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# A Quantitative Model to Determine Factors Affecting Profits of Broiler Enterprises

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**Abstract:** The purpose of this study was to demonstrate the use of the profit function regression model as a decision support tool in commercial broiler production.

The fact that the estimated impact factors affecting profitability on the profit per kg live-weight were similar to those observed in the field indicates the power of the model as a decision support tool in broiler production.

Because the marginal impact of each independent variable on profit was the estimated coefficient value, they could simply be used to evaluate "what-if scenarios" and the risk of investment under changing circumstances in broiler production. It is, therefore, proposed that commercial broiler producers use such a modelling approach as a practical decision support tool.

**Key Words:** Commercial broiler production, profit function, decision support tool

## Broiler İşletmelerinde Kar'a Etkili Faktörlerin Kantitatif Yöntemlerle Tespiti

**Özet:** Bu çalışmanın amacı; ticari broiler yetiştiriciliğinde kâr fonksiyonu regresyon modelinin işletme kârına etki eden faktörlerin belirlenmesinde, karar destekleme aracı olarak nasıl kullanılabileceğini ortaya koymaktır.

Model tahmin sonuçlarının pratikte karşılaşılan ve beklenen değerlere yakın çıkması modelin tahmin gücünün bir göstergesidir.

Bu çalışmadaki regresyon modelinde  $\beta$  değerleri, her bir bağımsız değişkenin, kg canlı ağırlık başına kâr üzerine marjinal etkisini göstermektedir. Dolayısıyla bu değerler broiler üretiminde beklenen sonuçların tahmini yanında, fiyatların ve maliyet unsurlarının değişebileceği durumlarda risk değerlendirmesine de izin vermektedir.

Modelin bu özelliğinden dolayı, üreticilere ve sektöre danışmanlık hizmeti veren kişi veya kurumlarca "karar destekleme aracı" olarak kullanılabileceği düşünülmektedir.

**Anahtar Sözcükler:** Ticari broiler üretimi, kâr fonksiyonu, karar destekleme aracı

## Introduction

Modern broiler enterprises are characterised by mass production with a high turnover of capital, but low profit margin per bird. Success in business is mainly determined by the abilities of entrepreneurs to control production costs. For successful decision-making, managers/producers, need information on the expected marginal impact of each important factor affecting profitability, and they need to perform risk assessment to account for likely deviations from expected results to ensure the future success of the business.

Quantitative models have been utilised as decision support tools in poultry production since the 1960s (1). Heady et al. (2) used quadratic, square root and Cobb-

Douglas production function types to investigate the marginal substitution rate between soybean and maize used in broiler rations. Several other studies (3-6) also used the Cobb-Douglas production function to assess the partial productivity of each input used in livestock production and returns to scale. In these studies, however, the marginal impact of each input on profit could not be estimated directly since the dependent variable was income, i.e., not profit. The profitability of the businesses in such research had to be calculated indirectly from various profitability ratios.

It is possible to estimate factors affecting profit with profit function models. A linear profit function model has frequently been used to determine and quantify factors

affecting milk production (7-11) and broiler production (2,12,13) to determine long term strategies for breeding programmes. While we think that the profit function model may be used as a decision support tool for the management of broiler production, during our literature search we did not come across any study applying a profit equation for this purpose. For this purpose, conventional accounting tools have frequently been applied (14-16).

From this point of view, this research aimed to use the profit function model to estimate factors affecting profit in broiler production, while exploring its possible use as a practical decision support tool in the field by broiler producers.

## Materials and Methods

### Materials

The required data related to the technical and financial aspects of broiler production were obtained from 140 broiler production enterprises in Bolu Province and its districts via an interview survey between November 1993 and November 1994.\*

### Methods

#### Forming Regression Equation

The data obtained via interview surveys were processed to calculate profit per kg live-weight and other relevant information for inclusion in the profit function model.

Multiple regression model procedures were used to estimate the impact of several factors affecting the profitability of broiler production. The model was:

$$Y = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9, X_{10}, \text{dev}X_{10}^2)$$

Y: Profit (Turkish Lira-TL) per kg live-weight (LW)

X<sub>1</sub>: Sale price of broiler (TL/kg LW)

X<sub>2</sub>: Price of purchased chick (TL/chick)

X<sub>3</sub>: Price of feed (TL/kg)

X<sub>4</sub>: Cost of labour (TL/kg LW)

X<sub>5</sub>: Cost of veterinary service and medicine (TL/ kg LW)

X<sub>6</sub>: Other costs including building and machinery depreciation, repairs and maintenance and miscellaneous (TL/ kg LW)

X<sub>7</sub>: Cost of heating and lighting (TL/kg LW)

X<sub>8</sub>: Mortality rate (%)

X<sub>9</sub>: Feed conversion rate - FCR (kg feed consumed per kg LW gain)

devX<sub>10</sub>: Length of production cycle (day)\*\*

dev(X<sub>10</sub>)<sup>2</sup>: Quadratic term of devX<sub>10</sub>

As a first attempt during the model building procedure, various types of relationships (e.g. linear and quadratic) between the dependent variable (Y) and each independent variable (X<sub>i</sub>) were examined on scatter graphs. The relationships between Y and all X<sub>i</sub>'s except that of X<sub>10</sub> were observed to be linear. Only their linear terms were, therefore, included in the model. X<sub>10</sub> appeared to have a non-linear relationship with the dependent variable; therefore, both its linear and quadratic terms were included in the regression equation. Because the quadratic term of X<sub>10</sub> was derived from X<sub>10</sub>, they naturally highly correlate with each other. In order to avoid a likely multicollinearity problem, the quadratic term was derived from the deviation of X<sub>10</sub> from its mean rather than X<sub>10</sub> itself.

The value of all independent variables measured with money was affected by the high inflation rate in Turkey; the effect of inflation caused an exaggerated correlation amongst these variables (85-90%). Therefore, a retail price index has been applied to eliminate the effect of inflation. After performing these procedures a regression assumption that states independent variables are not highly correlated was fulfilled.

The regression equation was estimated by applying a stepwise regression procedure in the SPSS Statistical Package, Version 7.5 (17). In the stepwise regression procedure, the variables whose P values are greater than 0.05 are automatically discarded from the model, so that the best suitable model can eventually be constructed with a single run.

\* The raw PhD data of Gür (16) were used.

\*\* Note that the linear and quadratic terms use the deviation of X<sub>10</sub> from its mean rather than X<sub>10</sub> itself in order to reduce the correlation between these two terms.

## Results

The estimated regression results are presented in Table 1.

As can be seen from the table, amongst the independent variables entered in the model, only the statistical association of "labour costs ( $X_4$ )" with the dependent variable was not found to be significant at  $P < 0.05$ , and it was therefore dropped from the model. The rest had a strong statistical association with profit per kg live-weight ( $P < 0.0001$ ).

The model explained 98% of the variation in the dependent variable ( $R^2 = 0.98$ ). The beta values depicted in Table 1 are the estimated coefficient values. Each coefficient demonstrates the marginal impact of an independent variable in question on the profit per kg live-weight. However, the coefficient of  $X_{10}$  cannot simply be interpreted as the above because the value of  $\text{dev}X_{10}$  was not the real value of  $X_{10}$ . Nevertheless, the positive sign of a linear term, and the negative sign of a quadratic term of  $\text{dev}X_{10}$  depicts that as the day progress profit per kg live-weight increases, but at a diminishing rate. In fact, the scatter graph between Y and  $X_{10}$  shows that profit increases up to day 43, and then starts declining. This finding is compatible with our field observations.

As can be seen from Table 1, the relationships between the dependent variable and all independent variables were as expected.

It is possible to predict from the coefficient values that a rise in the price (TL/kg LW) of broiler meat ( $X_1$ ) by 1 TL will result in an increase in the profit per kg live-weight by 0.99 TL. In contrast, the rises in  $X_2$ ,  $X_3$ ,  $X_5$ ,  $X_6$ ,  $X_7$ ,  $X_8$  and  $X_9$  will lead to a drop in the profit per kg live-weight by 0.57 TL, 2.02 TL, 1.23 TL, 1.09 TL, 0.04 TL, 1.29 TL, and 5.16 TL, respectively.

## Discussion

### Reliability of Model Estimates

The reliability of the regression estimates may be undermined by a violation of the assumptions when using regression analysis.

The existence of any violation (abnormally distributed independent variable, autocorrelation, heteroscedasticity and multicollinearity) of the assumptions made in the least square estimation were tested by looking at the histogram of the dependent variable (Figure 1), the Durbin-Watson Test (column 6 of Table 1), the correlation table (Table 2) and the standardised residual plot (Figure 2), and no serious violation of the assumptions was encountered.

### Evaluation of the model findings

The findings of this study could not be compared with the literature as similar studies using the profit equation for commercial broiler production were not encountered

Table 1. Estimated regression model of profit per kg live-weight (TL) on several factors affecting profitability in broiler production.\*

factors	$\beta$	t	Sig. P	$R^2$	Durbin-Watson	F	SigF
1	2	3	4	5	6	7	8
(Constant)	10.906	60.990	0.000	0.98	2.024	3700.6	0.000
$X_1$	0.993	159.866	0.000				
$X_2$	-0.569	-56.311	0.000				
$X_3$	-2.021	-132.712	0.000				
$X_5$	-1.233	-11.064	0.000				
$X_6$	-1.089	-23.853	0.000				
$X_7$	-0.035	-13.745	0.000				
$X_8$	-1.287	-18.401	0.000				
$X_9$	-5.162	-60.212	0.000				
$\text{Dev}X_{10}$	0.073	18.143	0.000				
$\text{Dev}(X_{10})^2$	-0.005	-3.731	0.000				

\*The dependent variable is the profit from per kg live-weight (TL/kg live-weight)

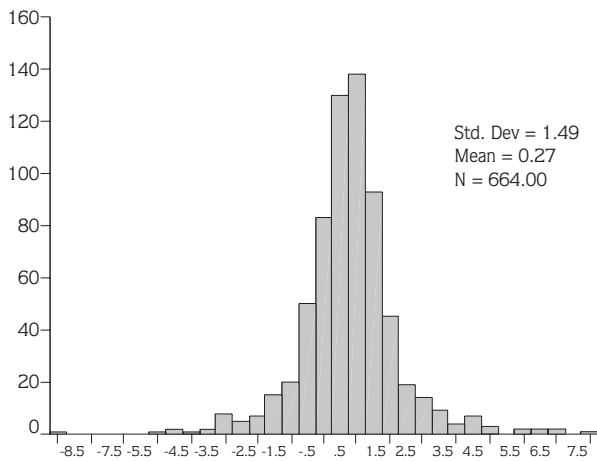


Figure 1. The distribution pattern of profit per kg live-weight.

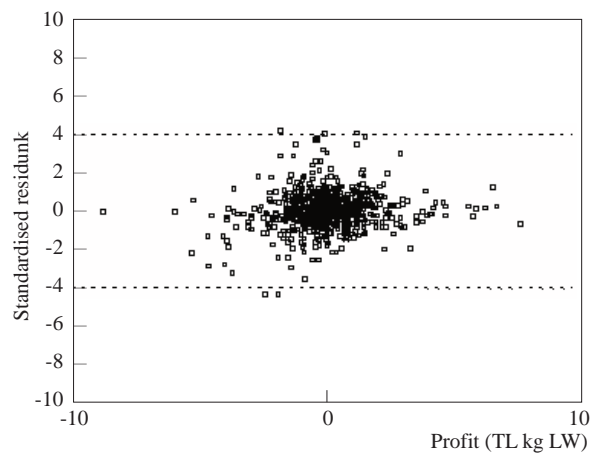


Figure 2. The relationships between the dependent variable (profit from per kg live-weight) and standardised residuals.

Table 2. Correlation matrix of the variables entered in the regression model.

	Y	X <sub>1</sub>	X <sub>2</sub>	X <sub>3</sub>	X <sub>5</sub>	X <sub>6</sub>	X <sub>7</sub>	X <sub>8</sub>	X <sub>9</sub>	DevX <sub>10</sub>	Dev(X <sub>10</sub> ) <sup>2</sup>
Y	1										
X <sub>1</sub>	0.409	1									
X <sub>2</sub>	-0.145	0.232	1								
X <sub>3</sub>	-0.284	0.498	-0.183	1							
X <sub>5</sub>	-0.209	0.203	0.242	0.010	1						
X <sub>6</sub>	-0.286	0.242	0.311	0.103	0.324	1					
X <sub>7</sub>	-0.096	0.041	0.625	-0.399	0.288	0.356	1				
X <sub>8</sub>	-0.320	0.027	0.081	0.007	0.455	0.159	0.113	1			
X <sub>9</sub>	-0.317	0.106	0.031	-0.052	0.328	0.269	0.147	0.392	1		
DevX <sub>10</sub>	0.050	-0.013	-0.051	-0.031	-0.035	0.076	0.059	-0.087	0.202	1	
Dev(X <sub>10</sub> ) <sup>2</sup>	-0.179	-0.061	-0.092	0.096	0.004	0.078	-0.039	0.095	0.181	0.398	1

during our literature survey. However, the model estimates were quite compatible with field observations.

As observed in the field, the most important factors affecting profit in this study were the price of feed and the feed conversion rate.

The reason why the impact of labour cost on profit was not statistically significant may be the fact that the majority of the labour required was provided by the family of the producers.

While a higher mortality rate was associated with lower profits, its financial importance appeared to be negligible. This could be because a majority of the deaths came from chicks in the early stages of the production period.

The estimates obtained from our research are the average value of all enterprises included in the project. It is, however, possible to establish similar models not only for different production scales (small, medium and large), different production seasons (winter, spring, summer and autumn) and different regions, but also for individual enterprises using their time series data from previous years.

Commercial broiler producers could use such a modelling approach as a decision support tool to evaluate “what-if scenarios” and the risk of investment under changing circumstances in broiler production.

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