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AN ECONOMIC STUDY TO ESTIMATE THE PRODUCTIVE PROFITABILITY EFFICIENCY OF BROILER PRODUCTION PROJECTS USING THE SHORT-TERM COST FUNCTION IN IRAQ (AL-QADISIYAH GOVERNORATE): AN APPLIED MODEL FOR THE PRODUCTION SEASON 2019

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Abstract

The study aimed to estimate the cost function, economic, cost and technical efficiencies, as well as the supply function, price elasticity, production capacity (number of birds) and profitability efficiency of broiler projects at the optimum and profit-maximizing level of production. A random sample of 30 fields was selected from the total 44 fields in Al-Qadisiyah Governorate during the 2019 season. For quantitative analysis, Ordinary Least Squares (OLS) method was used to estimate the cost function parameters. The results indicated that broilers producers did not achieve the economic efficiency in their production, and therefore, the economic resources used in the production process were not optimally invested. By calculating the lowest price acceptable to the producer (1369 dinars/kg) and comparing it with the actual price (3000 dinars / kg), we find that the latter can achieve economic profits that encourage breeders to continue and expand production. As for technical efficiency, it reached 53.22%, while cost efficiency was 0.63. The results of the study indicated the lack of optimal utilization of economic resources, which implies that actual production is far from optimal production. Depending on the cost efficiency of 0.63 of broiler production projects, it is possible to produce the same amount (actual production) with a cost savings of 37%. Therefore, the study recommends the necessity of reallocating the available resources by producers in order to achieve the economic efficiency of these resources.
Keywords: Chicken meat, Cost Function, Supply function, Technical Efficiency, Economic Efficiency.

Introduction

Livestock is an essential and important part of the agricultural sector, as it is no less important than the plant side (Naji, 1985). Poultry forms an important part of livestock, and chicken meat is at the forefront of poultry in terms of food, industrial and commercial importance. Due to the increasing demand for chicken meat and other products, production systems have evolved in this field, and meat production has become an integrated industry involving multiple technologies that complement each other. This industry has evolved rapidly so that many techniques are used in it started from the establishment of barns passing through the different stages of education and ending with the slaughterhouses (Al-Fayadh *et al.*, 1989). The importance of chicken meat is evident in that it is easy to digest as well as it contains calories and protein in good proportions, and vitamins, fats and carbohydrates (Al-Fayadh and Nagy, 1989). Furthermore, the low prices of chicken meat compared to other meat prices have exacerbated the demand for this product (Masoudi, 2007). Also, chicken, and its products are used in many industries such as shampoo, soap, toys and animal feed (Shukair, 1997). Chicken waste is used as a fertilizer for agricultural crops, as it is rich in organic materials that increase soil fertility and improve its properties. The projects of chicken meat are characterized by the short capital cycle and the speed of its recovery period, as the productive cycle does not exceed (6-8) weeks and achieve profitable profits (Al-Zubaidi, 1986).

In Iraq, the first signs of intensive chicken production began at the twentieth century, specifically 1905. Then, this industry developed with the number of productive projects producing chicken meat reaching 1663 in 2017 and the production amount was (50073) tons, in which Al-Qadisiyah Governorate came in second rank, accounting for (14.7%) of meat production projects in Iraq. During this year, the number of projects reached 246, with a production of (16116) tons. (Arab Organization for Agricultural Development. 2017). However, this increase in the number of projects and production was not sufficient to meet the increasing local demand for chicken meat. Such demand arises from the increase in the population, the improvement of the living conditions, and the lower price of the product compared to other meat. The average annual per capita share of poultry meat was (7.9) kg/person/year in 2017 (Arab Organization for Agricultural Development, 2018). Which is an indication of insufficient domestic production. To scope with this increase in demand, the government legislated the importation of chicken meat which increased steadily in the years from 2003 to 2018. In 2003, Iraq imported about (250) thousand tons costing (190) thousand dollars, and the quantity increased until the year 2015 (413 thousand tons), costing 241 million dollars. In 2018, the imported quantities decreased by about half, as they amounted to (212) thousand tons, with an annual growth rate of (20%) (Statistical publications for years (1980-2016).

Materials and Methods

The basic cross-sectional data were obtained through a random sample of broiler breeders in Al-Qadisiyah Governorate for the season 2019 according to a questionnaire prepared for the study objectives. A random sample of 30 fields was selected to represent the total number of breeders (44) in the governorate. The questionnaire included information about production, costs and revenues. Analysis was performed using Eviews.10 software. For quantitative analysis, the Ordinary Least Squares (OLS) method was used to estimate the cost function parameters.

Several previous studies addressed this problem using poultry projects in geographical locations (Dahla, 2002; Ogundari *et al.*, 2006; Oda, 2009; Qasim *et al.,* 2009; Thamer *et al.,* 2010; El-Akwa, 2013; Al-Tarawneh, 2013; Hamza, 2014; Al-Ukeili *et al.,* 2015; El-Abd *et al.,* 2016; Mahmood *et al*., 2018).

First: the total variable costs:

Production costs are generally divided into two parts: variable production costs and fixed production costs. In this study, the most important items of fixed production costs were alternative opportunity costs for each of the capital interest that was calculated on the basis of 5% of the value of variable costs and the rental value that includes rent land and halls, as well as the costs of permanent workers. On the other hand, the most important items of variable production costs included the purchase of chicks, feed costs, medicines, vaccines and other costs that include electricity, water, fuel, maintenance costs, and chicken bed as well as the costs of the leased work and transport. It is clear from Table 1 that the fixed and variable costs constitute 86.171% and 13.829% of the total production costs respectively. This encouraged breeders to invest their money in the production of broilers, for the possibility of recovering the capital invested, and there is a good possibility to control the total cost through variable costs or through the process of replacement or the variable production elements.

As for the variable cost items (table 2), the relative importance of feed costs came first accounting for 78.420% of the total variable costs. This indicates the high price of feed for broiler 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. Chicken costs came next with 15.678% 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 2.453%, 1.852%, 0.823%, 0.34%, 0.221%, 0.124%, and 0.09% of the total variable costs, respectively.

As for the fixed costs items, the costs of land and hall renting occupied the first rank by 61.669%, and this can be attributed to the increase hall rent in the study area. The interest costs on capital came second by 25.112% due to the low interest rate in the stock market. The permanent work occupied the last rank with 13.215% of the total fixed cost due to the dependence of the poultry farmers on the permanent leased workers in view of the experience gained by these workers from working in poultry projects.

Table 1 : The relative importance of the variable costs of the total costs per ton for the research sample for the 2019 season.

Costs	the amount of costs in thousand dinars	the relative importance %
Feed	24029.999	78.420
Chickens	4804.161	15.678
Medicines and vaccines	751.665	2.453
Leased work	567.503	1.852
Electricity and water	252.189	0.823
Fuel	103.879	0.339
Bed	67.720	0.221
Maintenance expenses	37.997	0.124
Transportation	27.578	0.09
Total	30642.695	**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 for the 2019 season

Costs	Amount of costs, thousand dinars	the relative importance%
Hall rent	3032.658	61.669
Interest on invested capital	1234.917	25.112
permanent workers	649.866	13.215
Total	4917.638	%100

Source: Prepared by the researchers, based on the questionnaire

Results and Discussion

Estimate the cost function

According to the economic theory, the total costs are a function of total production in the short term, that is, one or more of the factors of production is fixed in this period and that the cost function can be linear or non-linear. In the current study, the production costs function has been estimated for broiler projects using three forms of cost functions (linear, quadratic and cubic). The result showed that the cubic form is the most appropriate form for the relationship because of its consistency with statistical, standard and economic tests. The general form of the model can be written as following (AL-Shafi'i, 2005):

$$SRTC = b_0 + b_1Q + b_2Q^2 + b_3Q^3 + ui$$

Where:

TC: Total costs (thousand dinars).

Q: Total production, which represents (number of chicks - mortality) ×chicken weight (kg).

b_0, b_1, b_2, b_3 : Parameters for the fixed model are, b_o represents the total fixed costs TFC.

When quantitative analysis was performed for the short-term total cost function, it was found to be in agreement with the economic logic, and passed the statistical tests (R^2 F, t) and the standard tests.

Table 3 : Estimated coefficients for the function costs of broiler projects using the usual least squares method
Dependent Variable : TC
Method : Least squares
Date :12/3/19 Time:19:17
Sample: 1-30
Included observation :30

Variable	Coefficient	Std. Error t-Statistic	Prob.
C	-9154190	7752770 1.180764-	0.2484
Q	2947.087	824.4818 3.574472	0.0014
Q^2	-0.061991	0.025830 -2.399983	0.0239
Q^3	6.09E-07	2.38E-07 –2.562259	0.0165
R-squared	0.939048	Mean dependent var	34475667
Adjusted R-squared	0.932015	S.D. dependent var	14132675
S.E. of regression	3684938	Akaike info criterion	33.20097
Sum squared reside	3.53E+14	Schwarz criterion	33.38780
Log likelihood	-494.0146	Hannan-Quinn alter.	33.26074
F-statistic	133.5220	Durbin-Watson stat	1.402884
Prob(F-statistic)	0.000000		

Source: Calculated using Eviews.10.

Statistical analysis

According to the t test, the estimated parameters were significant at the level of 5% and that the value of the determination coefficient reached 0.94. That means that the total production explains about 94% of the changes occurred in the production costs of broiler projects, while the other variables (about 6%) are attributed to factors not included in the model Table (3).

Standard Analysis

The model shows that there is no auto-correlation problem because the calculated DW value is equal to (1.403), which is between (du <d <4-du) i.e. (1.143 <1.403 <1.650) 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 Q2 and Q3 are functionally related to the variable Qi, 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 (Gujarati,2004) has been tested using Eviews.10, which includes the estimation of error square regression equation as a dependent variable (Q), Q2 and Q3 as independent variables(Mahfouz, 2008). The test proved significant (F) from which it is possible to conclude that the estimated model does not suffer from the problem of heteroscedasticity as shown in Table 4.

Table 4 : Heteroskedasticity Test: Breusch-Pagan-Godfrey (BPG).

F-statistic	0.666500	Prob. F(3,26)	0.5802
Obs*R-squared	2.142361	Prob. Chi-Square(3)	0.5434
Scaled explained SS	2.483016	Prob. Chi-Square(3)	0.4784

Source: Calculated using Eviews.10

Economic analysis

1. Determining the Cost-minimizing Optimal Production Level:

The optimum level of output can be obtained by finding the minimum term for the average total cost function and equalizes it to zero (Doll and Orazem, 1984).

$$Tc = -9154189.609 + 2947.087Q - 0.062Q^2 + 0.000000609Q^3 \ldots\ldots(1)$$

$$ATC = \frac{TC}{Q} = -9154189.609Q^{-1} + 2947.087 - 0.062Q + 0.000000609Q^2 \ldots\ldots\ldots(2)$$

$$\frac{\delta ATC}{\delta Q} = 9154189.609Q^{-2} - 0.062 + 0.00000122Q = 0 \ldots\ldots\ldots(3)$$

Multiplying equation 3 by Q2 results in:

$$-9154189.609 + 0.062Q^2 - 0.000000122Q^3 = 0 \ldots\ldots(4)$$

The equation can be solved by trying and error or Newton's method to solve non-linear equations (4). This method requires assuming an initial value to find the current value and these calculations are repeated until the two values are equal or close to each other to achieve the required accuracy, i.e. the last value is almost equal to its current counterpart (Al-Ashaikh, 2011). The broiler output is then estimated at the lowest point of the average total cost (the optimal output rate) at 47,493 kg, and it decreases at the level of the actual production level, which amounted to about 25,276 kg, by 22,217 kg

2. Determining the Maximum Output Level for Profit:

The profit-maximizing production can be obtained by equating the marginal cost with the output price (AL-Shafi'i , 2005) of 2300 dinars / kg.

$$2947.087 - 0.124Q + 0.00000183Q^2 = 2300 \ldots(5)$$

Equation 5 can be solved by constitution:

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

It was found through economic analysis that the level of the profit-maximizing product reached about 62062 kg, which is more than the optimal production level, which amounted to about 47493 kg, by 14,569 kg.

3. The minimum price that farmers accept to display their broilers product:

The minimum price that farmers accept to display their production is estimated by performing the first differentiation of the average variable cost function and equalizes it to zero (Debertin, 1986).

SRAVC =

$$2947.087 - 0.062Q + 0.000000609Q^2 \dots\dots (6)$$

$$\frac{dSRAVC}{dQ} = -0.062 + 0.00000122Q$$

$$Q = \frac{0.062}{0.00000122}$$

Q=50903

Thus, the production level at the lowest point of the average variable costs is estimated to be 50,903 kg. When compensating by equation 6, the lowest value of the average variable costs can be obtained which was 1369 dinars and represents the lowest price the product accepts.

Cost Elasticity

Cost elasticity can be found by dividing the short-term marginal costs by the average short-term costs of broiler for three production levels actual, optimal, and most productive level of profit of (25276 kg, 47493 kg, 62062 kg, respectively). These levels were substituted for both MC and ATC. The elasticity at the actual production level was 0.698 which is less than the correct one, indicating that the production is subjected to increased production i.e. production subjected to a relative at a lower relative cost. Cost elasticity at the optimal production level was 1 which means that at this level, the relative increase in the reduction is equal to the relative increase in costs, i.e. the production in projects is subjected to the stage of constant production at its optimum level. As for the level of production of the greatest profit, the elasticity was 1.77, which means that there is a relative increase in production with a greater relative increase in costs. Thus, the production of these projects is subjected to a diminishing phase. Table (5) shows the average total costs, marginal cost, and cost elasticity.

Table 5 : Marginal costs, average variable costs, and average total costs for broiler projects in Al-Qadisiyah Governorate

Quantity	Average total costs	Average variable costs	Marginal costs	Elasticity cost
10000	1472.57	2387.99	1890.09	1.28
15000	1543.83	2154.11	1498.84	0.97
20000	1492.98	1950.69	1199.09	0.80
25000	1411.54	1777.71	990.84	0.70
25276	1406.88	1769.05	982.01	0.70
30000	1330.05	1635.19	874.09	0.66
35000	1261.56	1523.11	848.84	0.67
40000	1212.63	1441.49	915.09	0.75
45000	1186.89	1390.31	1072.84	0.90
47493	1183.42	1376.17	1185.68	1.00
50000	1186.50	1369.59	1322.09	1.11
55000	1212.87	1379.31	1662.84	1.37
60000	1266.92	1419.49	2095.09	1.65
62062	1297.42	1444.92	2300.00	1.77
65000	1349.28	1490.11	2618.84	1.94
70000	1460.41	1591.19	3234.09	2.21

Source: Prepared by the researchers, based on the estimated cost function

Estimating the economic and technical efficiencies of broiler projects

Economic efficiency means achieving the greatest profit with a certain amount of cost, or achieving the same amount of (income) profits with the lowest possible cost (Doll, 1984) and it is measured according to the following formula :

Economic Efficiency

$$= \frac{Optimum\ production\ for\ average\ cost}{Actual\ production\ for\ average\ cost} *100$$

$$\text{Economic Efficiency} = \frac{118342.410}{1406.881} *100$$

According the economic efficiency (84.11%) which is less than the correct one, the producers can achieve the same level through reducing production costs or reducing the amount of resources used by (15.89)%, suggesting that there is a relative increase (deviation) in the average cost of actual production exceeds the average cost for the optimal production by 15.89%.

Technical efficiency means producing the largest possible amount of production with a certain amount of resources, or achieving the same amount of production with the least amount of resources (Depoju, 2008), and it can be estimated as follows.

Technical efficiency = (actual production ÷ optimal production) *100

$$\text{Technical efficiency} = \frac{25276}{47493.08} * 100 = 53.22\ \%$$

Based on the results of technical efficiency (53.22%), the producers work in the first stage of production (the non-economic stage), that is, they can increase their production by (53.22%) without increasing in economic resources used in the economic process. As such, there are losses (waste) In using economic resources, and the producers afford additional costs equal to (46.78%) of the resource costs. Furthermore, these projects can produce the same previous production with resources less than (46.78%) of the actually used resources.

Estimating the cost-efficiency for broiler projects

Cost efficiency can be calculated by dividing the total costs of the actual production level by the total costs of the optimal production level (Samurai, 2007).

$$\text{Cost Efficiency } C_{EE} = \frac{c^{b}}{c^{min}} = \frac{35560333}{56204361} = 0.63$$

As:

C_{EE}: Cost efficiency.

C^{b}: observed cost (represents actual production costs).

C^{min}: minimum cost (represents the level of the minimum total production costs).

This implies that the cost efficiency of the study sample was 0.63, which is less than the correct one, which is an indicator confirms that the resources used were not optimized. So, it is possible to produce the same amount (actual production) with a cost savings of 37%.

Supply function for broiler projects

To find out the reaction of broiler breeders to the changes in production price, the supply function must be derived by equating marginal costs with the price of the output, i.e. the supply function can be derived from the necessary condition for the profit function, as follows (Zaidan, *et al.* 2011):

$$\pi = TR - TC$$

$$\frac{\partial \pi}{\partial Q} = P - \frac{\partial LRTC}{\partial Q} = 0$$

$$P = LRMC$$

Substitution of the above marginal cost equation derived from the total cost function in the long-run estimated results in:

$$0.00000183Q^{2} - 0.124Q + 2947.087 = P \ldots\ldots (7)$$

$$0.00000183Q^{2} - 0.124Q + (2947.087 - P) = 0 \ldots\ldots (8)$$

Solving this equation by constitution method gives the function of supply (21), as follows:

$$S = \frac{-b \pm \sqrt{b^{2} - 4ac}}{2a}$$ *for a*=0.00000183, *b*= –0.124,

C= (2947.087 –P)

$$S = \frac{0.124 \pm \sqrt{(-10.124)^{2} - 4(0.00000183)(2947.087 - P)}}{2(0.00000183)}$$

$$S = \frac{0.124 \pm \sqrt{0.00000732P - 0.00619}}{0.00000366} \ldots\ldots (9)$$

This function represents the long-term supply of broiler breeders to find out the breeders' response to the different price levels according to the estimated supply function, different price levels have been assumed as shown in the table (6), from which the supply curve can be drawn for the study sample of breeders in the long term as shown in Figure (1).

Table 6: the supplied quantities and the price supply elasticity for the studied breeders

Product price	Supplied quantity (Dinar / Kg)	price elasticity
1369	34927	0.674
1400	34989	0.671
1500	35189	0.665
1600	35389	0.665
1700	35589	0.668
1800	35789	0.674
1900	35989	0.681
2000	36189	0.689
2100	36389	0.699
2200	36589	0.709
2300	36789	0.720
2400	36989	0.731
2500	37189	0.743
2600	37389	0.755
2700	37589	0.768
2800	37789	0.781
2900	37989	0.794
3000	38189	0.808

Source: Prepared by the researchers, based on the estimated supply function.

Price Supply Elasticity

The price supply elasticity broiler projects, which is one of the most important indicators that can be estimated from the supply function, was calculated from the first differentiation of supplied quantity in relative to the price (Al-Mayahi, 2014) as follows:

$$\frac{dQs}{dP} = \frac{1}{0.00000366}\left(\frac{d}{dP}(0.124) + \frac{d}{dP}\sqrt{(0.00000732P - 0.00619\ )}\right)$$

$$\frac{dQs}{dP} = \frac{1}{0.00000366}\left(0 + \frac{0.00000366}{\sqrt{(0.00000732P - 0.00619\ )}}\right)$$

$$\frac{dQs}{dP} = \frac{1}{\sqrt{(0.00000732P - 0.00619\ )}} \ldots\ldots (10)$$

By applying the law of price elasticity, we have**:**

$$Es = \left(\frac{\partial Qs}{\partial P}\right)\left(\frac{P}{Qs}\right)$$

It is obvious from the data in table (6) that the minimum price accepted by the breeders is (1369) dinars / kg, and the supplied quantity of broilers amounted to (34927) kg, while this quantity has increased to approximately (38189) kg when the market prices increased to approximately (3000) dinars / kg. Figure (1) shows the direct relationship between the production quantity and the price of the chicken. The price elasticity was 0.674 at the minimum price that breeders accept to display their production. That means when prices exceed their minimum limit by 10%, the supplied quantity increases by (6.3%). The supply elasticity at price 3000 dinars was about 0.808. Thus, when the prices increases by 10%, the supplied quantity increases by 80.8% which indicates that breeder were facing a great difficulty in controlling production in the event of price changes.

Fig. 1 : Curve of chicken meat projects

Source: From the work of the researcher using data on the table**(6)**

Measuring the production capacity of broiler projects at the optimum and profit-maximizing level of production

To calculate the productive capacity (the number of birds) that achieves the optimum and profit-maximizing level of production, the equation of production capacity in which the number of birds per project was considered as a dependent variable and the estimated production amount as an independent variable will be relied upon (Hudhud *et al.,* 2015).

$M = b_0 + b_1Q$

As:

M: production capacity for each project.

Q: Production level (number of birds-mortality)×chicken wt.

$M = 513.857 + 0.512Q$ ....(11)

t= 0.768 21.29

$R^2=0.94$ *F=2482.47*

Substitution the magnitude of the optimal cost-minimizing and the profit-maximizing production level, which amounted to about (47493 kg and 62062 kg respectively) in the equation (11) gives the optimum production capacity that minimizes costs and profit-maximizing productive capacity (24826 birds and 32284 birds, respectively). By comparing these capacities with the actual productive capacity (the actual rate of birds, 13453 birds), it was found that this capacity is less than its ideal counterpart and profit-maximizing capacity (11373 birds and 18830 birds, respectively). That means that the efficiency ratio of the optimum production capacity and the profit-maximizing capacity was (0.54% and 0.42% respectively) in relation to the actual production capacity. This was reflected in a decrease in actual production, and hence the projects did not achieve the optimal levels which affected the economic efficiency of these projects.

Estimating the profit efficiency at the level of the actual and optimal cost-minimizing and proft-maximizing production for broiler projects

Profitability efficiency is defined as the ability of the project to achieve the highest possible profit with prices and quantities from fixed factors the project (Mulie, 2014). The profitability efficiency was estimated by dividing the net income by the total costs. Bases on the profit equation, net income was obtained for actual production, optimal production, and profit-maximizing level (25276 kg, 47493kg and 62062 kg, respectively). Keeping in mind that the price per for chicken meat was 2300 dinars/ kg.

$$\pi = TR - TC$$

$$\pi = 2300Q + 9154189.609 - 2947.087Q + 0.062Q^2 - 0.000000609Q^3 \quad ...(11)$$

Substituting these levels of production in the equation (11), it is clear that the net estimated income for the three levels amounted to 22574467 dinars, 53029539 dinars and 62221958 dinars, respectively.

After net income and total costs have been obtained, it is possible to measure the profitability efficiency of the actual production and cost-optimizing and profit-maximizing level which were 0.63, 0.94, 0.77, respectively. This means that the dinar that was invested in actual production achieved 630, 940, 770 files.

By measuring profitability efficiency, it can be deduced that the actual level of production is less than the profitability efficiency for the optimum and most profitable level by 310 files and 140 files, respectively per invested dinar, i.e. (32.98%, 18.18% respectively). Therefore, the producers can increase their profits through the ideal use of resources as in the table7:

Table 7 : Profitability efficiency of the actual production, optimal cost-minimizing and profi-maximizing level for broiler projects in Al-Qadisiyah Governorate

Indicators	actual production	Optimal production	Profit-maximizing
Production level (kg)	25267	47493	62062
Total costs (dinars) A	35560333	5620436	80520642
Total revenue (dinars)	62704900	109233900	142742600
Net income (dinars) B	22574467	53029539	62221958
Profitability A / B	0.63	0.94	0.77

Source: From the work of researchers based on the cost function (1) and the profit function No. (11)

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