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ORIGINAL ARTICLE

AN ESTIMATION OF PROFIT AND COST FUNCTION AND ECONOMIC EFFICIENCY OF BROILER PRODUCTION PROJECTS IN THE MIDDLE OF IRAQ (A CASE STUDY) FOR 2019

M.H. AL-Sammarraie[1,*], M.A. Hamaza[2] and Z.H. Mahmood[3]

[1]Billad Alrafidain University College, Iraq.
[2]Department of Agricultural Economics, College of Agriculture, University of Anbar, Iraq.
[3]Department of Agricultural Economics, College of Agriculture, University of Baghdad, Iraq.
E-mail: dr.maida@bauc14.edu.iq

Abstract: This study aimed to estimate the profit and cost functions as well as economic, price, cost, and technical efficiencies besides the other economic indices at actual, optimal and profit-maximizing production of broiler projects. A random sample of 84 fields was selected from total 524 in central Baghdad (Qadisiyah, Babil and Wasit) province during 2019. From efficiency scales of profit function, it was shown that the production price had the greatest impact on the profit compared to other variables (average production costs and production quantity). According to the cost function, the optimal cost-minimizing production level was 21.54 ton. This average is greater than that of actual production (18.27 tons) by 3.27 tons. Economic analysis showed the product level which maximizes the profit was 28.02 tons which was higher than the optimal production level (21.54) by 6.94 tons. As for technical efficiency, it reached 84.82%, while cost efficiency was 0.85. This implies that resources were not optimally exploited. From these results, it can be concluded that government support is required for productive inputs, through facilitating loans, preventing poultry importing, and adoption of strategic policy for the agricultural sector in general and poultry production in particular.

***Key words*:** Profit function, Cost function, Technical efficiency, Economic efficiency, Cost efficiency

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1. Introduction

The poultry industry occupies great importance not only in the Iraqi economy, but also in most world economies as it provides a basic foodstuff for citizens because it contains protein in eggs and chicken meat. Meat chicken is characterized by its high conversion efficiency for food. In Iraq, its importance is increasing in that it operates tens of thousands of the unemployed by virtue of the fact that most of the poultry production projects in Iraq are small and widespread in most governorates of Iraq. In addition, to the stability and low prices of poultry is very important because it will lead to the stability of prices red meat obtained as it is cheaper and healthier than red meat. Thus, consumer considered chicken as an important food item and within the limits of his income. Poultry projects are also characterized by the short capital turnover and quick recovery, and thus they achieve rewarding profits. In spite of the large increase that occurred in the production of poultry, the real problem still exists, which is the limited production compared to the continuous increase in demand for reasons including the increase of the population, the improvement in their income levels, the development of their cultural awareness, as well as the obstacles facing red meat production.

Since the seventies, the state has been interested in establishing a number of projects producing chicken meat in all governorates of Iraq. Among the leading

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governorates in this industry are Qadisiyah, Babil and Wasit. The total production reached 109 thousand tons in 2019 and the percentage of the contribution of these province was estimated to be about 14.5%, 10.2%, 11.5%, and the number of projects during 2019 reached (198, 217 and 109), respectively. Despite the availability of the necessary capabilities and resources for poultry raising projects, there is a lack of production and a lack of self-sufficiency in this product, which may be due to many reasons that overshadow the reluctance of the projects set for the advancement of this product. The most important of these reasons is the failure to create a safe investment environment for breeders to make a quantum leap in poultry production.

This study aimed to estimate the profit function and the functional production costs in the short term, and to measure the technical, economic and cost efficiency of a sample of poultry production projects in order to clarify how to expand production that achieves the optimum level of outputs and inputs. Several other studies have addressed this issue using projects to raise broiler chickens in different geographical locations [Qasim and Al-Dansouri (2009), Zaidan *et al.* (2011), Al-Tarawneh (2013), Hudhud *et al.* (2015)].

2. Materials and Methods

Well Organized Questionnaires were used to collect cross sectional data from a random sample of 85 chicken meat breeder which represented 7.5% of the total population of Qadisiyah, Babil and Wasit, for the 2019 season collected data were analyzed in statistical programs, Excel and Eviews10.

Table 1: The relative importance of the variable costs of the total costs for the research sample.

Costs	The Amount of Costs (Million Dinars)	The Relative Importance%
Feed	20746.66	73.16
Chicks	4941.09	17.43
Medicines and vaccines	1213.15	4.28
Leased work	720.29	2.54
Electricity and water	348.80	1.23
Fuel	120.52	0.43
Bed	91.03	0.32
Maintenance expenses	153.70	0.54
Transportation	22.69	0.08
Total	28357.93	100%

Source: Prepared by the researchers, based on the questionnaire

Table 2: The relative importance of fixed costs from the total costs per ton for the research sample fields.

Costs	Amount of Costs (Million Dinars)	The Relative Importance%
Interest on invested capital	1841.16	45.20
Hall rent	1645.64	40.40
permanent workers	586.57	14.40
Total	4073.37	100

Source: Prepared by the researchers, based on the questionnaire.

Table 3: Relative importance of fixed and variable costs from total costs of broiler project sample study.

Total Costs Items	Value (Million Dinars)	Relative % Importance
Variable cost	28357.93	87.44
Fixed cost	4073.37	12.56
Total cost	32431.30	100%

Source: Calculated based on the questionnaire form.

2.1 Descriptive analysis of chicken meat breeder costs for the research sample

Total variable costs (TVC)

Table 1 shows variable costs (for each project) including production requirement costs (feed, chicks, medicines, vaccines, leased work, electricity, water, fuel). The relative importance of feed costs came first accounting for 73.16% of the total variable costs. This indicates the high price of feed for chicken meat production. That is partially because breeders depend on the imported feed from the private sector (in dollars) as a result of halted local feed projects, and absence governmental support.

Chicks costs came next with 17.43% of the relative importance of the variable costs, which emphasizes the high interest of the breeders of the research sample in importing chicks of high quality, disease resistance and productivity. The relative importance of each of the items of medicines, vaccines, leased work, electricity, water, fuel, used bed, maintenance expenses, and transportation, was 4.28%, 2.54%, 1.23%, 0.43%, 0.32%, 0.54%, and 0.08% of the total variable costs, respectively.

Fixed costs (FC)

As regard for the fixed costs items, the interest

Table 4: Estimation of profit function of broiler project.

Dependent Variable: LPROFIT
Method: Least Squares
Date: 02/28/21 Time: 10:05Sample: 1 84
Included observations: 70

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.229065	0.886453	1.386498	0.1703
LPY	0.951431	0.119300	7.975115	0.0000
LATC	– 0.166582	0.0129222	–12.89144	0.0000
LQ	0.126702	0.023123	5.479539	0.0000
R-squared	0.782095	Mean dependent var		7.370051
Adjusted R-squared	0.772190	S.D. dependent var		0.140265
S.E of regression	0.066947	Akaike info criterion		–2.514372
Sum squared resid	0.295809	Schwarz criterion		–2.385887
Log likelihood	92.00302	Hannan-Quinn criter		–2.463336
F-statistic	78.96147	Durbin-Watson stat		1.696870
Prob(F-statistic)	0.000000			

Source: Calculated using Eviews.10.

costs on capital came first by 45.20%. It was relatively high due to low financial capacity of most breeders who resort to get loans (which involve interests), and the minimum requirement insurance to get loans. The costs of land and hall renting came next by 40.40%, and this can be attributed to the increase hall rent in the research area. The permanent work occupied the last rank with 14.40% of the total fixed cost due to the dependence of the poultry breeders on the permanent leased workers in view of the experience gained by these workers from working in poultry projects (Table 2).

Total costs (TC)

The total costs of the Chicken meat was divided into fixed costs and variable costs. The variable cost contribution ratio was 87.44%, while the fixed costs share did not exceed 12.56%. This gives a clear picture that the relative importance of variable costs is greater than fixed costs as shown in (Table 3).

3. Results and Discussion

3.1 Estimation of profit function

Ordinary least square was used to estimate the parameters of profit function and short-term cost function. The function model was estimated according to economic theory which states that the profit equals to total revenue (TR) minus total cost (TC) [Debertin (1986)]. The cost function can be derived as follows.

$$\pi = TR - (TVC + TFC) \quad (1)$$

$$TR = P_Q * Q, TC = P_X . X + TFC$$

$$\pi = \sum P_Q . Q - \left[\sum P_X . X + TFC \right] \quad (3)$$

where,

π : Profit or net return.

P_Q : Product price.

Q : Product size.

X : quality of variable resources.

P_X : price of variable resources.

TFC : total fixed costs.

From Equation (2), the profit function can be derived as follows.

$$\pi = (P_Q, C, Q)$$

Accordingly, the profit function model [Pavithra *et al.* (2016)] can specified as follows.

$$\pi = b_0 + b_1 P_Q - b_2 C + b_3 Q + U_I$$

where,

π : profit.

P_Q : sale price per kg (ID)

C : average production cost (1000 ID/ton)

Q : product level of chicken meat projects (ton)

b_0 : intsercept

b_i : regression coefficients

Table 5: Diagnostic tests.

Breusch-Godfrey Serial Correlation LM Test Null hypothesis: No Serial correlation at up to 2 lags			
F-statistic	0.299191	Prob. F(2,64)	0.7424
Obs*R-squared	0.648418	Prob.Chi-Square(2)	0.7231
Heteroscedasticity Test Breusch-Pagan-Godfrey Null hypothesis: Homoskedasticity			
F-statistic	1.639083	Prob. F(3,66)	0.1888
Obs*R-squared	4.853649	Prob. Chi-Square(3)	0.1828
Scaled explained SS	12.48769	Prob. Chi-Square(3)	0.0059
Heteroskedasticity Test ARCH			
F-statistic	0.339278	Prob.F(1,57)	0.5625
Obs*R-squared	0.349105	Prob.Chi-Square(1)	0.5546

Source: Calculated using Eviews.10 .

Table 6: Variance inflation factors test.

Variance Inflation Factors Date: 02/28/21 Time: 10:11 Sample: 1 84 Included observations: 70			
Variable	**Coefficient Variance**	**Uncentered VIF**	**Centered VIF**
C	0.785799	12272.73	NA
LPY	0.014232	12939.23	1.171095
LATC	0.000167	222.5633	3.069013
LQ	0.000535	90.49138	2.801078

Source: Calculated using Eviews.10

U_I : error term.

3.2 Economic, statistical and econometric analysis of profit function

The econometric relationships among profit function were analyzed by OLS which showed that the best model, according to economic and statistical logic, was the logarithmic model (Table 4).

Diagnostic tests indicated that the model has passed the econometric tests such as the absence of autocorrelation by using LM at 0.1828 probability for two lag periods. Therefore, the null hypothesis could be accepted, that is the model is free from autocorrelation. Breusch-Pagan-Godfery and ARCH tests revealed the absence of heteroscadiscity at 0.1888 and 0.5625 probability respectively for two lag periods (Table 5). The result of Ramsey Reset test suggested a rejection for the presence of error in model determination, while multicollinearity between independent variables was found to be less than 10 using variance inflation factors test (Table 6). From the last result, it can be concluded that the model is free from multicollinearity [Gujrati (2004)].

According to the t-test, the estimated parameters were significant at the level of 5% and that the value of the determination coefficient R^2 reached 0.78. That means the total change in the profit function explains about 78% of the changes occurred in the (LPY, LAC, and LQ), while the other changes (about 22%) are attributed to factors not included in the model.

Studying the overall significance of the model reveals that calculated F value was 78.96 significant at 1% level, which is a proof that the model has a high statistical significance and the explained variables within this model have an effect on the profit function.

The profit function of chicken meat projects would take the following form:

$$L\pi = 1.229 + 0.951 LPy + 0.127 LQ - 0.167 LAC$$

The sign of all variables was in accordance with economic theory. Coefficients of product price and quantity took the positive sign with profit which implies a positive association between the profit and each of product price and quantity. That means, an increase of 1% in price will result in 0.951 ID increase in profit, and one-ton increase in product will result in 0.127 ID in profit (with other factors are fixed). On the other hand, production cost coefficients took the negative sign with profit, which implies a reverse relationship between profit and the average cost of production. An increase of 1% ID in production cost will result in 0.166 ID

Table 7: Estimation of cost function of broiler projects.

Dependent Variable: TC
Method: Least Squares
Date: 03/01/21 Time: 20:48
Sample (adjusted): 1 84
Included observations: 84 after adjustments

Variable	Coefficient	Std.Error	t-Statistic	Prob.
C	9073.119	4641.742	1.954680	0.0541
Q	1306.890	334.9932	3.901245	0.0002
Q^2	–0.160589	6.265119	–0.025632	0.9262
Q^3	0.002858	0.030748	0.092964	0.9262
R-squared	0.888372	Mean dependent var		45953.87
Adjusted R-squared	0.884186	S.D. dependent var		30297.41
S.E. of regression	10310.66	Akaike info criterion		21.36619
Sum squared resid	8.50E+09	Schwarz criterion		21.36619
Log Likelihood	–893.3801	Hannan-Quinn criter		21.41272
F-statistic	212.2215	Durbin-Watson stat		1.508177
Prob(F-statistic)	0.000000			

Source: Calculated using Eviews.10.

decrease in profit. It obvious from coefficients of scale variables that the production price has a great influence on the profit.

3.3 Estimation of cost function

The total cost function was estimated using OLS and different functional formulas to determine the appropriate relationship for variables included in the mathematical form. Several models were used for estimation of this relationship (linear, quadratic, and cubic). It was found that the cubic model was the most suitable model for the relationship in this study because of its consistent with econometrics, and economic tests. Based on economic theory, the short-run total cost [Doll and Orazem (1984)] function takes the following formula:

$$TC = a_0 + b_1 Q + b_2 Q^2 + b_3 Q^3 + u_i$$

The model shows that there is no auto-correlation problem because the calculated DW value is equal to 1.949, which is between (du < d < 4-du) *i.e.* (1.481 < 1.508 <1.529) and is located in the acceptance area of the null hypothesis which states that there is no problem of autocorrelation between residues. It is important to note that Q^2 and Q^3 are functionally related to the variable Q_i, but the relationship is nonlinear. Thus, this model satisfies the assumption that there is no linear relationship between the independent variables because the model is non-linear

Because of the adoption of cross-sectional data, it is necessary to detect the problem of Heteroscedasticity. Breusch-Pagan-Godfrey has been tested using Eviews.10, which includes the estimation of error square regression equation as a dependent variable (Q), Q_2 and Q_3 as independent variables [Panchal (2016)]. The test proved significant (F) from which it is possible to conclude that the estimated model suffers from the problem of heteroscedasticity as shown in Table 8.

3.4 Economic analysis

3.4.1 The optimal cost minimizing production

The optimal production can be obtained by finding the minimum limit of total average cost function and equals it with zero [Mahmood *et al.* (2018)].

$$SRTC = 3574.547 + 1587.923Q - 6.474Q^2 + 0.329Q^3 \quad (4)$$

Both marginal and average costs were derived from the estimated production cost function and could be expressed in the following equations:

$$SRMC = 1587.923 - 12.948Q + 0.987Q^2 \quad (5)$$

$$SRATC = \frac{SRTC}{Q} = \frac{3574.547}{Q} + 1587.923 - 6.474Q + 0.329Q^2 \quad (6)$$

According to average current production of farms which is 18.270 tons, both marginal and Average production costs are estimated at (1680.81, 1775.11)

Table 8: Heteroskedasticity test by breusch-pagan-godfrey (BPG).

Heteroskedasticity Test: Breusch-Pagan-Godfrey Null hypothesis: Homoskedasticity			
F-statistic	0.144346	Prob.F(3,80)	0.9330
Obs*R-squared	0.452241	Prob. Chi-Square(3)	0.9293
Scaled explained SS	2.774854	Prob. Chi-Square (3)	0.4277

Source: Calculated using Eviews.10.

Table 9: Estimation of cost function of broiler projects.

Dependent Variable: TC
Method: Least Squares
Date: 03/01/21 Time: 22:49
Sample (adjusted):1 84
Included observations: 84 after adjustments
Weighting series: 1/TC
Weight type: Inverse standard deviation (EViews default scaling)

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	3574.547	2703.898	1.321998	0.1899
Q	1587.923	283.7297	5.596606	0.0000
Q^2	–6.473813	7.460526	–0.867742	0.4664
Q^3	0.329288	0.449965	0.731807	0.4664
Weighted Statistic				
R-squared	0.839023	Mean dependent var		34747.61
Adjusted R-squared	0.832986	S.D. dependent var		2.52E-12
S.E. of regression	6067.115	Akaike info criterion		20.30560
Sum squared resid	2.94E+09	Schwarz criterion		20.42136
Log likelihood	–848.8353	Hannan-Quinn criter		20.35213
F-statistic	138.9881	Durbin-Watson stat		1.503226
Prob(F-statistic)	0.000000	Weighted mean dep.		26542.93
Unweighted Statistics				
R-squared	0.878218	Mean dependent var		45953.87
Adjusted R-squared	0.873651	S.D. dependent var		30297.41
S.E. of regression	10769.39	Sum square resid		9.28E+09
Durbin-Watson stat	1.195712			

Source: Calculated using Eviews.10.

thousand dinars respectively. The estimated cost elasticity at this production level is about 0.946. Therefore, these farms are subjected to the increase in yields, and when the cost is increased by a certain amount, the production will further increase.

$$Min\,ATC = \frac{SRATC}{Q} = --3574.547Q^{-2} - 0.658Q - 6.474 \quad (7)$$

Multiply Equation (3) by Q^2 results that

$$0.658Q^3 - 6.474Q^2 - 3574.547 = 0 \quad (7)$$

Equation (4) can be solved by trial and error or by Newton approach for solving non-linear Equations (5). The last approach requires the assumption of an initial value to find out the current value. This calculation was repeated until the two values (initial and current) are equal or too closed to achieve the required accuracy *i.e.* the past value is almost equal to its current counterpart. Chicken meat projects production was then estimated at lowest point of ATC (optimal production average) to be about 21.54 tons. This average is greater than that of actual production (18.27 tons) by 3.27 tons.

Table 10: Marginal costs, elasticity Cost average variable costs and average total costs of broiler project.

Quantity	Average Total Costs	Average Variable Costs	Marginal Costs	Elasticity Cost
5	2278.69	1563.78	1547.858	0.68
9.83	1919.71	1556.07	1556.017	0.81
10	1913.54	1556.08	1557.143	0.81
15	1803.14	1564.84	1615.778	0.90
18.27	1775.11	1579.46	1680.817	0.95
20	1768.77	1590.04	1723.763	0.97
21.54	1767.07	1601.12	1766.963	1.00
25	1774.68	1631.70	1881.098	1.06
28.019	1792.39	1664.81	1999.992	1.12
30	1808.95	1689.80	2087.783	1.15
35	1866.49	1764.36	2343.818	1.26
40	1944.73	1855.36	2649.203	1.36
45	2042.25	1962.82	3003.938	1.47
50	2158.21	2086.72	3408.023	1.58

Source: Calculated based on the questionnaire.

3.4.2 Profit maximizing production size

This size can be calculated by equivalence the marginal cost with the product price which is 2000 ID/kg.

$$0.0987Q^2 - 12.948Q + 1587.923 = 2{,}000$$

$$0.987Q^2 - 12.948Q - 412.077 = 0$$

$$Q = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

For $a = 0.987, b = -12.984, c = -412.077$

$$Q = \frac{12.948 \pm \sqrt{(-12.948)^2 - 4(0.987)(-412.077)}}{2(0.987)}$$

$$Q = \frac{12.948 \pm 42.362}{1.974}$$

Economic analysis showed the product size which maximizes the profit was 28.02 tons which is higher than the optimal production size 21.54 by 6.94 tons.

3.4.3 The least price accepted by chicken meat breeder to supply their products

This was estimated by achieving the first differentiation for average variable cost function and equating it to zero.

$$SRAVC = 1587.923 - 6.474Q + 0.329Q^2 \quad (8)$$

$$\frac{SRAVC}{Q} = 0.658Q - 6.474 = 0 \quad (10)$$

$Q = 9.83$ ton

Thus, the production size at the lowest point of average variable costs was estimated to be about 9.83 tons. By substitution of this value in Equation (9), the minimum value for average variable cost was obtained which was 1556 ID that represents the minimum price acceptable by the Chicken meat breeder.

Cost elasticity

The cost elasticity can be found by dividing the marginal costs on the average costs in the short-run for each of production levels represented by the actual production level of 18.27 tons, optimum production level of 21.54 tons, and the profit-maximizing level of 28.02 tons. The actual, optimal and profit-maximizing level were substituted in both MC and ATC. The elasticity at the actual output level (0.95) was less than the correct one. This indicates that production is subjected to increasing yields *i.e* there is a relative increase in production at a lower relative cost. Cost elasticity at optimal output was 1. This means that at optimal production level of 21.54 tons, the relative increase in output is equal to relative increase in the cost. Therefore, the production in these project will be subjected to the stage of yield stability. At profit-maximizing level of 28.02 tons, the elasticity was 1.12, which means that the relative increase in output is achieved with a relatively higher cost. Thus, the production of these projects is subject to the period of decreasing yields. (Table 10).

3.4.4 Measuring the technical efficiency of broiler project

Technical efficiency, in general, means the production of as much as possible net output using a certain amount of resources, or achieve the same amount of output with the minimum possible resources. Technical efficiency can be measured as follows [Mahmood *et al.* (2018)].

Technical Efficiency = (Actual Output / Optimum Output) * 100

= (18.27 / 21.54) * 100 = 84.82%

It is evident from the technical efficiency measures that about 85% of the economic resources have not been fully exploited and this value is low, which indicates that the chicken breeders are efficient in using the productive resources.

3.4.5 Cost efficiency of broiler project

Cost efficiency can be obtained by dividing TC at actual production level on TC at optimal production level, according to the following formula [Ogundari *et al.* (2006)]:

$$CE = \left(Ci^{bi} Ci^{min}\right).$$

where,

CE : Cost efficiency

Ci^{bi} : TC at actual production level

Ci^{min} : TC at optimal production level

$$CE = \frac{32431.30}{38062.67} = 85$$

From the aforementioned results, it can be concluded that production price has the greatest impact on profit function of broiler projects compared with production level variables and cost average. According to TE and CE, the economic resources used for production were not optimally exploited, a case which led to a decrease in production efficiency and an increase in the production cost of production. Cost efficiency for broiler project breeder less than the unit implies that resources were not optimally exploited. Thus, there is a need for supporting the poultry production sector in Iraq by providing sufficient and appropriate quantities of feed, vaccines and chicks to breeders at reasonable prices to advance the reality of poultry industry and production in Iraq. Besides, establishing modern abattoirs should be prepared on hygienic basis similar to their counterparts in developed countries.

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