Journal of Animal & Plant Sciences, 36(3): 2026, Page: 766-780
ISSN (print): 1018-7081; ISSN (online): 2309-8694
https://doi.org/10.36899/JAPS.2026.3.0063

MODELING THE DYNAMIC IMPACT OF ECONOMIC FACTORS ON POULTRY MEAT PRODUCTION IN EGYPT

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ABSTRACT

The present paper examines key economic determinants affecting levels of commercial broiler (poultry) production using Autoregressive Distributed Lag (ARDL) to estimate short- and long-run effects on a sample data from 1995 to 2023, constraints that would limit the possibility for achieving full self-sufficiency or increased per capita availability, as well as identifying major challenges facing commercial broiler poultry sector in Egypt. The results show that there are economic factors affecting potential of self-sufficiency. The results of the study using the autoregressive distributed lag method over the period (1995-2023) indicated that there is a statistically significant positive relationship in the short term between the price of poultry in the current year and the quantity of broiler poultry production in the current year, and a statistically significant negative relationship between poultry investment in the previous year and the amount of broiler poultry production in the current year, and a statistically significant negative relationship between the inflation rate in the previous year and the quantity of broiler poultry production in the current year. This was due to the value of the error correction coefficient (ECt-1) which showed that the imbalance in the quantity of poultry meat produced could be corrected within the short term but the balance achieved in the long term within a period of less than two years. The long-term results showed a statistically significant negative relationship between the price of feed in the previous year and the quantity of broiler production in the current year, and a statistically significant negative relationship between the real per capita income in the last year and the amount of broiler production in the current year. The study recommends increasing investments in the poultry sector, as a 1% increase in investment leads to a long-term increase in broiler production of approximately 0.625%. The study also recommends expanding the application of inflation-control policies, as a 1% increase in inflation leads to decreases in broiler production of approximately 0.107% and 0.274% in the short- and long-term, respectively.

Keywords: Poultry meat - Poultry investment – Inflation rate - Self-sufficiency – ARDL

Published first online February 14, 2026 Published final May 05, 2026

INTRODUCTION

Poultry meat is one of the most important sources of animal protein for the population, accounting for about 40% of global meat consumption. There are approximately 34.4 billion chickens, producing approximately 103.7 million tons, and investments are estimated at roughly $360.5 billion in 2023. The United States of America is the largest producer which produces about 21.08 million tons of poultry meat, which is about 20 percent of the total world market. Brazil comes after it with a figure of about 14.9 million tons which is approximately 14 percent of the world production. China is the third major producer of poultry in the world and the first in Asia with a production of about 14.8 million tons which represents about 14 percent of the world market. In 2023, Egypt will be the top producer of poultry meat in Africa and the Arab world where it will generate about 1.85 million tons (USDA, 2023).

Production of livestock in Egypt has a significant discrepancy between supply and demand, mostly because of short production of green fodder especially in summer. This makes the country more and more dependent on the importation of dry feed and concentrates, which greatly increases production expenses when the Egyptian pound is weakening against the U.S. dollar. This production-consumption imbalance directly affects per capita animal protein availability, prompting the government to import large quantities of red meat and, to a lesser extent, poultry meat to mitigate the food deficit and enhance relative food security.

However, this heightened dependence on imports exerts additional pressure on foreign currency reserves, triggering inflationary waves that further escalate prices (Rodrigues *et al.*, 2024).

Recently, there has been an expansion in the commercial production of meat poultry to cover the growing demand for animal protein, considering the high prices of red meat, as the volume of investments directed to the poultry sector reached about 2807.45 million pounds and the production quantity reached about 2.15 million tons in 2023 (CAPMS, 2023), at a time when private investment decreased by about 13% at the national level and the lack of international liquidity to exit about 20 billion dollars of foreign investments, the widening of the financing gap from foreign exchange, and the decrease in GDP by about 2.5% from the target in 2023 (MPED, 2023). This is because the poultry industry is one of the labor-intensive activities that suit the economies of developing countries and is characterized by high production efficiency in terms of rapid capital turnover, high food conversion rates, and high clearance rates per unit produced, in addition to the use of by-products from farm residues and slaughter products in the manufacture of plant fertilizers and animal feeds However, the poultry industry represents about 80% of imported production inputs, most of which are concentrated in feed and veterinary serums, which makes it greatly affected by exchange rate changes and the subsequent waves of imported inflation that raise production costs to the degree that leads to the inability of small producers to continue the production process, As a result, the limited production capacity has hindered the sector's ability to meet domestic demand.

The study of the impact of economic factors on broiler meat production is one of the most important methods and tools for understanding the causes of the production gap for goods and services at the macroeconomic level. This is done by prioritizing the impact of these economic factors on the size of the production gap. Thus, the production gap for poultry can be addressed without significantly increasing imports and the resulting increase in foreign exchange demand crises.

At the same time, it increases the efficiency of using local production resources through monetary policy tools, while reducing the impact of the variables under study. This is in light of the global food crisis and the sharp increase in food prices across 164 countries by about 74% (WB, 2023). a large part of which is due to the impact of the coronavirus pandemic and the Russian-Ukrainian crisis, which resulted in rising prices of production inputs due to fluctuations in the local currency exchange rate in many countries and the occurrence of a massive inflationary wave that led to an increase in the general level of prices for all goods and services, Among them is the Egyptian economy, especially food gap commodities, whose production inputs depend to a large extent on imports. This makes it more sensitive than other commodities to inflationary waves and the resulting decline in production and rise in prices, particularly in the poultry industry in Egypt.

MATERIALS AND METHODS

The Egyptian economy has recently faced several economic crises due to several factors, including the allocation of a large portion of the state's resources to rehabilitate the infrastructure of vital sectors characterized by long-term returns, in addition to the occurrence of several international and regional economic crises, the most important of which are the Corona pandemic and the Russian-Ukrainian war, which negatively affected foreign exchange resources, including the decline in Suez Canal revenues, remittances of workers abroad, and the exit of some foreign investments (hot money), which led to fundamental economic changes, the most important of which is the rise in the general inflation rate by about 33.88% in 2023 (WB, 2023).

These changes contributed significantly to the increase in the food production deficit, including the inability of the poultry sector to achieve self-sufficiency in the production of broiler poultry, as a result of the high costs of production inputs, the cessation of small producer farms, the rise in broiler poultry prices, and the inability of current broiler poultry production to cover the current demand volume despite the increase in the volume of investments directed to the poultry sector, by about 319.89 million pounds and an increase in the quantity of broiler poultry production by about 212,000 tons in 2023 compared to 2022. These changes also led to a decrease in real per capita income (a decline in consumers' purchasing power), resulting in a drop in the per capita share of poultry meat from about 14.1 kg in 2019 to about 10.9 kg in 2023.

The research aims to study the current status of broiler poultry production in Egypt over the study period (1995-2023). This period was chosen because it reflects major transformations in the Egyptian economic structure that led to structural changes in the poultry production sector in a cumulative and successive manner, most notably the economic reform programs represented by the liberalization of production input prices, then the global financial crisis in 2008 and its impact on economic growth rates, including the poultry sector, then the January 2011 revolution, the Corona crisis in 2020, and the Ukrainian-Russian war in 2022 and their negative effects on economic indicators such as inflation and a significant weakening of the local currency. These events were followed by a partial managed liberalization of the exchange rate three times from November 2016 until 2023, which caused a significant increase in poultry production costs and varying changes in the quantity of

production that require an in-depth study during this period.

The research also aims to study the economic factors affecting the production quantity over the study period to identify the impact of the most important of these factors on the inability of the poultry sector to achieve absolute self-sufficiency and improve the per capita share, where the Autoregressive Distributed Lag (ARDL) method was used, to help the decision maker in addressing the effects of these factors on broiler poultry production in both the short and long term and to determine the time period required to address the imbalance and remedy the defect in production quantities in light of their relative importance to the impact of these variables, as well as to study the most critical problems and obstacles facing broiler poultry production in Egypt.

Data collection: The study used descriptive economic analysis and quantitative statistical methods, such as simple regression, to examine general time trends and analyze poultry meat production in Egypt over the study period.

Econometric analysis was also used in the research to investigate the effect of economic variables in the production of poultry meat by the Autoregressive Distributed Lag (ARDL) regression model in logarithmic form. This was to determine the most significant economic variables that influence the amount of production in the short and long term within the study period.

The secondary data were obtained on food balance bulletins, agricultural income bulletins published by the Ministry of Agriculture, (CAPMS), economic reports published by the Ministry of Planning and Economic Development, periodic reports published by the World Bank, special sites, as well as research and studies that were directly related to the research topic.

Data analysis: The research used the Autoregressive Distributed Lag (ARDL) approach, also known as the Bounds Test method (Pesaran *et al*., 2010). This method is distinguished from other cointegration methods by the following: The ARDL method can be applied regardless of whether the independent variables are I(0) integrated or I(1) integrated, provided that one of the variables is not I(2) integrated or higher (Georgescu and Kinnunen, 2025; Albahouth, 2025), The ARDL method is recognized for its robustness in cointegration analysis, particularly in small sample studies, where it proves to be more reliable than traditional methods that require large sample sizes to ensure accuracy and efficiency (Sharaf *et al*., 2025), (Abdulrahman *et al*., 2024), The ARDL method enables the simultaneous estimation of short-term and long-term relationships (Kripfganz and Schneider, 2023), and It helps eliminate issues of statistical parameter estimation, such as the omission of variables, autocorrelation, and bias, making the estimators efficient (Khan *et al*., 2025).

The autoregressive distributed lag approach to the study of the effects of economic factors on the production of broiler poultry in Egypt follows the following steps: Identify the variables to study the broiler poultry production function in Egypt, Test the stationarity of the model variables through unit root test, Test the cointegration through the ARDL method, Estimate the unconstrained ARDL error correction model (ARDL-ECM), Test the structural stability of the ARDL-ECM coefficients and Testing the predictive performance of the estimated ARDL-ECM model.

To estimate the poultry meat production function using the standard model with time series data, several stages must be carried out as follows:

Define the poultry meat production function model:

$$QP=f(PP\ .PM\ .PIV\ .PIF\ .INF\ .ARI)$$

Where:

QP = The dependent variable representing the amount of poultry production.

Independent variables:

Average poultry prices (PP), Average red meat prices (PM), Poultry Investment Volume (PIV), Average feed price (PIF), Average inflation rate (INF), Average real per capita income (ARI).

According to economic theory, the expected relationship between the independent and dependent variables suggests that poultry meat production is positively correlated with poultry prices, red meat prices, the quantity of poultry investment, and real per capita income, where an increase in poultry and red meat prices, increased poultry investment, and higher real per capita income leads to an increasing in the quantity of meat poultry production and vice versa. In contrast, the amount of poultry meat production is inversely related to feed prices and the inflation rate: higher feed prices and a higher inflation rate led to lower production .

The poultry production function was converted to logarithmic form to address variable variation over the study period. Thus, the econometric model became as follows:

Testing the stationarity of the model variables using the unit root Test: Time series stability was tested over the study period to determine whether the series is stationary or non-stationary, its degree of integration, and the order of integration for each variable. Before applying the (ARDL) method for the cointegration of the variables under study, one must first determine the order of cointegration of these variables. The goal is to avoid misleading results and ensure that the variables are not stationary in their second differences or in second-order integrated [I(2)] form. This is a crucial requirement of the ARDL model, and the ADF(Augmented Dickey-Fuller) test was used to assess the presence of a unit root and determine the cointegration order. The ADF test was used

to test the null hypothesis: the presence of a unit root in the series values means that the time series is not stationary, against the alternative hypothesis: the absence of the unit root in the series values means that the time series is stationary (Table 1).

Table 1: Results of the unit root test for level and first differences using the Augmented Dickey-Fuller (ADF) method

Variables		Level			First Difference		
		None	Intercept	Trend & Intercept	None	Intercept	Trend & Intercept
Ln(QP)		0.007 (0)	-0.017 (0)	-0.213 (0)	-0.907 (0) **	-1.032 (0)**	-1.042 (0)**
Ln(PP)		0.025 (0)	-0.152 (1)	-0.103 (4)	-0.672 (0) *	-1.042 (0)**	-1.680 (2)**
Ln(PM)		0.030 (0)	0.039 (0)	-0.221 (0)	-0.381 (0) *	-1.0211 (0)**	-1.149 (0)**
Ln(PIV)		0.0141 (0)	0.0142 (0)	-0.122 (0)	-0.510 (0) **	-0.735 (0)**	-0.757 (0)**
Ln(PIF)		0.0143 (0)	-0.026 (0)	-0.625 (0)	-0.919 (0) **	-2.116 (2)**	0.543 (2)**
Ln(INF)		-0.010 (0)	-0.257 (0)	-0.463 (0)	-0.852 (0) **	-0.851 (0) **	-0.880 (0) **
Ln(ARI)		-0.002 (0)	0.006 (0)	-0.262 (0)	-0.909 (0) **	-0.949 (0) **	-1.021 (0) **
Critical values	1%	**-2.65**	**-3.689**	**-4.323**	**-2.653**	**-3.699**	**-4.339**
	5%	**-1.953**	**-2.971**	**-3.58**	**-1.953**	**-2.976**	**-3.587**

Significance level: (*) significant at the 5% level, (**) at the 1% level. The value in parentheses means the length of the appropriate holding period according to the Akaike Info Criterion (AIC).
Source: Results of analyzing data from Table 9, using the EViews program.

The variables were not stationary at their level, as the calculated test values were lower than the absolute critical values. After taking the first difference, all variables were stationary at the 5% significance level, indicating that they are integrated of degree I(1). These results align with econometric theory, which suggests that most macroeconomic variables are non-stationary at their original levels but become stationary after taking first differences (Mashaal and Ibrahim, 2016).

Although the ARDL model allows the variables to be either stationary in their levels D(0) or to reach stationarity after taking their first differences D(1), it must be ensured that the dependent variable is integrated of the first order and that the independent variables reach stationarity without taking the second differences D(2) (Rodrigues *et al.*, 2024).

Cointegration test using the bounds approach: The ARDL model uses the bound test to confirm the existence of a balanced relationship in the long term (cointegration) between the independent variables and the dependent variable by comparing the F-statistic value calculated for the coefficients of the lagged independent variables with the critical F value at 1.0% - 10%, according to the limits set by Narayan, (2005).

The F-statistic value is estimated at 8.172, which is greater than the critical value of the lower and upper limit at most levels of significance (tabular value), which means the possibility of a balanced relationship in the long run between the independent variables and the dependent variable (Table 2).

Table 2: Cointegration test of the study variables according to the F-bound test method

Test Statistic	Value	k
F-statistic	8.172129	6
	Critical Value Bounds	
Significance	**(0) Bound I**	**(1) Bound I**
1%	3.976	5.691
5%	2.794	4.148
10%	2.334	3.515

* I (0) and I (1) are the stationary and non-stationary bounds, respectively.
Critical values for small samples (Narayan,2005). **Source:** EViews program output.

RESULTS

ARDL Model: After performing the static and Cointegration tests, the ARDL method can be applied with the following formula:

$$\Delta Ln(QP_t) = \alpha + \beta_1 Ln(QP_{t-1}) + \beta_2 Ln(PP_{t-i}) + \beta_3 (PM_{t-i}) + \beta_4 (PIV_{t-i}) - \beta_5 Ln(PIF_{t-i}) - \beta_6 Ln(INF_{t-i}) + \beta_7 Ln(ARI_{t-i}) + \sum_{i=1}^{p} \gamma_{1i} \Delta Ln(QP_{t-i}) + \sum_{i=0}^{q} \gamma_{2i} \Delta Ln(PP_{t-i}) + \sum_{i=0}^{q} \gamma_{3i} \Delta Ln(PM_{t-i}) + \sum_{i=0}^{q} \gamma_{4i} \Delta Ln(PIV_{t-i}) - \sum_{i=0}^{q} \gamma_{5i} \Delta Ln(PIF_{t-i}) - \sum_{i=0}^{q} \gamma_{6i} \Delta Ln(INF_{t-i}) + \sum_{i=0}^{q} \gamma_{7i} \Delta Ln(ARI_{t-i}) + EC_{t-1} + u_t$$

Where:
Δ = First differences of the variables.
q, *p* = lags.
($\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6, \beta_7$ = long-term coefficients.
($\gamma_1, \gamma_2, \gamma_3, \gamma_4, \gamma_5, \gamma_6, \gamma_7$) = short-term coefficients.
α = constant term.
Ln = natural logarithm.
U_t = random error term.
EC_{t-1} = Error correction term.

The ARDL approach was employed to estimate the model in logarithmic form to address the problem of heteroskedasticity, examining the relationship between poultry meat production and economic variables over the short and long term for the period 1995–2023.

Short-term impact estimation: The results show evidence of statistically significant differences between the independent economic variables and the dependent variable at a significance level of 1% in the short term, and the (R^2) value of 0.94 indicates that about 94% of the changes in the amount of meat poultry production during the period is due to the influence of the economic factors included in the measurement model, showing the high explanatory power of these variables,. The value of the F test statistic indicates the overall quality of the estimated model from a statistical perspective (Table 3).

The value of the error correction coefficient for the model (ECt-1) indicates the speed of return of the variables to equilibrium. It requires that the coefficient be negative and statistically significant, thereby confirming cointegration among the model's variables. Since the error correction coefficient (ECt-1) is negative and statistically significant, with an estimated value of -0.582, this confirms a dynamic relationship between poultry meat production and the independent variables in the model. When the quantity of poultry meat deviates from its equilibrium value in the short term, about 58.2% of this deviation is corrected in the long term. It will take less than 2 years to address this imbalance and achieve balance in poultry meat production (Table 3).

Long-term impact estimating: The results show evidence of statistically significant differences between the independent economic variables and the dependent variable in the long run for each of the volume of poultry investment (PIV) in the previous year, the inflation rate (INF) for the last year and the quantity of meat poultry production (QP) in the current year at a significant level At a significance level of 1%, and between the average price of feed (PIF) in the previous year, the average real per capita income (ARI) in the last year and the amount of meat poultry production (QP) in the current year at a significance level of 5%. In contrast, the statistical significance of the remaining independent economic variables with the dependent variable was not established in the long run (Table 4).

Table 3: Results of estimating the relationship between poultry production quantity and economic variables in the short run

Included observations: 26				
Cointegrating Form				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
D (LN_QP(-1))	0.129	0.071	1.836	0.085
D (LN_PP)	0.636	0.071	8.918	0.000
D (LN_PM)	0.557	0.096	-5.812	0.000
D (LN_PIV)	0.172	0.085	2.017	0.061
D (LN_PIV(-1))	-0.434	0.091	-4.748	0.000
D (LN_PIF)	-0.016	0.069	-0.234	0.618
D (LN_INF)	-0.107	0.022	-4.767	0.000
D (LN_INF(-1))	0.186	0.026	7.226	0.000
D (LN_ARI)	0.427	0.112	3.823	0.002
ECt-1	-0.582	0.054	-10.78	0.000
R-squared	0.945	**Mean dependent var**		0.053
Adjusted R-squared	0.914	**S.D. dependent var**		0.149
S.E. of regression	0.044	**Akaike info criterion**		-3.126
Sum squared resid	0.031	**Schwarz criterion**		-2.642
Log-likelihood	50.63	**Hannan-Quinn criteria.**		-2.986
F-statistic	30.45	**Durbin-Watson stat**		2.134
Prob (F-statistic)	0.000	**-**		**-**

The value in parentheses means the length of lag
Source: EViews program output.

Table 4: Results of estimating the relationship between the quantities of poultry production and economic variables in the long run

Levels Equation				
Case 2: Restricted Constant and No Trend				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
LN_PP(-1)	0.077	0.373	0.207	0.838
LN_PM(-1)	0.650	0.340	-1.911	0.071
LN_PIV(-1)	0.626	0.123	5.062	0.000
LN_PIF(-1)	-0.464	0.233	1.990	0.050
LN_INF(-1)	-0.274	0.082	-3.344	0.003
LN_ARI(-1)	-1.195	0.555	-2.152	0.044
C	13.89	5.241	2.649	0.016

The value in parentheses means the length of lag

CE = LN_QP(-1) - (0.077338*LN_PP(-1) - 0.650187*LN_PM(-1) + 0.625711*LN_PIV(-1) + 0.464218*LN_PIF(-1) - 0.274299*LN_INF(-1) - 1.195372*LN_ARI(-1) + 13.887941)

Source: EViews program output.

Econometric tests of the model: The estimated model was subjected to several standard tests before starting to interpret its results, the most important of which are the following:

Residual Diagnostic Tests:

Histogram Normality Test: The normal distribution is a key assumption in economic analysis, ensuring that error term observations have a mean of zero and constant variance. The Jarque-Bera test statistic is 0.825, which exceeds the 5% significance level, indicating that the residuals are approximately normally distributed (Fig. 1).

Testing for multicollinearity between independent variables: There are several ways to detect multicollinearity among independent variables with lags, and the research used the correlation matrix to assess statistical independence among the independent variables (Table 5).

Testing the serial correlation of the residuals: The test evaluates the independence of the error term observations. The most used tests for this purpose are the Lagrange Multiplier (LM) Test, and the Breusch-Godfrey Serial Correlation Test. The Lagrange Multiplier test is statistically insignificant, with a probability value of 0.337, which exceeds the 5% significance level. This suggests that the residuals are independent, confirming the absence of serial correlation (Table 6).

Testing for heteroscedasticity of the residuals: One of the fundamental assumptions of regression analysis is that the error term variance is constant. In case this assumption is not met, then heteroscedasticity will occur and hence false estimates of the regression slope will be obtained and consequently there will be an effect on the predictive reliability of the model.

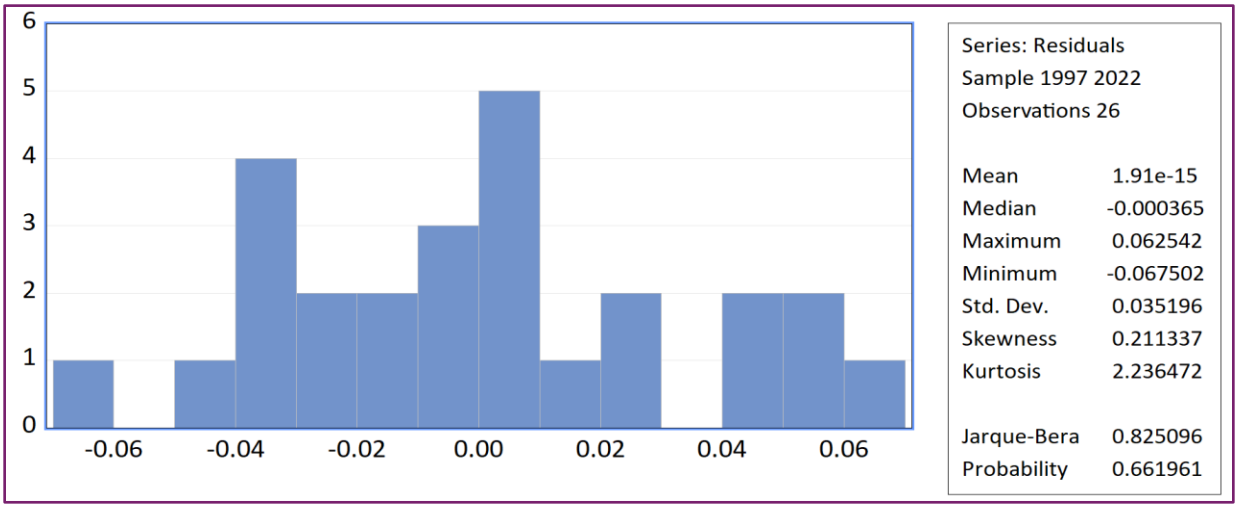

Figure 1: Jarque-Bera expected distribution test results.
Source: EViews program output.

Table 5: Correlation coefficients matrix for independent variables with lag periods

Data	*Ln(QP)*	*Ln(PP)*	*Ln(PM)*	*Ln(PIV)*	*Ln(PIF)*	*Ln(INF)*	*Ln(ARI)*
Ln(QP)	1						
Ln(PP)	0.82	1					
Ln(PM)	0.86	0.48	1				
Ln(PIV)	0.90	0.20	0.44	1			
Ln(PIF)	0.83	0.57	0.28	0.52	1		
Ln(INF)	0.65	0.54	0.49	0.40	0.51	1	
Ln(ARI)	-0.74	-0.49	-0.48	-0.58	-0.45	-0.46	1

Source: EViews program output.

Breusch-Pagan-Godfrey Test: This test is used to verify heteroscedasticity. The results indicate no statistical evidence of variance instability in the random error term, with a probability value of approximately 0.964, which exceeds the 5% significance level. This confirms the absence of heteroscedasticity (Table 6).

ARCH Test: This test is used to detect heteroscedasticity. The results indicate no statistical evidence of variance instability in the random error term, as its probability value is approximately 0.841, which exceeds the 5% significance level. This confirmed the absence of heteroscedasticity (Table 6).

Stability Diagnostic Test: This type of test is used to determine the suitability of the model in terms of the functional form and the structural changes that occur in it, and the most important of these tests are the following:

Ramsey RESET Test: This test evaluates the adequacy of the model's functional form, ensuring it is correctly specified and free from misspecification errors. The test's probability value is 0.209. Since this value exceeds the 5% significance level, the null hypothesis, which confirms the model's correct specification, is accepted (Table 6).

Table 6: Results of diagnostic tests to assess the quality of the ARDL model

Test	F	Prob.
LM Test	1.274	(0.337)
Arch Test	0.260	(0.841)
Normality Test	0.825	(0.662)
Breusch - Pagan -Godfrey	0.361	(0.964)
Ramsey Reset	1.863	(0.209)

Source: EViews program output.

Structural stability Test for model parameters: This test is used to verify that the estimated model is free of structural changes over time, namely: The Cumulative Sum of Recursive Residual test and the Cumulative Sum of Recursive Residual Squares test.

The structural stability of the model coefficients is confirmed if the test statistic graph remains within the 5% critical bounds. However, if the graph of either test statistic exceeds these bounds, it indicates instability in the model coefficients (Ahmed and Abdelateef, 2022).

The cumulative amount of residuals (CUSUM) does not cross the critical values of 5% level of significance, which proves the structural stability of the model estimated coefficients (Fig. 2).

Cumulative sum of squares (CUMUM of Squares) is within the critical limits of the 5 percent level of significance which shows that structure of the model is stable as the estimation line is between the two confidence levels (Fig. 3).

Testing the model's ability to predict: One of the most important tasks in the econometric analysis is to assess the predictive capability of a model, and Theil Inequality Coefficient is one of the most important tests directed to this task. The coefficient of determination 0.002 was almost zero and this implied that the model has a high predictive accuracy (Figure 4).

The status of poultry meat production in Egypt over the study period (2014-2023): The prevailing condition of broiler poultry production in Egypt at the time of conducting the study. Egypt recorded a value of livestock production worth about EGP 97.8 billion in 2014, and this has increased to an average of about EGP 507.2 billion in 2023, with an average annual value of about EGP 217.28 billion during the study period (Table 7). The general trend equation shows that the livestock production value has a strong upward trend, which grows at an average of EGP 39.3 billion every year in the study period. This was statistically significant at a 1percent significance level. Also, the coefficient of determination (R^2) was 0.97 meaning that about 97 percent of the change in livestock production value during the study period could be explained by the time related factors (Table 8). The broiler poultry production value stood at EGP 21.8 billion that constituted about 22.3% of the value of animal production, which stood at about EGP 97.8 billion in 2014. The broiler poultry production was estimated at about EGP 140.4 billion, about 27.7 percent of the value of the animal production that was estimated at about EGP 507.2 billion in 2023. The mean yearly

production worth of broiler poultry amounted to about EGP 59.99 billion during the research time (Table 7). The general trend equation indicates that production value has an upward trend which is about EGP 12.7 billion every year in the period of the study. The level of statistical significance was set to 1% and the determination coefficient (R^2) was 0.99 meaning that about 99% of the variation in the production of broilers over the time is attributed to those factors that are captured in the time factor (Table 8).

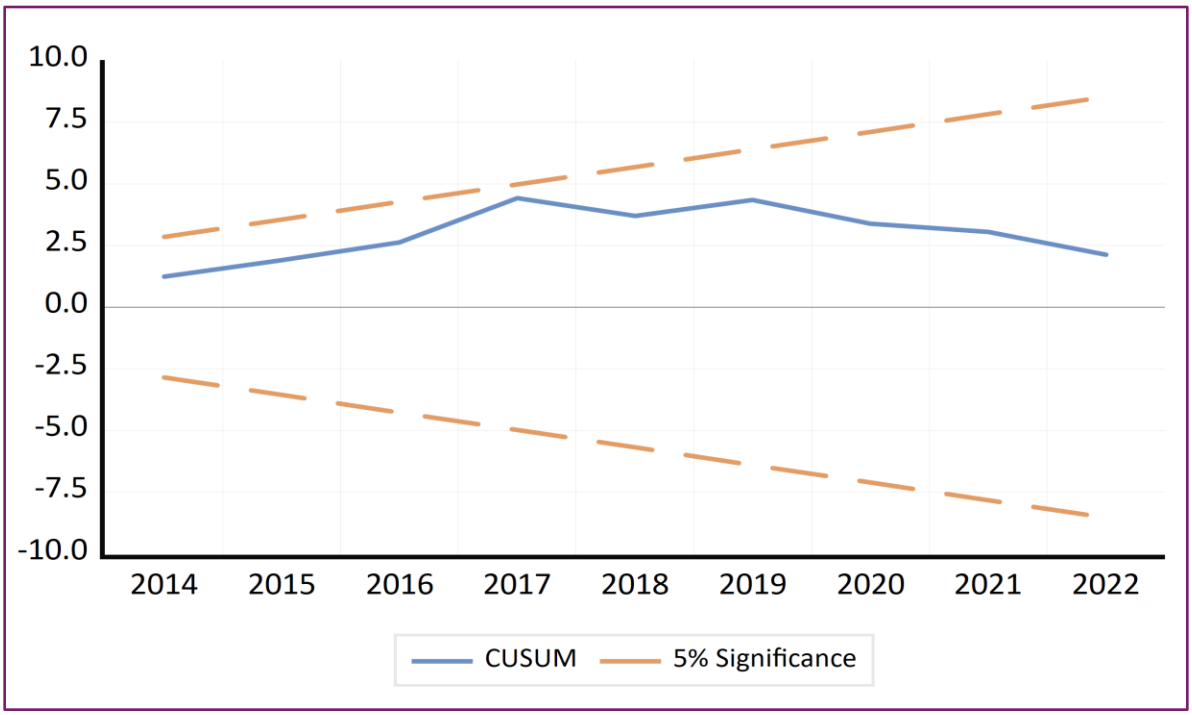

Figure 2: Results of the Cumulative Sum of Remains Test (CUSUM).

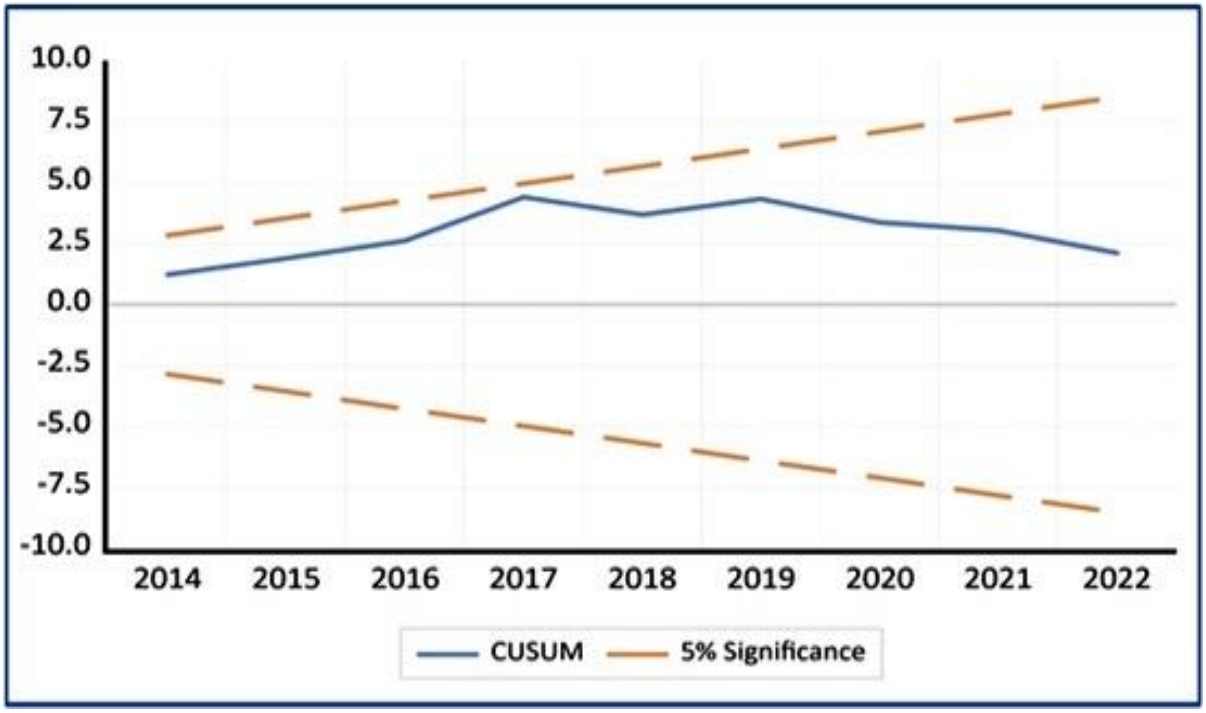

Figure 3: Results of the cumulative sum of squares Test.
Source: EViews program output.

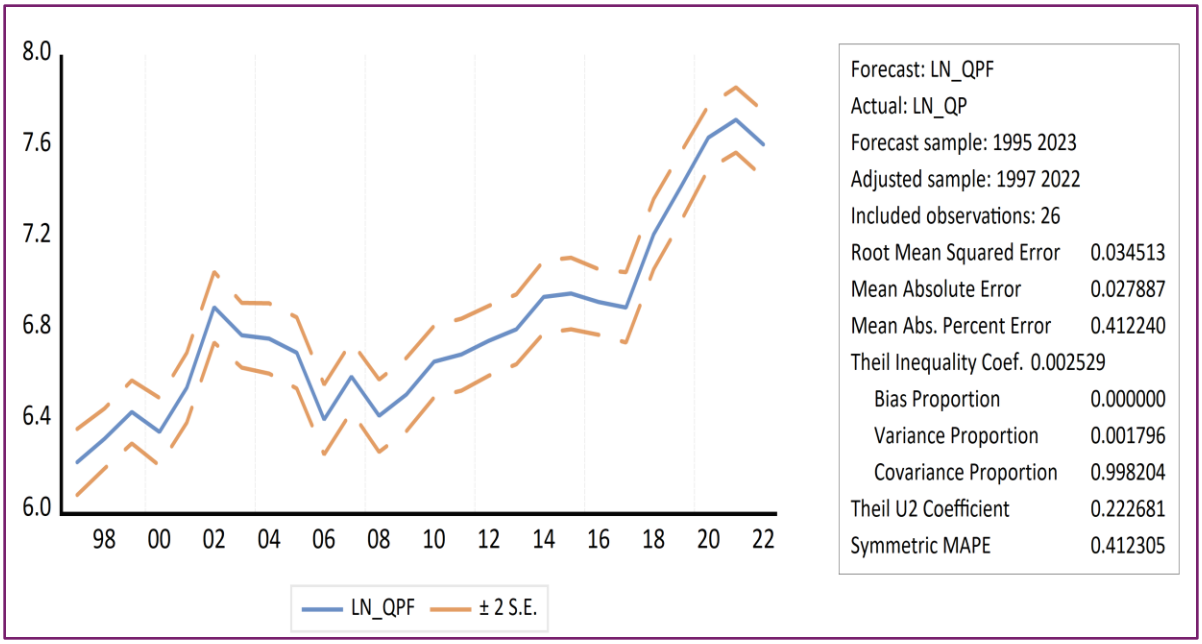

Figure 4: Results of the model's predictive power Test.
Source: EViews program output.

The total number of broiler farms in 2014 amounted to about 20234 farms with a production capacity of about 577.8 million chickens, while the number of farms amounted to about 23,368 farms in 2023 with a production capacity of about 1,508.97 million chickens, with an average production capacity of about 939.58 million chickens annually over the study period (Table 7). The general trend equation shows that the production capacity had a positive upward trend with an increment of around 126.6 million chickens per year in the study period. It was statistically significant at a 1% level and the value of (R^2) was 0.78 which implies that approximately 78 percent of the fluctuations in the production capacity of broiler chicken within the period of study can be attributed to factors whose impacts are captured by the time factor (Table 8).

In 2014, national consumption of poultry meat was approximately 1322 thousand tons and in 2023, it was approximately 2189 thousand tons with average annual consumption of about 1771.90 thousand tons. The trend equation of the general time shows that consumption of poultry meat is on an upward trend with a total of approximately 121.2 thousand tons per year of consumption during the study period. (Table 7). The level of statistical significance was set to the 1% level. The coefficient of determination (R^2) was 0.78 which means that 78 percent of the variation in the poultry meat consumption in Egypt in the study period can be attributed to the effects of factors, effects that are not constant over time (Table 8). The rate of self-sufficiency stood at about 97.35% in the year 2014, as compared to 98.30% in the year 2023, and the average rate in the study period stands at about 97.83%. (Table 7). The overall time trend equation shows statistically significant positive trend in the self-sufficiency rate within the identified period, at the 1 percent level of significance. The (R^2) value was 0.68, which means that an estimated 68% of the variation in the self-sufficiency rate over the period of the research can be attributed to factors whose influence is captured by the time factor (Table 8).

Poultry production grew to contribute to the overall value of livestock production to a high of about 34.5 in 2021 compared to about 22.1 in 2015. This increase was associated with an increase in domestic poultry meat consumption that peaked during the study period to about 2407.0 thousand tons (Table 7). In 2014, poultry meat consumption was estimated to be 10.5 kg/capita, and in 2023, the same was 10.9 kg/capita and the annual average share of poultry meat consumption was 12.07 kg/capita during the period of the study (Table 7). The decrease in the proportion of poultry meat per capita during 2020-2022 is attributed to the negative impacts of the Russian-Ukrainian war on the Egyptian economy that caused the rise of the exchange rate of the pound against the dollar, thus triggering the wave of inflation that caused an increase in the cost of production (imported inflation). Production of poultry meat declined and the overall consumer price increased as the purchasing power was reduced due to a decrease in the real per capita income and this resulted in a drastic reduction in the per capita share of poultry meat. The general trend equation indicates a statistically significant downward trend in per capita poultry meat consumption, declining at an average rate of 0.26 kg per year during the

study period, with significance confirmed at the 5% level. Additionally, the coefficient of determination (R^2) was 0.64, suggesting that approximately 64% of the variation in per capita poultry meat consumption over the period can be attributed to time-related factors.

Table 7: Status of poultry meat production in Egypt (2014-2023)

Years	Value of livestock production (EGP billion)	Value of poultry production (EGP billion)	%	number of farms (farms)	Actual production capacity (million chickens)	Local consumption volume (thousand tons)	Self-sufficiency rate (%)	Per capita (kg/year)
2014	97.8	21.8	22.3	20234	577.8	1322	97.35	10.5
2015	112.2	24.8	22.1	21097	589.1	1385	93.36	10
2016	119.4	27	22.6	20678	577.1	1345	93.53	9.9
2017	134	30	22.5	21541	595.2	1373	92.94	11.4
2018	170.1	36.5	20.8	20997	690.2	1575	100	13.7
2019	187.8	46.8	20.7	21237	594.5	1973	97.77	14.1
2020	210.5	67.1	31.9	22962	1396.2	2187	103.75	16.2
2021	266.3	91.9	34.5	22979	1433.9	2407	97.96	13.5
2022	367.5	113.6	30.9	22963	1432.8	1963	103.31	10.5
2023	507.2	140.4	27.7	23368	1508.97	2189	98.3	10.9
Mean	**97.8**	**21.8**	**22.3**	**20234**	**577.8**	**1322**	**97.35**	**10.5**
STDEV	**130.8**	**41.9**	**5.2**	**1144.3**	**435.3**	**416.2**	**3.8**	**2.2**

Source: Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Food Balance Bulletin, various issues, Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Agricultural Income Bulletin, various issues.

Economic factors affecting poultry meat production over the study period (1995-2023): The quantitative alterations in the economic factors affect the production of broiler meat during the research period, which demonstrates the significance of the problem because of the interdependence of the effects of economic factors on the production levels. The broiler meat production stood at approximately 479.3 thousand tons in 1995 and 2152 thousand tons in 2023 with an average yearly production of 998.10 thousand tons. This is a growth in the overall production of about 348.9 percent (Table 9).

The price of broiler meat increased from EGP 5.50 per kg in 1995 to about EGP 71.25 per kg in 2023, with an average of EGP 19.22 per kg, or an increase of about 1,195% (Table 9). Similarly, the price of red meat increased from around EGP 13.40 per kg in 1995 to about EGP 324.74 per kg in 2023, with an average of EGP 75.24 per kg, or a total increase of about 2,323.4%. Imported feed and concentrates increased from about $92.37 per ton in 1995 to about $1030.6 per ton in 2023, with an average of $419.3 per ton, or an increase of 1015.73% (Table 9). The significant increase in investment at current prices in the poultry sector, rising from approximately EGP 195.68 billion in 1995 to around EGP 2807.45 billion in 2023. The average annual investment toward the poultry sector amounted to approximately EGP 859.36 billion, representing a total increase of about 1334.71% (Table 9).

Conversely, the average real per capita income declined from approximately EGP 8545.38 in 1995 to around EGP 4802.62 in 2023, with an average annual real per capita income of approximately EGP 8232.2. This reflects a total decrease of about 77.9% in real per capita income during (Table 9).

The analysis indicates that the increase in the inflation rate from about 15.74% to about 33.88%, with an increase of about 18.3% as a result of the fluctuations in the exchange rate and the decline in the value of the local currency against the dollar during the study period led to a significant increase in the prices of production inputs, most importantly imported feed and concentrates, which led to a rise in poultry meat prices and a decrease in real per capita income, which led to a weak impact of the volume of investments directed to the poultry sector, despite the increase in its market value. However, its effect on the quantity of poultry production was limited due to high inflation. The table also shows that the percentage change in poultry meat production was lower than the increases in red meat, broiler, and feed prices. In other words, the negative impact of changes in economic factors outweighed the positive effect on the quantity of broiler poultry production during the study period, leading to a decrease in real per capita income and, in turn, a decrease in the per capita share of poultry meat. It was also shown from the table that the percentage of change in the quantity of broiler meat production was low compared to the increase in red meat prices, poultry prices, and feed prices. That is, the negative impact of the change in economic factors is greater than the positive impact on the quantity of broiler production during the period under study, which led to the inability of the poultry sector to achieve absolute self-sufficiency, and at the same time a decline in real individual income, which led to a decrease in the per capita share of meat poultry.

Table 8: The trend equation for the current state of poultry meat production in Egypt (2014-2023)

Variables	Equation	R^2	F	Amount of change
Value of animal production (billion pounds)	$Y1=147.1 – 33.3T + 6.6T^2$ $(-2.57)^{*}$ $(5.72)^{**}$	0.97	106.6^{**}	39.3
Value of poultry production (billion pounds)	$Y2=31.04 - 8.2T + 1.9T^2$ $(-5.65)^{**}$ $(14.99)^{**}$	0.99	910.9^{**}	12.7
Actual production capacity (million chickens)	$Y3 = 243.6 + 126.5T$ $(5.24)^{**}$	0.78	27.48^{**}	126.6
Consumption (thousand tons)	$Y4 = 1105.27 + 121,21T$ $(5.29)^{**}$	0.78	27.96^{**}	121.2
Self-sufficiency rate (%)	$Y5 = 93.48 + 0.79T$ $(2.59)^{*}$	0.68	5.51^{**}	0.79
Per capita (kg/year)	$Y6 = 6.74 + 2.24T- 0.18T^2$ $(2.75)^{*}$ $(-2.52)^{*}$	0.64	5.04^{**}	0.26

Where: $\widehat{Y}_t$= The dependent variable is the poultry meat production in Egypt in year t, X_t = The independent variable is the time variable, t = (1, 2... 15). The value in parentheses represents the (T) value of the regression coefficients.
Significance level: (*) represents a significance level of 0.05, (**) represents a significance level of 0.01
Source: Calculated from Table 7.

Table (9): Economic factors affecting poultry production in Egypt (1995-2023)

Years	Amount of poultry production (thousand tons)	Average poultry prices (EGP/kg)	Average red meat prices (EGP/kg)	Poultry investment volume (EGP million)	Average feed price ($/ton)	Inflation rate (%)	Average real per capita income (EGP)
1995	479.3	5.5	13.4	195.68	92.37	15.74	8545.38
1996	483	6.76	14.8	219.05	102.1	7.19	8790.07
1997	505.8	6.8	15.2	250.72	112.86	4.63	9539
1998	516.2	6.95	15.78	276.15	124.76	3.87	9745.89
1999	627.6	7.22	17.07	290.88	137.9	3.08	9852.4
2000	548	5.12	17.93	320.5	142.67	2.68	9911.51
2001	734	5.31	18.79	343.1	141.67	2.27	10095.44
2002	989	7.48	19.65	350	147.67	2.74	10624.58
2003	899	7.33	20.51	376.4	164.33	4.51	10230.96
2004	827	8.06	21.37	397.6	187	11.27	10411.18
2005	845	7.3	26.86	477.6	169	4.87	11108.56
2006	608	8.27	29.37	525.9	169.33	7.64	11032.2
2007	705	11.94	32.86	519.2	218	9.32	11098.13
2008	629	11.94	36.26	554.6	385.33	18.32	10168.42
2009	671	12.01	40.48	560.1	390.67	11.76	7793.01
2010	744	14.62	59.61	524.2	374.67	11.27	8333
2011	796	16.63	61.9	444	302	10.06	7768.14
2012	822	20.26	64.9	472.6	428	7.11	6771.43
2013	953	22.63	67.15	389.5	425	9.47	7165.08
2014	1035	24.92	79.49	650.2	682.33	10.07	6674.98
2015	1028	24.5	88.54	1014.1	605.33	10.37	7650
2016	1007	29.42	98.89	1239.6	549.3	13.81	6824.91
2017	1044	35.54	137.71	1513.5	711.7	29.51	5795.3
2018	1325	34.17	145.62	1607.7	783.3	14.4	5330.31
2019	1758	35.32	142.71	1861.3	851.3	9.15	5228.84
2020	2029	34.12	167.36	2049.5	829.45	5.04	5627.76
2021	2245	37.35	189.15	2202.87	907.75	5.21	6208.13
2022	1940	38.6	213.77	2487.56	993.43	13.9	5606.71
2023	2152	71.25	324.73	2807.45	1030.6	33.88	4802.62
Mean	**998.1**	**19.22**	**75.24**	**859.36**	**419.3**	**10.11**	**8232.2**
STDEV	**521.9**	**15.3**	**75.6**	**761.3**	**306.6**	**7.4**	**2046.1**

Source: Central Agency for Public Mobilization and Statistics (CAPMAS), Poultry Production, Consumer Prices, Economic Indicators, Various issues, Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Food Balance Bulletin, various issues, Ministry of Planning and Administrative Reform, Annual Report of Investment Indicators in Egypt (unpublished data), World Development Indicators (WDI), Global Development Finance Department, World Bank (different issues).

DISCUSSION

Meanwhile, the use of econometric analysis to examine the impact of economic factors on poultry meat production, employing the Autoregressive Distributed Lag (ARDL) model in both the short and long run, revealed several key findings, the most significant of which are:

Economic evaluation of short-term parameters: There was a statistically significant positive relationship between the poultry price (*Ln-PP*) in the current year and the broiler meat production quantity *(Ln-QP*) for the same period. A 1% increase in poultry prices leads to a 0.636% rise in production quantity. This is since an increase in poultry prices will increase the profitability of production, which will encourage producers to produce more which is an economic principle of high prices leading to high production (Table 3).

The short-term relationship between Ln-PM and Ln-QP is positive and statistically significant, with a 1 percent increase in the price of red meat leading to a 0.557 percent increase in broiler meat production, because if red meat prices rise substantially, then a rise in the price of red meat beyond what consumers can afford will cause a higher quantity demanded of poultry meat, which will stimulate a higher quantity of broiler meat production (Table 3).

The short-term relationship between poultry investment (Ln-PIV) in the previous year and broiler meat production (Ln-QP) in the current year was statistically significant and inverse, such that a 1% increase in poultry investment last year will cause a 0.434% decrease in current production. This is due to a sharp increase in inflation, which erodes the value of any investment in the poultry industry. Despite the nominal increase in poultry investment, the impact of new investments on expanding production capacity is diminished due to the substantial rise in costs, ultimately negating their effect (Table 3).

There was a short-term, negative, inverse, and statistically significant response between the inflation rate (*LN-INF*) in the current year and the quantity of broiler production (*LN-QP*) in the current year, where a 1% increase in the inflation rate leads to a 0.107% decrease in the production quantity. This is because a high inflation rate raises the costs of production inputs, which leads to a decline in the production quantity due to the weak financing capacity of small producers and their exit from the production process, and thus a decrease in the actual production capacity of the sector, which leads to a decline in the quantity of production (Table 3).

There was a short-term, positive, and statistically significant response between the inflation rate (*LN-INF*) in the previous year and the quantity of broiler production (*LN-QP*) in the current year, where a 1% increase in the inflation rate in the last year leads to a 0.186% increase in the quantity of production in the current year. This may be because the high inflation rate raises poultry prices, encouraging large producers to increase production by expanding current capacity, given their financial ability to achieve capacity savings (Table 3).

There is a short-term, positive, and statistically significant response between the average real per capita income (*LN-ARI*) in the current year and the quantity of broiler production (*LN-QP*) in the current year, where a 1% increase in real per capita income leads to a rise in the amount of production by about 0.427%. The reason is that when the real per capita income increases, it increases the purchasing power of consumers leading to higher demand, thus causing an increase in the profitability of producers due to higher prices hence the improvement of future production in terms of entry of new units or higher production capacity of the existing units (Table 3).

The error correction term (ECt-1) indicates that there is a dynamic relationship between broiler meat production and the independent variables in the model. Given its negative algebraic sign and statistical significance—both of which indicate the speed at which variables return to equilibrium—approximately 58.2% of the short-term imbalance can be corrected. As a result, long-term equilibrium in broiler meat production can be restored in less than two years ($1/0.582 \approx 1.72$ years) (Table 3).

Economic evaluation of long-term parameters: There was a statistically significant positive long-term relationship between poultry investment (*Ln-PIV*) in the previous year and broiler meat production (*Ln-QP*) in the current year. A 1% increase in poultry investment in the prior year leads to a 0.625% increase in production quantity in the current year. This result is because higher poultry investment, whether from government or private sources, enhances producers' financial capacity to expand the production capacity of existing farms or attract new investors to the poultry sector, ultimately boosting overall production (Table 4).

There was a statistically significant negative long-term relationship between feed prices (*Ln-PIF*) in the previous year and broiler meat production (*Ln-QP*) in the current year. A 1% increase in feed prices in the last year resulted in a 0.464% decline in production quantity in the current year. This is because the rising cost of dry feed and concentrates increases production expenses, weakening the financial capacity of some producers, leading to their exit from the market and, consequently, reducing overall production (Table 4).

There was a statistically significant negative long-term relationship between the previous year's inflation rate (*LN-INF*) and broiler meat production (*Ln-*

QP) in the current year. A 1% increase in the inflation rate from the preceding year leads to a 0.274% decline in production quantity in the current year. A 1% increase in the inflation rate in the previous year leads to a 0.274% decrease in production in the current year. This is because a high inflation rate raises the costs of production inputs, which increases poultry prices, reduces current demand, and reduces profit margins, leading to reduced production by large producers and the exit of small producers (Table 4).

There is a negative, inverse, and statistically significant long-run response between the average real per capita income (LN-ARI) in the previous year and the quantity of broiler production (LN-QP) in the current year, where a 1% increase in the real per capita income in the last year leads to a 1.195% decrease in the quantity of production in the current year. This is because a significant increase in real per capita income improves purchasing power, leading some consumers to shift toward red meat with higher nutritional value and better flavor. This leads to a decrease in demand for poultry meat, a relative price reduction, a decline in profits, and small producer units stopping production, resulting in a slight decrease in production (Table 4).

From the above, it is clear from studying the impact of independent economic variables on the quantity of broiler poultry production in the short term that the most critical factors leading to an increase in production are the rise in poultry prices, the rise in red meat prices, and the increase in real per capita income, in order of relative importance. In contrast, the factors leading to a decrease in the quantity of broiler poultry production are the increase in poultry investment in the previous year and the increase in the inflation rate, in order of relative importance.

In the long run, the most important independent factors affecting the quantity of broiler production, the increase of which leads to an increase in production, are represented by the rise in poultry investment in the previous year, while the factors that lead to a decrease in the quantity of broiler production by increasing it was represented by each of the increase in the average real per capita income, increase in feed prices, and the increase in the inflation rate, in order of relative importance of these factors.

Therefore, decision makers must pay attention to the impact of these factors on the quantity of broiler poultry production in light of their relative importance when planning production policy for the poultry sector by enhancing the positive aspects that increase production quantity and limiting the adverse effects of factors that reduce the amount of broiler poultry produced to achieve self-sufficiency and improve the per capita share of poultry meat.

The Challenges and Obstacles Facing Poultry Meat Production in Egypt: The poultry meat industry in Egypt has a lot of structural problems that inhibit its growth. The high dependence of imported products, such as feed and vaccines, leaves the industry vulnerable to fluctuations in the exchange rates and the expensive costs. Small-scale producers are specifically limited by a lack of financial resources and increased prices of inputs, and high costs of production locally, in winter, exacerbate profitability. The presence of large poultry companies dominating the market, the lack of proper cooperative support and the lack of specialized financial institutions undermine competition and restrict access to technical and financial resources. Lack of strong government control has led to the instability of the feed markets and absence of large scale production complexes and long term strategy to eliminate over-dependence on imports has still hindered the growth of the sector.

Conclusions: The findings affirm the existence of a stable long-run cointegration between the production of broiler poultry in Egypt and its major economic factors between the year 1995 and 2023 with a proportion of about 58.2 percent of short-run disequilibrium being mitigated in a year. Production is in the short-term positively related to the poultry and red meat prices and real per capita income and negatively related to inflation because it raises the costs of production. In the long-run, investment will contribute to the growth of production, and increase in feed prices, inflation, and real income decrease the output because of cost pressures and consumption changes. All in all, to continue with the growth of poultry production it is important to contain the inflation level, minimize reliance on imported feed, and enhance the efficiency of investment policy in the sector.

Recommendations: The paper suggests the adoption of a combined policy framework to boost production of broiler poultry in Egypt. They involve reinforcement of feed policies through domestic production of feeds, investment on hybrid forage crops and reuse of agricultural residues to minimize reliance on imported inputs. In financial terms, it is necessary to create a poultry development bank and extend access to low interest production loans to aid small scale producers and promote investment as the long-run effect of poultry investment on output is positive. The policies of regulating the market can be aimed at the introduction of transparent pricing systems, control of profit margins to limit market power and the manipulation of prices by large producers, and the empowerment of cooperatives to minimize marketing expenses and enhance producer margins. Concurrently, it is important to reduce inflation through tightening monetary and fiscal policies, as it is having a severe effect on poultry production both in the short and long run. Lastly, increasing government control over the prices of inputs, improving the number of

veterinary service centers, and offering technical assistance to small-scale producers will help in increasing production efficiency, reducing costs and sustaining the poultry industry and its development in the long term.

Conflict of Interest: The authors declare no conflict of interest.

Acknowledgments: Princess Nourah bint Abdulrahman University Researchers Supporting Project number (PNURSP2026R260), Princess Nourah bint Abdulrahman University, Riyadh, Saudi Arabia

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