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Analysis of the Turkish broiler sector: the case of price competition

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Abstract Production technology used in the Turkish broiler sector is well developed. Eighty percent of production is mostly carried out at integrated facilities, using internationally competitive techniques that are employed in developed countries. Broiler slaughter capacities are 15 000–17 000 units/h. The increase in the concentration ratio of top four firms (CR4) in the broiler sector has caused doubts about the competitiveness. According to 2004 data, the top 20 firms produce 84% of the total production and CR4 is 38.7%. In this study, a differentiated product oligopoly model has been applied to the Turkish broiler sector, and the price competition from 1998 to 2004 has been analysed. The top five firms, which have the highest competitive power and which are the only firms that meet the European Standards and are exporting broiler meat to the EU countries, have been included in the analysis. The results show that these firms have elastic demand and positive price cost margin.

Keywords competitiveness; broiler sector; demand elasticities; oligopoly model

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INTRODUCTION

The broiler sector has developed rapidly within the last 50 years and has become an important agricultural sector in Turkey. As a result of contract farming after the 1970s, using internationally competitive techniques employed in some developed countries, broiler breeding became widespread and changed its type of production from village production to industrial production using improved technology (Çetin 1984; Kocak et al. 2005). Broiler breeding in Turkey was carried out in small enterprises without complete integration until the 1990s; the entrance of large scale enterprises to the sector has developed the production structure and spread broiler breeding.

The technology is at the same level as in developed countries where internationally competitive techniques are employed, and the developments in Turkey helped the broiler sector to develop rapidly. The Turkish broiler sector, which consisted of small and medium scale enterprises at the beginning, has faced problems such as lack of infrastructure, animal health, feed supply, and marketing, and firms could not find permanent solutions to these problems (Anon. 2005). One of the most important characteristics of the Turkish broiler sector that makes it competitive is the establishment of slaughter houses which have EU Standards. The average daily slaughter capacity is 3500 tonnes and the average annual capacity is 1 150 000 tonnes (Besd-Bir 2004). The capacity using rate in the slaughter firms and the breeding firms for 2005 is 84%. The quality perception in the broiler sector has started to change since the 1980s. The production methods were relatively primitive compared to the modern technology used in the broiler sector today. As a result of the modern technology used in production and processing, the variety and quality have increased and thus the added value has increased. The five integrated broiler firms, which have been analysed in this study, have received the accreditation certificate with the EU Standards as a result of the inspection of the EU

Food and Veterinary Office. Therefore, the sector has experienced developments that have led to broiler export opportunities since 2005.

As widely known, the feed cost makes up 70% of the production costs in broiler production. The corn price in Turkey exceeds the corn prices abroad because of the pricing policies applied by the government. However, 90% of the corn is now being imported from foreign sources where the prices are lower than Turkey, and as a result the production costs have declined. Being able to produce the corn at a lower cost in Turkey would help the broiler sector to develop and overcome the feed cost problem. In addition, the relatively low labour prices in Turkey and the developments achieved in productivity, quality, packing and product variety increase the competitive power of the Turkish broiler sector in international markets.

The firms have tried to survive without integration and have not been able to establish unions that would be efficient in production and marketing. Thus, the firms sold their products in a market at prices and conditions determined and controlled by large scale firms. As a result, most of the firms went bankrupt and the industry has come under the control of a limited number of large scale firms using contract farming (Anon. 2001).

Firms adopting the new technology have increased the existing production structure to a level which can compete with developed countries (Isin 2003). Thus, these firms now have the opportunity to market healthy, high quality broiler meat. Integrated firms consider quality as the most important factor in production, and their goals are to maintain the standards of the European Union and the United States (Gillin 2004). Integration, which includes all the phases from chick to the final product, has helped the Turkish broiler sector to develop, increase production and climb up at the world ranking (Rehber et al. 2002).

Another factor that increases the competitive power of the Turkish broiler sector is that firms are driving towards integration because of the reduced transaction costs. Most of the firms have a structure that includes each step beginning from breeding and ending in marketing (Budak & Çetin 1998). Integration has advantages of increased communication and control between the integrated firms, control of costs and marketing, meeting the capital needs of the contractual farmers and the maintenance of stability of production.

Solving the marketing problems of the farmers and strictly controlling the performance values will help the firm increase productivity and competitive power, and improve economies of scale, which in turn can accelerate progress toward external competitiveness and domestic growth.

There is a total of 66 integrated broiler firms in Turkey and 84% of the total production is produced by the top 20 firms (Anon. 2005). The top five firms have a market share of 47%. The aim of this study is to investigate the competitive power of the top five firms by using a differentiated product oligopoly model. Differentiated products compete with each other with price, rather than quantity, as the strategic variable in an imperfectly competitive industry. Liang (1989), Cotterill et al. (2000), and Canan & Cotterill (2006) have used a differentiated product oligopoly model in which price was the strategic variable.

MATERIALS AND METHODS

The model we used in this study is the Liang's differentiated oligopoly model. Liang's model has two demand equations and two price reaction equations in which cross equation restrictions link the estimated price reaction function coefficients to the estimated demand coefficients.

Liang assumes that the differentiated product demand function for firm 1 is a simple linear relationship and is a function of the two prices and income (Liang 1989):

$$Q_1 = a_1 - b_1 P_1 + c_1 P_2 + d_1 Income \quad (1)$$

where Q_1 is the output of firm 1, P_1 is the price for firm 1 and P_2 is the price for firm 2. Demand is decreasing in own price and increasing in substitute price.

Differentiating this demand equation with respect to own price, we obtain:

$$\frac{\partial Q_1}{\partial P_1} = -b_1 + c_1 \frac{\partial P_2}{\partial P_1} = -b_1 + c_1 cv_1 \quad (2)$$

where $cv_1 = \frac{\partial P_2}{\partial P_1}$ is firm 1's price conjectural variation with respect to firm 2.

Firm 1's profit maximisation problem is:

$$\underset{P_1}{Max} \Pi_1 = P_1 Q_1 - C_1(Q_1) \quad (3)$$

subject to $Q_1 = a_1 - b_1 P_1 + c_1 P_2 + d_1 Income$

where C_1 is the production cost of firm 1.

Firm 1 maximises profits, Π_1, by choosing price, P_1. The firm's first order condition for profit maximisation is:

$$\frac{\partial \Pi_1}{\partial P_1} = Q_1 + P_1\left(\frac{\partial Q_1}{\partial P_1}\right) - MC_1\left(\frac{\partial Q_1}{\partial P_1}\right) = 0 \quad (4)$$

where $\frac{\partial Q_1}{\partial P_1} = -b_1 + c_1 cv_1$ and MC_1 is the marginal cost of firm 1.

This first order condition can be expressed as a price reaction function. The continuous price reaction functions $R_1(P_2)$ define the firm's price as a function of its rival's price and its own marginal cost.

$$R_1(P_2):\ P_1 = f_{01} + f_{11}P_2 + f_{21}MC_1 \quad (5)$$

As Liang shows the reaction function parameters are functions of the demand coefficients and the conjectural variation. The coefficient on rival price (f_{11}) is a direct measure of price interdependence.

$$f_{11} = \frac{-c_1}{-2b_1 + c_1 cv_1} \quad (6)$$

Liang demonstrates that these coefficients in the two good case exhibit the same properties as the Lerner Index, and have values between –1 and 1. Price cost margin (PCM) can be calculated by using the following form:

$$PCM_1 = \frac{-1}{(-b_1 + c_1 cv_1)(P_1/Q_1)} \quad (7)$$

We now analyse the five-firm case. As analysed by Canan & Cotterill (2006), CV parameters can not be determined in a Bertrand differentiated product oligopoly that has more than two brands because of the singular matrix problem. The firms analysed in our study are the top five firms meeting the European Union Standards and exporting broiler meat to the European Union. Thus, we assume that the firms' conjectural variations are equal to 1, which means that they might be pricing interdependently. The corresponding demand and price reaction equations for firm 1 in the five firm case are:

$$Q_1 = \beta_{10} + \beta_{11}P_1 + \beta_{12}P_2 + \beta_{13}P_3 + \beta_{14}P_4 + \beta_{15}P_5 \quad (8)$$

$$P_1 = \alpha_{10} + \alpha_{11}P_2 + \alpha_{12}P_3 + \alpha_{13}P_4 + \alpha_{14}P_4 \quad (9)$$

Demand for firm 1 is a function of the prices of the five firms and the price reaction function for firm 1 is a function of the rival firms' prices. The slopes of the reaction functions also provide useful information about firm behaviour.

The price reaction coefficients for firm 1 derived from the first order profit maximisation conditions are:

$$\alpha_{11} = \frac{-\beta_{12}}{2\beta_{11} + \beta_{12}cv_{21} + \beta_{13}cv_{31}} \quad (10)$$

$$\alpha_{12} = \frac{-\beta_{13}}{2\beta_{11} + \beta_{12}cv_{21} + \beta_{13}cv_{31}} \quad (11)$$

In a model with more than two goods, price reaction elasticities must be used to measure market power at brand level. Actual price reaction elasticities are used to calculate the own price demand elasticities of each firm. The own price demand elasticity for firm 1 is as follows:

$$\eta_1 = \eta_{11} + \eta_{12}R_{21} + \eta_{13}R_{31} + \eta_{14}R_{41} + \eta_{15}R_{51} \quad (12)$$

where R_{ij} (% change in P_i for a % change in P_j) are the price reaction elasticities and η_{ij} are cross price elasticities.

In the five firm model one can calculate a firm's PCM as follows:

$$PCM_i = \frac{P_i - MC_i}{P_i} = \frac{-1}{\eta_{ii}} = \frac{-1}{\beta_{i1}\left(\frac{P_i}{Q_i}\right)} \quad i = 1,2,3,4,5 \quad (13)$$

EMPIRICAL MODEL

There are five integrated broiler firms in Turkey with 47% of the market share, which can compete at the European Union Standards. Based on Liang's differentiated product oligopoly model, we specify a simultaneous system of 10 equations. There are five demand equations and five price reaction function equations in our model. Table 1 gives the description of variables used in our model. The empirical model is presented in Table 2.

Data used in this study is from Besd-bir (Turkish Poultry Sector Association). The database provides

Table 1 Description of variables. TL, Turkish lira.

P_1	Retail price of Firm 1 (TL/kg)
P_2	Retail price of Firm 2 (TL/kg)
P_3	Retail price of Firm 3 (TL/kg)
P_4	Retail price of Firm 4 (TL/kg)
P_5	Retail price of Firm 5 (TL/kg)
Q_1	Sales of Firm 1 (kg)
Q_2	Sales of Firm 2 (kg)
Q_3	Sales of Firm 3 (kg)
Q_4	Sales of Firm 4 (kg)
Q_5	Sales of Firm 5 (kg)
MC	Average cost of feed consumption to obtain 1 kg carcass weight plus the price of chick (TL)
Income	Average income per capita in Turkey (TL(million))

Table 2 Empirical model.

$$Q_1 = \beta_{01} + \beta_{11}P_1 + \beta_{21}P_2 + \beta_{31}P_3 + \beta_{41}P_4 + \beta_{51}P_5 + \beta_{61}MC \qquad Q_2 = \beta_{02} + \beta_{12}P_1 + \beta_{22}P_2 + \beta_{32}P_3 + \beta_{42}P_4 + \beta_{52}P_5 + \beta_{62}MC$$

$$Q_3 = \beta_{03} + \beta_{13}P_1 + \beta_{23}P_2 + \beta_{33}P_3 + \beta_{43}P_4 + \beta_{53}P_5 + \beta_{63}MC \qquad Q_4 = \beta_{04} + \beta_{14}P_1 + \beta_{24}P_2 + \beta_{34}P_3 + \beta_{44}P_4 + \beta_{54}P_5 + \beta_{64}MC$$

$$Q_5 = \beta_{05} + \beta_{15}P_1 + \beta_{25}P_2 + \beta_{35}P_3 + \beta_{45}P_4 + \beta_{55}P_5 + \beta_{65}MC$$

$$P_1 = \left(\frac{-b_{01}}{2b_{11} + b_{21} + b_{31} + b_{41} + b_{51}}\right) + \left(\frac{-b_{21}}{2b_{11} + b_{21} + b_{31} + b_{41} + b_{51}}\right)P_2 + \left(\frac{-b_{31}}{2b_{11} + b_{21} + b_{31} + b_{41} + b_{51}}\right)P_3 + \left(\frac{-b_{41}}{2b_{11} + b_{21} + b_{31} + b_{41} + b_{51}}\right)P_4 +$$

$$\left(\frac{-b_{51}}{2b_{11} + b_{21} + b_{31} + b_{41} + b_{51}}\right)P_5 + \left(\frac{-b_{61}}{2b_{11} + b_{21} + b_{31} + b_{41} + b_{51}}\right)Income + \left(\frac{b_{11} + b_{21} + b_{31} + b_{41} + b_{51}}{2b_{11} + b_{21} + b_{31} + b_{41} + b_{51}}\right)MC$$

$$P_2 = \left(\frac{-b_{02}}{2b_{12} + b_{22} + b_{32} + b_{42} + b_{52}}\right) + \left(\frac{-b_{22}}{2b_{12} + b_{22} + b_{32} + b_{42} + b_{52}}\right)P_1 + \left(\frac{-b_{32}}{2b_{12} + b_{22} + b_{32} + b_{42} + b_{52}}\right)P_3 + \left(\frac{-b_{42}}{2b_{12} + b_{22} + b_{32} + b_{42} + b_{52}}\right)P_4 +$$

$$\left(\frac{-b_{52}}{2b_{12} + b_{22} + b_{32} + b_{42} + b_{52}}\right)P_5 + \left(\frac{-b_{62}}{2b_{12} + b_{22} + b_{32} + b_{42} + b_{52}}\right)Income + \left(\frac{b_{12} + b_{22} + b_{32} + b_{42} + b_{52}}{2b_{12} + b_{22} + b_{32} + b_{42} + b_{52}}\right)MC$$

$$P_3 = \left(\frac{-b_{03}}{2b_{13} + b_{23} + b_{33} + b_{43} + b_{53}}\right) + \left(\frac{-b_{23}}{2b_{13} + b_{23} + b_{33} + b_{43} + b_{53}}\right)P_1 + \left(\frac{-b_{33}}{2b_{13} + b_{23} + b_{33} + b_{43} + b_{53}}\right)P_2 + \left(\frac{-b_{43}}{2b_{13} + b_{23} + b_{33} + b_{43} + b_{53}}\right)P_4 +$$

$$\left(\frac{-b_{53}}{2b_{13} + b_{23} + b_{33} + b_{43} + b_{53}}\right)P_5 + \left(\frac{-b_{63}}{2b_{13} + b_{23} + b_{33} + b_{43} + b_{53}}\right)Income + \left(\frac{b_{13} + b_{23} + b_{33} + b_{43} + b_{53}}{2b_{13} + b_{23} + b_{33} + b_{43} + b_{53}}\right)MC$$

$$P_4 = \left(\frac{-b_{04}}{2b_{14} + b_{24} + b_{34} + b_{44} + b_{54}}\right) \left(\frac{-b_{24}}{2b_{14} + b_{24} + b_{34} + b_{44} + b_{54}}\right)P_1 + \left(\frac{-b_{34}}{2b_{14} + b_{24} + b_{34} + b_{44} + b_{54}}\right)P_2 + \left(\frac{-b_{44}}{2b_{14} + b_{24} + b_{34} + b_{44}\quad b_{54}}\right)P_3 +$$

$$\left(\frac{-b_{54}}{2b_{14} + b_{24} + b_{34} + b_{44} + b_{54}}\right)P + \left(\frac{-b_{64}}{2b_{14} + b_{24} + b_{34} + b_{44} + b_{54}}\right)Income + \left(\frac{b_{14} + b_{24} + b_{34} + b_{44} + b_{54}}{2b_{14} + b_{24} + b_{34} + b_{44} + b_{54}}\right)MC$$

$$P_5 = \left(\frac{-b_{05}}{2b_{15} + b_{25} + b_{35} + b_{45} + b_{55}}\right) \left(\frac{-b_{15}}{2b_{15} + b_{25} + b_{35} + b_{45} + b_{55}}\right)P_1 + \left(\frac{-b_{35}}{2b_{15} + b_{25} + b_{35} + b_{45} + b_{55}}\right)P_2 + \left(\frac{-b_{45}}{2b_{15} + b_{25} + b_{35} + b_{45} + b_{55}}\right)P_3 +$$

$$\left(\frac{-b_{55}}{2b_{15} + b_{25} + b_{35} + b_{45} + b_{55}}\right)P_4 + \left(\frac{-b_{65}}{2b_{15} + b_{25} + b_{35} + b_{45} + b_{55}}\right)Income + \left(\frac{b_{15} + b_{25} + b_{35} + b_{45} + b_{55}}{2b_{15} + b_{25} + b_{35} + b_{45} + b_{55}}\right)MC$$

4-week period data on price and quantity sold in Turkey for 84 periods from January 1998 to December 2004. The retail prices have been deflated by using the consumer price index.

The generalised method of moments (GMM) is used to estimate the simultaneous system of equations. Hausman et al. (1994) show that the GMM estimation is asymptotically equivalent to Full Information Maximum Likelihood, and provides consistent and asymptotically efficient estimates. GMM estimation increases efficiency if heteroscedasticity exists. If the disturbances are homoscedastic, then it is asymptotically the same as non-linear three-stage least square estimation (Greene 2000). The estimation is done by using SHAZAM 8.0.

ESTIMATION RESULTS AND DISCUSSION

Table 3 reports the estimation results. We hypothesise the own price coefficient to be negative since the demand curve has negative slope. In all the demand equations the own price coefficients are negative and significant at the 1% level, i.e., as the price of the firm goes up, the quantity sold will go down. The cross price coefficients are all positive and significant at 1% level, telling us that the brands are substitutes. For example, in the demand equation of firm 4, the own price coefficient for firm 4 is –1.6379 and significant at 1% level, i.e., as the price of firm 4 goes up, the quantity sold will go down. The cross price coefficients for firms 1, 2, 3, and 5 are all positive and significant at 1% level. Firms 1, 2, 3, 5, and 4 are substitutes in the firm 4 demand equation which shows that consumers switch to firm 4 when the price of other brands increase and firm 4 quantity demanded increases.

The coefficient of income is positive but not significant. The price of broiler meat is low compared to beef in Turkey and broiler meat is an important source of protein and thus broiler meat is preferred by all income groups (Sengor 2002). Since the coefficient is not significant, broiler meat can be considered as a necessity because it is a product that shows no change in demand despite change in income, and usually has an income elasticity of 0.

The variable raw material is calculated by adding the cost of feed consumption to obtain a 1 kg carcass weight and the price of chick. When we look at the price equations, all the price coefficients are positive and significant at the 1% level. All the coefficients for raw material in the price equations are positive and significant at the 1% level as expected.

Table 3 Empirical results of the differentiated product oligopoly model. *, Significant at 1% level; **, significant at 5% level. *t* ratios are given in parentheses.

	Q_1	Q_2	Q_3	Q_4	Q_5	P_1	P_2	P_3	P_4	P_5
Intercept	0.1358*	2.9726*	0.2803*	1.6794*	3.2654*	0.0216	0.1521**	0.1759*	0.1565	0.1674**
	(21.233)	(41.245)	(21.360)	(44.182)	(77.363)	(1.8245)	(1.9854)	(2.8243)	(1.8605)	(2.1884)
P_1	–1.3059*	1.1161*	1.4161*	1.1922*	1.2420*	–	0.2119*	0.2491*	0.3381*	0.3091*
	(3.48092)	(8.38610)	(5.71380)	(3.9827)	(7.3891)		(8.9886)	(11.9222)	(6.9221)	(3.2758)
P_2	1.1996*	–1.2344*	1.4158*	1.1945*	1.2832*	0.19840*	–	0.24905*	0.4286*	0.3475*
	(2.94012)	(3.20752)	(7.5757)	(9.5101)	(7.4161)	(6.7220)		(4.2860)	(8.6174)	(7.35663)
P_3	1.5489*	1.3645*	–2.6745*	1.7348*	1.4066*	0.27143*	0.2444*	–	0.3029*	0.3082*
	(6.7966)	(8.4289)	(4.3022)	(8.8388)	(9.5632)	(11.6383)	(9.4301)		(5.1622)	(6.5102)
P_4	1.6411*	1.4236*	1.4161*	–1.6379*	1.6927*	0.18278*	0.1603*	0.2991*	–	0.3122*
	(3.5161)	(3.2682)	(10.1087)	(5.5205)	(2.9623)	(7.5609)	(7.7745)	(7.8217)		(3.2654)
P_5	1.1051*	0.9338*	1.4162*	1.7264*	–1.1451*	0.2160*	0.1916*	0.2412*	0.3144*	–
	(4.7855)	(5.2553)	(4.1643)	(7.5205)	(6.1821)	(6.9152)	(8.5135)	(8.7722)	(4.7263)	
Income	0.65420	0.78453	0.30705	0.1180	0.16435	0.10820	0.1347	0.2510	0.2944	0.33420
	(0.59150)	(0.13189)	(0.26733)	(0.2125)	(0.4981)	(0.5914)	(0.1318)	(0.2562)	(0.61574)	(0.3676)
MC						0.6569*	0.9591*	0.8355*	0.7566*	0.7896*
						(8.1215)	(9.2656)	(6.2071)	(6.8259)	(5.7492)

Table 4 Own price demand elasticities of the analysed firms.

Firm	Own price demand elasticity
1	–8.77
2	–3.55
3	–11.49
4	–12.68
5	–4.71

Table 5 Price cost margins of the analysed firms.

Firm	Price cost margins
1	0.114
2	0.281
3	0.087
4	0.078
5	0.212

Feed material is the most important and expensive part of the production because most of the raw material used for the preparation of feed material mixture is imported and thus the high price of feed increases the price of chicken meat (Sengor 2004).

When we look at the own price demand elasticities presented in Table 4, all the firms have elastic demand. However, firms 1, 3, and 4 are more elastic than firms 2 and 5, which means that firms 1, 3, and 4 are more sensitive to the changes in price. Firm 2 is the least sensitive to price changes.

Price cost margins (PCM) of firms are presented in Table 5. Firm 2 has the highest PCM with the value of 0.281 which means that firm 2 has the highest profits among all the five firms analysed. Firm 5 has the second highest PCM with the value of 0.212. Firm 4 has the lowest PCM.

As seen from the results, all the firms have elastic demand and positive PCMs. The firms analysed in this study have increased their competitive power by meeting the technical standards (food quality and safety) besides the economic criteria. As a result they were able to make a US$5 million trade connection with the EU countries (Akman 2003). These firms exporting broiler meat to the EU are considered to be an important part of the development of the Turkish broiler sector.

CONCLUSION

In this study, the differentiated product oligopoly model has been applied to the Turkish broiler sector and the price competition from 1998 to 2004 has been analysed. The own price demand elasticities and price cost margins of top five firms have been investigated.

All the firms have elastic demand and positive price cost margins. There is a general relationship between each firm's market share and its degree of profitability (Sengor 2002). The firms analysed in this study have increased their competitive power by meeting the technical standards (food quality and safety) as well as the economic criteria and as a result they were able to make a US$5 million trade connection with the EU countries (Sengor 2004). Thus, this export value might increase in the near future and this increase would encourage other firms in the industry to reach the technical and economic competitiveness. These firms having the chance to export broiler meat to the EU is considered to be an important support for the development of the Turkish broiler sector. The fact that the top five firms have a strong competitive power, and they have reached the European Standards, will motivate the Turkish broiler sector and thus activate the export potential.

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