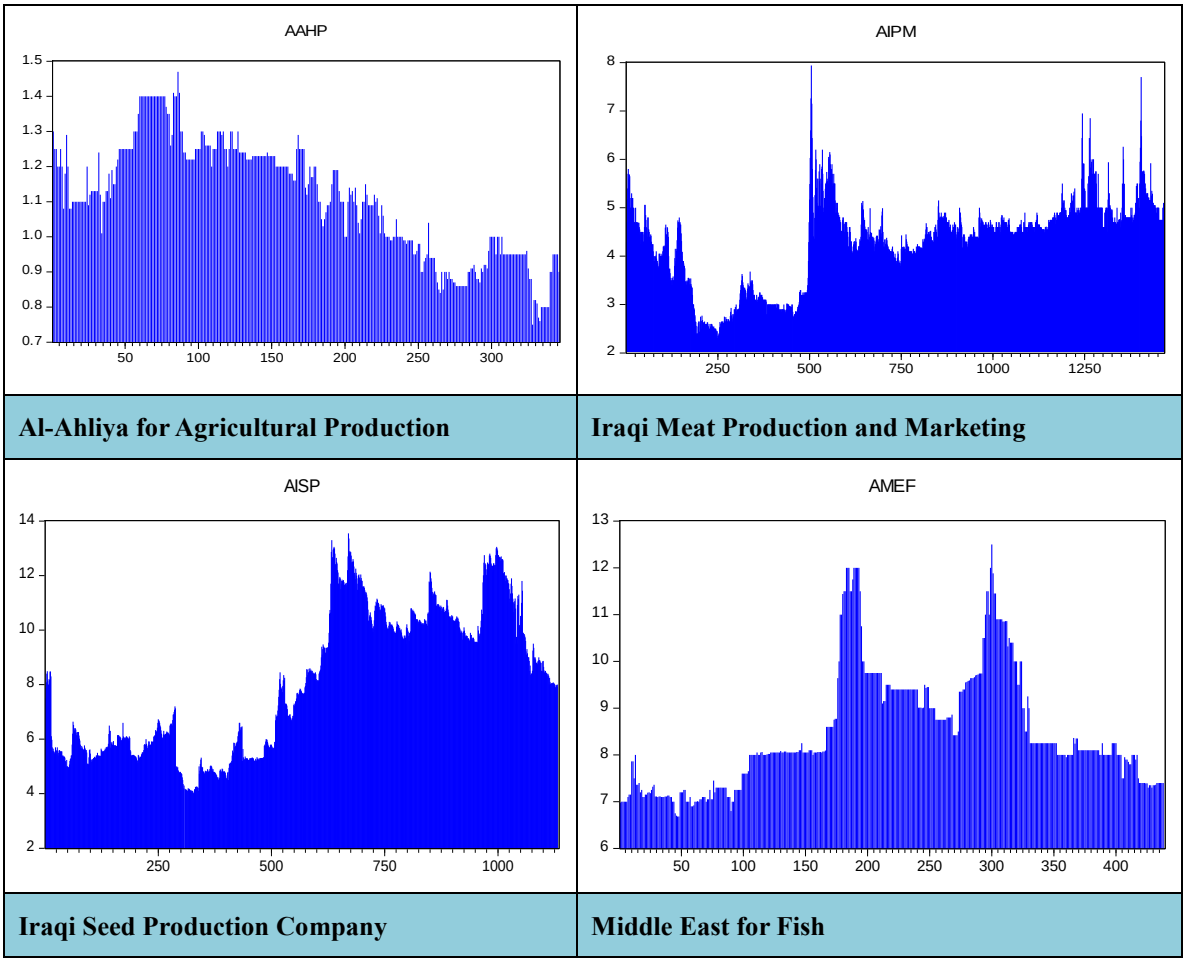

Figure 1. Closing price series of agricultural companies listed in the Iraqi financial market.

Figure 1. represents the time series data of daily closing prices for a group of agricultural companies listed on the Iraq Stock Exchange for the period 2015-2024, where (346) observations were obtained for Al-Ahliya Agricultural Production Company, (1464) observations for the Iraqi Company for Meat Production and Marketing, (1133) observations for the Iraqi Seed Production Company, and (439) observations for the Middle East Fish Company. It is noted from Figure 1. that the closing prices of the agricultural companies listed in the Iraq Stock Exchange do not follow a normal distribution (asymmetrical), a characteristic that most financial indicators of financial markets exhibit.

4.1. Descriptive Statistics Indicators:

The results of the descriptive statistics in Table 1 for the agricultural companies in the sample study show that the number of observations varies from one company to another based on the available official data issued by the official website of the Securities Commission in Iraq. It is also evident that the highest mean of closing prices was for the Middle East Fish Company (AMEF), with a mean closing price of (8.472) dinars, while the lowest mean closing price was for the Al-Ahliyah Agricultural Production Company (AAHP), which was (1.11) dinars. At the company level, the highest closing price for AMEF was approximately (12.50000) dinars, while the lowest closing price recorded was (6.680000) dinars. The highest closing price for AAHP reached (1.470000) dinars, while the lowest closing price for the shares of this company was (0.163254) dinars. The skewness coefficient for the Al-Ahliyah Agricultural Production Company and the Iraqi Company for Meat Production and Marketing was (-0.090878, -0.293278) respectively, indicating a negative skewness, which means that the series of fluctuations in closing prices is skewed to the left, indicating that closing prices are more affected by negative shocks than by positive shocks. In contrast, the skewness

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coefficient for the Iraqi Seed Production Company and the Middle East Fish Company was (0.215380, 1.037251) respectively, indicating that the series of fluctuations in closing prices is skewed to the right, meaning that the closing prices of the shares are more affected by positive shocks than by negative shocks.

Table 1: Results of the descriptive statistics for the closing prices of agricultural companies.

Statistical indicators	Agricultural production eligibility	Iraqi Meat Production and Marketing	Iraqi Seed Production	Middle East for Fish
	AAHP	**AIPM**	**AISP**	**AMEF**
Mean	1.110376	4.302459	8.080071	8.472073
Median	1.120000	4.500000	8.000000	8.080000
Maximum	1.470000	7.940000	13.55000	12.50000
Minimum	0.750000	2.310000	4.000000	6.680000
Std. Dev.	0.163254	0.885951	2.623314	1.252940
Skewness	-0.090878	-0.293278	0.215380	1.037251
Kurtosis	2.073901	3.036625	1.643772	3.579791
Jarque-Bera	12.84086	21.06880	95.59262	84.86813
Probability	0.001628	0.000027	0.000000	0.000000
Heteroskedasticity Test: ARCH				
F-statistic	1894.031	6374.493	25680.74	4756.793
Probability	0.0000	0.0000	0.0000	0.0000
UNIT ROOT TEST RESULTS (ADF) Without Constant & Trend at level				
t-Statistic	0.4820	-0.7176	-0.5185	-0.3288
Probability	**0.8187**	**0.4059**	**0.4921**	**0.5666**

It is also evident that the time series of stock closing prices were non-stationary, meaning the t-statistic was not significant with the constant and the trend at level, indicating significant fluctuations in those prices, which necessitates the construction of a standard model to measure those fluctuations.

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4-2- Estimation of ARCH Models

Table 2: Results of agricultural companies listed in the Iraq Stock Exchange

ARCH Model Estimates				
	AAHP	AIPM	AISP	AMEF
$\hat{r}_t = \hat{\beta}_0$:	1.22***	4.61***	5.58***	8.07**
$\hat{h}_t = \hat{\alpha}_0 + \hat{\alpha}_1 \hat{e}^2_{t-1}$	0.001***+1.025***	0.001 ***+1.038***	0.013***+1.009**	0.001***+1.07**
(*) Significant at the 10%; (**) Significant at the 5%; (***) Significant at the 1% and (no) Not Significant				

Table 2. shows the estimation of (ARCH) models for agricultural companies as follows:

The results for AAHP company indicate that the average daily closing price of the company's stock during the research period was (1.22) dinars. The variance equation shows a positive fluctuation in the company's stock price at a rate of 0.001 daily. The first-order variance parameter was (1.025), indicating a continuous fluctuation in the closing prices of AAHP shares. All these parameters were significant at the 1% level. It is worth noting that the variance estimator parameters (0, α1α) had values greater than zero. As for AIPM company, the average closing price reached (4.61) dinars, and the stability of the fluctuation rate was 0.001, similar to AAHP, in addition to the first-order variance parameter reaching (1.038), indicating continuous and increasing fluctuations in the closing prices of AIPM shares. Regarding companies (AISP and AMEF), the estimation results indicated that the average daily closing prices for these two companies were (5.58 and 8.07) dinars, respectively, along with positive fluctuations in the closing prices of (0.013 and 0.001) respectively. The first-order variance parameter was (1.009) for AISP and (1.07) for AMEF.

It is evident from the above that the highest fluctuations in closing stock prices were in AMEF company at (1.07), while the company with the lowest fluctuations in closing stock prices was (AISP) at (1.009).

4.3. Estimation of GARCH models for agricultural companies listed in the Iraq Stock Exchange.

Table 3: GARCH models for agricultural companies listed in the

	GARCH Model Estimates		GARCH(p, q))
	$\hat{r}_t = \hat{\beta}_0$:	$h_t = \delta + \alpha_1 e^2_{t-1} + \beta_1 h_{t-1}$	
AAHP	1.22***	6.54E-05**+0.96***+0.260***	GARCH(1, 1)
AIPM	4.62***	0.004***+0.774***+0.258***	GARCH(1, 1)
AISP	5.58***	0.012***+0.911***+0.121***-0.030***	GARCH(1, 2)
AMEF	8.07***	0.005***+0.807***+0.235***	GARCH(1, 1)
(*)Significant at the 10%; (**)Significant at the 5%; (***) Significant at the 1% and (no) Not Significant			

Table (3) shows the results of estimating GARCH models for the research sample companies. The results for company AAHP indicate that the first-order error variance parameter (α1= 0.96) means that previous fluctuations in stock closing prices affect current closing prices in the short term, while the GARCH effect coefficient (β1=0.260) indicates the persistence of closing price fluctuations in the long term. These parameters are significant at the 1% level, confirming

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the presence of a volatility clustering feature. It is noteworthy that the sum of the previous error variance coefficient and the GARCH effect for the model (α1 + β1=1.22) is greater than one, indicating the persistence of shocks and previous fluctuations on current fluctuations, increasing over time.

For company AIPM, the first-order error variance parameter for the past period was (α1= 0.774), indicating that previous fluctuations in closing prices affect current closing prices in the short term, while the GARCH effect coefficient (β1=0.258) indicates the persistence of closing price fluctuations in the long term. All parameters were significant at the 1% level, indicating the presence of a volatility clustering feature. It should be noted that the sum of the previous error variance and the GARCH effect for the model (α1 + β1=1.032) is greater than one, indicating the persistence of the effects of previous shocks and fluctuations for company AIPM on current fluctuations, increasing over time. This result is consistent with the study by Dum & et al [6].

However, the results of company (AISP) indicated that the parameter of the previous error variance of the first degree reached (α1= 0.911), which means that the previous fluctuations in stock closing prices affect the current closing prices in the short term, while the impact of the GARCH effect coefficient (β1=0.121) indicates the continuity of fluctuations in closing prices in the long term, noting that all parameters were significant at the 1% level, thus confirming the property of variance persistence. Additionally, the sum of the previous error variance and the GARCH effect for the model (α1 + β1=1.031) indicates the continued impact of shocks and previous fluctuations of company AISP on current fluctuations, increasing over time. Regarding the results of company (AMEF), it showed that the parameter of the previous error variance of the first degree reached (0.807), which means that the previous fluctuations in stock closing prices have a clear impact on current closing prices in the short term, as well as the continuity of closing price fluctuations in the long term, which was indicated by the GARCH effect coefficient (β1=0.235). Furthermore, the sum of the previous error variance and the GARCH effect for the model (α1 + β1=1.042) shows that since its value is greater than one, this indicates the continuity of the impact of shocks and previous fluctuations of company AMEF on current fluctuations, increasing over time.

Regarding the threshold GARCH models, the results confirmed the asymmetry in the impact of positive and negative news, as it was found that positive news often leads to greater volatility than its negative counterpart, except for AMEF, which was more affected by negative news, reflecting the sensitive nature of some agricultural activities to political and economic stability. This result supports the "reverse leverage effect" hypothesis, as discussed in the literature such as Glosten et al. 1993, which indicated that there is variation in response to shocks based on their type[26].

4.4. Estimation of the Threshold GARCH Model for Listed Agricultural Companies.

Table 4: Results of the Threshold Model.

	threshold ARCH model Estimates		GARCH(p, q))
	$\hat{r}_t = \hat{\beta}_0 +$	$h_t = \delta + \alpha_1 e_{t-1}^2 + \gamma d_{t-1} e_{t-1}^2 + \beta_1 h_{t-1}$	
AAHP	1.226***	5.00E-05**+1.162***-0.243+0.249**	GARCH(1, 1)
AIPM	4.627***	0.0048*+0.785***-0.0161+0.257***	GARCH(1, 1)
AISP	7.962**	0.0902**+0.811***-0.058-0.026+0.281**	GARCH(1, 2)
AMEF	8.068**	0.005***+0.788***+0.068+0.230**	GARCH(1, 1)
(*)Significant at the 10%; (**)Significant at the 5%; (***) Significant at the 1% and (no) Not Significant			

Table 4. shows the results of the threshold model for agricultural companies listed on the Iraq Stock Exchange. The results for the company (AAHP) indicate that the impact of positive news shocks was (1.162 α1=), while the impact of negative news shocks was (α1 + γ =0.91), which means that the impact of negative news shocks was less than that of positive news shocks on the volatility of the closing prices of AAHP shares. Additionally, all parameters were significant at the 1% level, and the financial leverage parameter (γ= -0.243) was significant and negative, indicating

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that the effect of positive shocks was more significant than the effect of negative shocks on the volatility of the company's closing prices. Meanwhile, the results for the company (AIPM) indicated that the impact of positive news shocks was (0.785 α1=), while the impact of bad news shocks was (α1 + γ =0.768), suggesting that the impact of positive news shocks was greater than that of negative news shocks on the volatility of the company's closing prices. Furthermore, all parameters were significant at the 1% level, and the financial leverage value (γ= -0.0161) was significant and negative, indicating that the effect of positive shocks was more significant than the effect of negative shocks on the volatility of the company's closing prices.

The results of the company (AISP) indicated that the effect of positive news shocks was (0.811 α1=), which is consistent with the study by (Singh & Tripathi, 2016). Meanwhile, the effect of negative news shocks was (α1 + γ =0.753), which means that the impact of negative news shocks was less than that of positive news shocks on the volatility of the company's closing stock prices. Furthermore, all parameters were significant at the 1% level, and the leverage parameter (γ= -0.058) was significant and negative, indicating that the impact of positive shocks is more significant than that of negative shocks on the company's closing stock price volatility. On the other hand, the results of the company (AMEF) indicated that the effect of positive news shocks was (0.788 α1=), while the effect of negative news shocks was (α1 + γ =0.856), suggesting that the impact of positive news shocks was greater than that of negative news shocks on the volatility of the company's closing stock prices. Additionally, all parameters were significant at the 1% level, and the leverage value (γ=0.068) was significant and positive, indicating that the impact of negative shocks was more significant than that of positive shocks on the company's closing stock price volatility, which is consistent with the study by Dritsaki 2017[27]. As shown in the Figure 2.

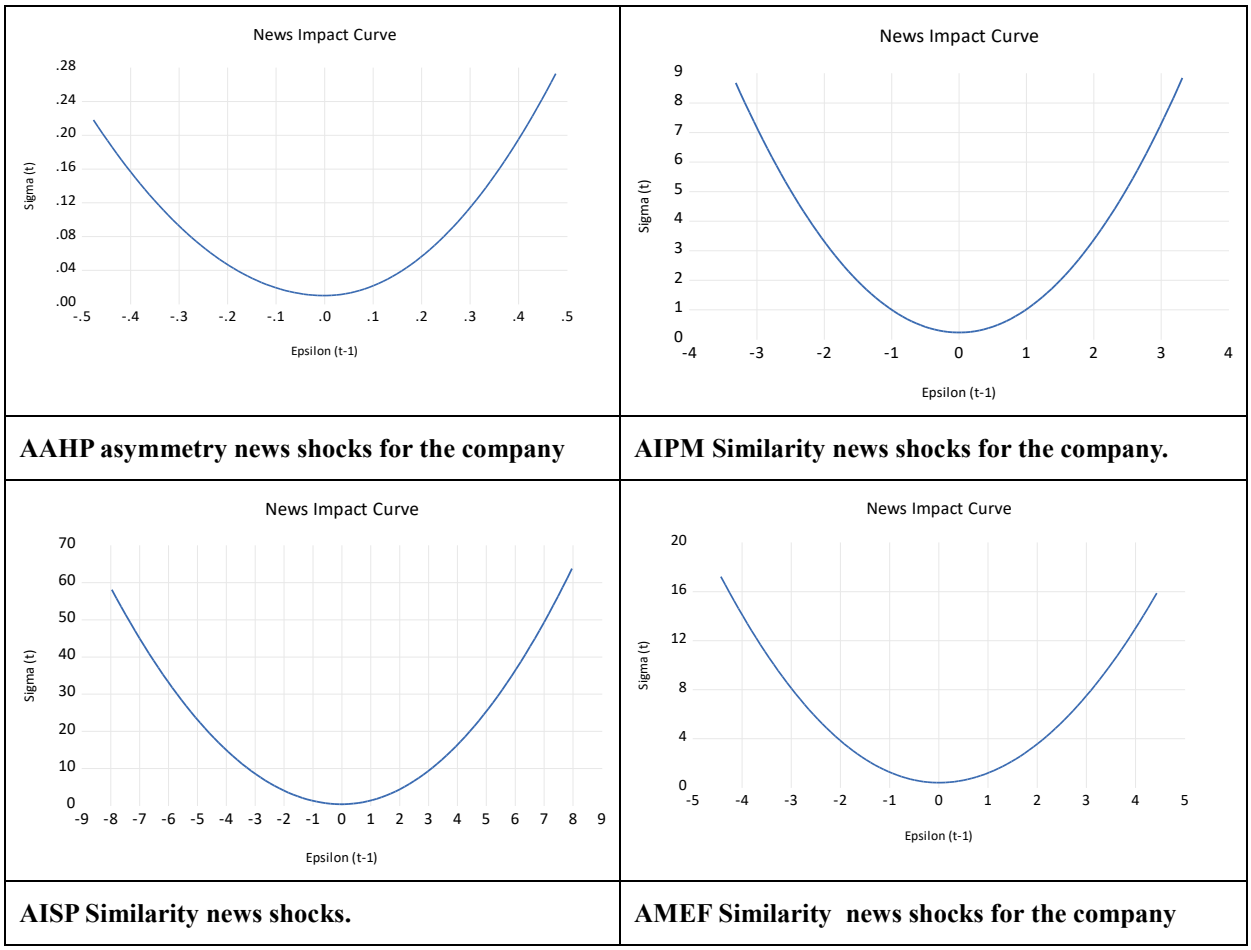

Figure 2. Symmetry of positive and negative news shocks for agricultural companies listed on the Iraq Stock Exchange

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It is evident from Figure 2. that positive shocks are more significant than negative shocks for the companies (Iraqi Seed Production Company AISP, Iraqi Meat Production and Marketing Company AIPM, Agricultural Production Company AAHP), while negative shocks were more significant than positive shocks for the Middle East Fish Company (AMEF).

4.5. Estimation of GARCH-M models with the mean.

Table 5: Results of GARCH-M models

	Estimated mean and variance of T-GARCH model		GARCH(p, q))
	$y_t = \beta_0 + \theta h_t + e_t$ Risk Premium	$h_t = \delta + \alpha_1 e_{t-1}^2 + \gamma d_{t-1} e_{t-1}^2 + \beta_1 h_{t-1}$ $h_t = \delta + \alpha_1 e_{t-1}^2 + \beta_1 h_{t-1},\ \delta > 0,\ 0 \le \alpha_1 < 1,\ 0 \le \beta_1 < 1$	
AAHP	0.002**-0.107**	0.0001***+00011***-0.0001+0.523***	GARCH(1, 1)
AIPM	0.015**-0.107*	0.0003*+0.165***-0139+0.888***	GARCH(1, 1)
AISP	0.020**-0.186***	0.004**+0.620***-0.599**+0.685***	GARCH(1, 1)
AMEF	0.0006***-0.007***	0.003***+0.197***-0.196***+0.411***	GARCH(1, 1)
(*)Significant at the 10%; (**)Significant at the 5%; (***) Significant at the 1% and (no) Not Significant			

Table 5. shows the GARCH-M model results for agricultural companies.

The results of the agricultural companies listed in the Iraq Stock Exchange sample indicate that the risk premium (θ = -0.107, -0.107, -0.186, -0.007) for (AAHP, AIPM, AISP, AMEF) respectively are negative and significant at the 5% level. This is since the closing prices for most agricultural companies are trending downwards, including the company (AAHP), which had a closing price of 1.3 dinars on 17/3/2015 and became approximately 0.9 dinars by the end of the period on 30/5/2024 due to weak trading in the Iraq Stock Exchange. This means that the decline in closing prices leads to a decrease in the risk premium, which aligns with financial analysis. The GARCH-M model results demonstrated a negative relationship between the level of risk and expected return (Risk Premium), showing that increased volatility leads to a decrease in expected stock returns, which is consistent with the reality of the Iraqi market characterized by low liquidity levels and modest trading volume. This behavior contradicts classical theory, which posits a link between higher risk and higher return, while simultaneously confirming the findings of previous studies conducted on emerging markets suffering from weak financial market infrastructure.

5. Conclusion

This study aimed to explore the dynamics of closing price fluctuations for agricultural company stocks listed on the Iraq Stock Exchange by applying ARCH, GARCH, T-GARCH, and GARCH-M models. This was part of an effort to understand the financial risk characteristics associated with this vital sector in the context of an emerging economy characterized by unstable market features. Daily closing price data for four agricultural companies were analyzed over a period extending several years, relying on the outputs of the EViews 12 statistical program. The results of the ARCH models highlighted significant volatility in all companies, reflecting the sensitivity of closing prices to daily events and their instability. The models also revealed that these fluctuations are characterized by persistence, indicating a weak market capacity to absorb short-term shocks, which reflects the characteristics of emerging markets that lack depth and transparency. Using GARCH models, the results showed a complex behavior of variance, where the sum of the ARCH and GARCH coefficients (α + β) exceeded one in most companies, indicating a long-term cumulative effect of shocks on price volatility, which aligns with modern financial literature regarding developing markets. All-time series of agricultural companies listed on the Iraq Stock Exchange (study sample) exhibit strong short-term fluctuations according to the ARCH test for heteroskedasticity. The rate of fluctuation in closing prices for these companies assists investors who wish to buy and sell shares in determining the upper and lower limits for buying and selling. Positive

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news shocks have a stronger impact than negative news shocks on the closing prices of agricultural company shares. However, the results for the Middle East Fish Company indicated that the negative news shock had a stronger effect than the positive news shock on the company's closing stock prices. Additionally, the first-order variance parameters were greater than one for all agricultural companies (study sample), indicating that the fluctuations in closing stock prices have taken a slight upward trend, which aligns with the logic of financial behavior in financial markets. Finally, the study concluded that the closing prices of agricultural companies are trending downwards, as confirmed by the risk premium results, which were negative for all companies, indicating that investing in these companies' shares carries high risks.

The entry of agricultural companies, such as dairy manufacturing companies, into the financial market in Iraq aims to enhance competition, increase trading volume, reduce financial investment risks, achieve investment profits, and promote transparency and disclosure in the Iraqi financial market. It also encourages companies to adhere to international financial reporting standards, as well as to develop laws and regulations for trading. Additionally, there is a focus on expanding the use of hedging tools and risk management, especially in sensitive agricultural sectors, along with the importance of encouraging applied research that links macroeconomics and market behavior.

The study suggests that future research should focus on using more advanced models, such as EGARCH and APARCH models, which may provide greater capacity to describe the asymmetric distribution characteristics of volatility. It is also advisable to include macroeconomic variables in predictive models to provide a broader and more accurate perspective for both decision-makers and investors.

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