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Full Length Research Paper

Demand for inputs in milk production: The case of Tokat province

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The purpose of this study was to determine the gross margin and price, cross and morishima technical substitution elasticities for the cost inputs which play a key role in the milk produced in enterprises making animal insurance (Group I) and not making animal insurance (Group II), such as labour, feed, health and energy in Turhal district of Tokat province in Turkey. Model solutions were performed with Seemingly Unrelated Regression (SUR), using Translog production function. In enterprises Group I, own price elasticities of labour, feed, health and energy were estimated from the inputs demand model as -0.344, -0.247, -0.312 and -0.309, respectively. In enterprises Group II also own price elasticities of labour, feed, health and energy were estimated from the inputs demand model as -0.184, -0.197, -0.989 and -0.607, respectively. In addition, the gross margin calculated for the enterprises Group I was found to be more than three times as high as the ones calculated for the enterprises of Group II.

Key words: Translog function, cost, demand, milk, Turkey.

INTRODUCTİON

According to the general agricultural census of 2001, vegetable and animal production are mixedly being performed in 67.4% of the available agricultural enterprises, while only 2.4% of them are dealing with only animal production. Milk productivity per milk cow is 2.59 ton/year. Milk production has 8.4% share in the agricultural sector and 7.0% share in the animal production (Anonymous, 2009). Milk is one of the most valuable and easily supplied foodstuffs. Accordingly, milk has been being produced in every part of the world since the time mankind emerged. Several policies have been implemented to increase the vegetable and animal production quantities in order to meet the milk need of the increasing population (Ikikat Tumer and Kumbasaroglu, 2008). The success of these policies depends on the estimation of the reactions of the farmers or the enterprises. Particularly, it is very important to know in advance which possible changes the farmers may make in the use of a given input or which input will substitute this given input and to what extent, for the success of the policies (Miran et al., 2002). The main purpose of determining usage levels of the costs and physical production inputs is to make the income and cost analyses of the individual production activities taking place in agricultural enterprises (Ozkan et al., 2005). It is observed that there is an increase in the tendency to obtain the obligatory and required economical criteria from the production functions. Translog production function is one of them and is being widely used for the functional analysis of the agricultural production activities during the last 20 years, particularly in the developed countries (Akcay and Esengun, 1999; Yılmaz et al., 2003). Increasing the milk production rate in Tokat province, which met 2% of the total milk production of Turkey in the year 2006, is of capital importance (Anonymous, 2008). In this study, the aim was to calculate the gross margin and price, cross and Morishima Technical Substitution Elasticities (MES) for the cost inputs which play a key role in the milk produced in enterprises making and not making animal insurance, such as labour, feed, health and energy in Turhal district of Tokat province.

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MATERIAL AND METHOD

Material

The main material of the study was the primary data obtained from the surveys performed in the enterprises dealing with milk cattle rising in Turhal district of Tokat province in the year of 2006.

Method

Fifty enterprises which made animal insurance (Group I) were selected using complete inventory method in according to data obtained from the records of Turhal District Agricultural Administration in the study region. Fifty enterprises which did not make animal insurance (Group II) and equivalent to these selected ones were determined randomly.

Theoretical framework

Translog Cost Function was used in the study. Model solutions were performed by Seemingly Unrelated Regression (SUR) (Chiang, 1984). Price and cross elasticity of the inputs were calculated by using these model solutions. Similarly, Morishima Technical Substitution Elasticities of the inputs were obtained by the numerator equalities models.

Translog cost function was described as it was in Equation 1 (Chambers, 1988).

$$\ln(m)=\alpha_0+\sum_i \alpha_i \ln(w_i)+\frac{1}{2}\sum_i\sum_j \gamma_{ij}\ln(w_i)\ln(w_j)+\beta_0\ln(Q)+\beta_1(\ln Q)^2+\sum_j \eta_j \ln Q \ln(w_j)+\delta_D+\sum_j \pi_j \ln 8w_j)D+\Phi_3 \ln Q(D) \tag{1}$$

Abbreviations in the equation are: *m*: Unit output cost. *w*: Input prices vector (labour, seedling, fertilizers and drugs). *Q*: Output quantity (productivity), *D*: Dummy variable.

If Shephard pre-theory is applied to Translog equation, cost function is obtained depending on the numerator equalities (Miran et al., 2002).

$$s_i=\alpha_i+\sum_i \gamma_{ij}\ln(w_i)+\beta_i\ln(Q)+\delta_i(D) \tag{2}$$

The cost numerator equality given in Equation 2, S_i, shows the numerator of the varying production factor within the cost. In the equation, described as numerator equalities, the cross price estimators should be symmetrical and the total of cost numerators should be equal to 1 according to the Young theorem. These features call for the addition of the restrictions shown in the parameters in Equation 3 to the model when predicting the cost function (Miran et al., 2002).

$$\sum_i \alpha_i=1;\gamma_{ij}=\gamma_{ji};ve\sum_i \gamma_{ij}=\sum_i \beta_i=\sum_i \delta_{ik}=0 \tag{3}$$

Cost numerator equalities provide the foundation for input demand and substitution elasticities determined in this study. After testing the usability of the numerator equalities model, price elasticities are calculated through in Equation 4 and 5:

$$\varepsilon_{ii}=\gamma_{ii}/S_i+S_i-1 \tag{4}$$

$$\varepsilon_{ij}=\gamma_{ij}/S_i+S_i \tag{5}$$

Allen and Morishima substitution elasticities can also be calculated using the same model. Allen partial substitution elasticity (σij), is calculated by dividing the cross price elasticity between these inputs to the cost numerator of the j^{th} input (Sj). Morishima input substitution elasticities were calculated to measure the variance in usage rates of any two inputs depending on the variation of the price ratios of these inputs (Tanrıvermiş, 2000).

Seemingly Unrelated Regression (SUR) was used as estimator in this study. In order to avoid the matrix to be singular in the estimation of the equality system, drug input was excluded from the model fort he estimation of the cost numerator equality. Labor, seedling and fertilizer price indexes were used in the equation system. The parameters required for the drugs which remained out of the equation system were calculated from total and homogeneity constraints. SHAZAM Professional Edition was used as econometric software in the study.

RESULTS AND DISCUSSION

Farmers and enterprises data

50.78% of the farmers in the study region were in Group I enterprises, and 49.22% in Group II. Average age of farmers in Group I was 50.10, while average age in the ones in Group II was found as 49.80. Average education time of these farmers was found as 3.23 and 3.48 years, respectively. Concerning the quality of labour in the enterprises with which the survey was conducted, it was average 3.96 MLU[1] for Group I enterprises and 3.87 MLU for Group II enterprises.

Average enterprise land was 46.82 decare in Group I and 48.15 decares in Group II, while average land parcel number was calculated as 6.28 and 6.84, respectively. Average animal number per enterprise was 14.74 cattle in Group I and 17.16 in Group II, and average cowhouse capacity was found as 22.20 cattle in Group I and 26.60 in Group II, respectively. Capacity utilization rate in these enterprises was calculated as 66.28% and 64.51%. There are 737 cattle cultivation race in Group I enterprises and 579 cross-breed and 279 cattle cultivation race in Group II enterprises, and total 858 cattle milk cow. Average milk quantity produced per cow was calculated as 10.06 kg in Group I enterprises and 6.66 kg in Group II enterprises. Gross magrin of 1 kg milk was 2.019 TL in Group I enterprises and 0.711 TL in Group enterprises (Table 1).

Numerator equalities SUR model

The sensitivity to price changes in labour, feed, health and energy in milk production in the study has been estimated by using derived demand model. Derived demand model was described and estimated as a cost

[1]MLU: Male Labour Unit. Here males between 15-49 year of age are considered as 1 MLU, females between 15-49 year of age as 0.75 MLU, males >50 as 0.75 MLU, females >50 as 0.50 MLU and children between 7-14 year of age as 0.50 male labour ınit. (Dagdemir 2005).

Table 1. Gross production value, variable expenses and gross margin for milk production (TL/kg).

	Group I enterprise	Group II enterprise
Gross production values (1)	6.495	4.627
Variable expenses (2)	4.476	3.915
Labor expenses	1.151	1.611
Feed	1.597	1.271
Health	0.082	0.077
Energy	0.021	0.018
Other variable expenses	1.626	0.939
Gross margin (1-2)	2.019	0.711

Source: Original calculations.

numerator equalities system, from the translog cost function point. It was understood that there is no positive value in eigenvalue vector of substitution elasticities in milk, and the models show concavity. Accordingly, it should be a prerequisite in the models that unit cost should increase when prices of the input(s) used in the production increased.

In order to meet the cost minimization condition the cost function should also be a monotonic function. It was found that estimated all values obtained by the numerator equalities model in milk production were bigger than zero (that is positive). Accordingly, it was found that the models were monotonic in both products. That means, input substitution rates remain constant when production increases. R^2 values of the equations related to cost numerators in the milk production in Group I and Group II enterprises range between 11.0 - 54.0 and 10.7 - 44.1% respectively (Table 2). It can be said that the explanation levels for horizontal section data were good.

The estimated total of the cost numerators is equal to 1 and the cross price estimators are the same. The highest rate among the cost numerators in Group I enterprises was in cost of feed, followed by labour, health and energy costs, respectively. In the Group II enterprises, the highest rate was in cost of labour, followed by feed, health and energy costs, respectively (Table 2). In both Group I and Group II enterprises, the numerators of health and energy costs are very low. The reason that feed cost is higher than labour in Group I enterprises may be explained by the fact that all cattle are cultivation race and the enterprises are basicly modern. The reason that labour is higher than feed in Group II enterprises may be explained by the fact that Group II enterprises are still producing in traditional base.

Input demand elasticities in milk production which were calculated by means of numerator equalities model in Group I and Group II enterprises are given in Table 3. Own price elasticities of labour, feed, health and energy in Group I enterprises were estimated from input demand model as -0.344, -0.247, -0.312 and -0.309, respectively. Elasticities of all inputs (own) are inelastic. 10% increase in the prices of labour, feed, health and energy will reduce the demand of these products 3.44%, 2.47%, 3.12% and 3.09%, respectively. According to these values, the input of which the farmer could give up when each input’s own price increases is labour, followed by health, energy and feed. Feed prices have the lowest elasticity among the inputs used for milk production in Group I enterprises. Since feed is an indispensable input for enterprises dealing with milk cow production, its elasticity is also low. Generally, the elasticities of the other inputs are close to each other and are low.

Own price elasticities of labour, feed, health and energy in Group II enterprises were estimated from input demand model as -0.184, -0.197, -0.989 and -0.607, respectively. Elasticities of all inputs (own) are inelastic. 10% increase in the prices of labour, feed, health and energy will reduce the demand of these products 1.84, 1.97, 9.89 and 6.07%, respectively. According to these values, the input of which the farmer could give up when each input’s own price increases is health, followed by energy, feed and labour. Labour prices have the hardest elasticity among the inputs used for milk production in Group I enterprises. Since labour is met by the family itself in enterprises dealing with milk cow production in traditional way, its elasticity is also low. Feed stil is an indispensable input, and therefore has a low elasticity. Generally, the reaction against health prices is high. In addition, expenses for health in traditional animal breeding is not much. Except the values on the main diagonal, those shown in Table 3 are cross price elasticities for Group I and Group II enterprises. The ones having the positive sign between them show a substitution relationship, and the ones with negative sign show complementary relationship.

In case of a price increase in any given input, it can be substituted with another input in a very low rate. Accordingly, it can be assumed that each input is essential for milk production. The highest substitution in Group I enterprises is between energy and labour, followed by labour-feed, feed-labour, health-feed and health-labour, respectively. As it can be seen in Table 2, the average

Table 2. Numerator equalities model SUR solution for milk in group I and II enterprise.

Independent variable (Ln)	Dependent variable: Cost numerators Group I enterprise				Dependent variable: Cost numerators Group II enterprise			
	Labor	Feed	Health	Energy	Labor	Feed	Health	Energy
Constant Term	0.504 (0.284)	0.344 (0.268)	0.131* (0.064)	-0.979	0.277 (0.199)	0.728* (0.195)	-0.022 (0.025)	-0.983
Ln (Productivity)	-0.175 (0.102)	0.174 (0.103)	-0.0006 (0.014)	0.0016	-0.109 (0.064)	0.096 (0.063)	0.015* (0.007)	-0.002
Ln (Labor Price/Energy Price)	0.102* (0.048)	-0.093* (0.045)	-0.009 (0.009)	0.000	0.149* (0.034)	-0.153* (0.033)	0.004 (0.004)	0.000
Ln (Feed Price/Energy Price)	-0.093* (0.045)	0.107* (0.045)	-0.010 (0.006)	-0.004	-0.153* (0.033)	0.160* (0.033)	-0.004 (0.004)	-0.003
Ln (Health Price/Energy Price)	-0.009 (0.009)	-0.010 (0.006)	0.020* (0.005)	-0.001	0.004 (0.004)	-0.004 (0.004)	-0.0003 (0.002)	0.0003
D (Dummy Variable)	-0.059 (0.038)	0.062 (0.038)	-0.002 (0.005)	-0.001	-0.044 (0.039)	0.042 (0.039)	0.004 (0.004)	-0.002
R^2	0.110	0.145	0.547		0.436	0.441	0.107	
Average Cost Numerator	0.4012	0.5627	0.0299	0.0062	0.5425	0.4294	0.0225	0.0056

Source: Original calculations.
Standard errors are shown in brackets. [1] Calculated from total constraint. *: Important for 5%.

Table 3. Input demand elasticities of group I and II enterprise in milk production.

Group I enterprise					Group II enterprise				
	Price elasticities								
	Labor	Feed	Health	Energy		Labor	Feed	Health	Energy
Labor	-0.344	0.331	0.007	0.007	Labor	-0.184	0.147	0.031	0.006
Feed	0.236	-0.247	0.012	-0.001	Feed	0.185	-0.197	0.012	-0.001
Health	0.088	0.221	-0.312	0.002	Health	0.737	0.238	-0.989	0.014
Energy	0.418	-0.121	0.011	-0.309	Energy	0.616	-0.066	0.058	-0.607
	Morishima technical substitution elasticities (MES)								
Labor	-	0.676	0.351	0.351	Labor	-	0.330	0.214	0.190
Feed	0.483	-	0.258	0.245	Feed	0.382	-	0.209	0.196
Health	0.400	0.533	-	0.314	Health	1.726	1.223	-	1.003
Energy	0.727	0.188	0.320	-	Energy	1.222	0.541	0.665	-

Source: Original calculations.

cost numerators of feed and labour within the total cost in Group I enterprises are very high. Therefore, an increase in feed and labour prices will also increase cost of milk in Group I enterprises. 10% increase in labour price increases the demand for feed 2.36%, while 10% increase in feed price increases the demand for labour 3.31%. 10% in labour price increases the demand for health 0.88%, while 10% increase in health price increases the demand for labour 0.07%. 10% increase in labour price increases the demand for energy 4.18%, while 10% increase in energy price increases the demand for labour 0.07%. Price increases of health and energy increase the demand for labour, however, the effect of price changes in these inputs is negligible, nearly zero. 10% increase in health price increases the demand for energy 0.11%, while 10% increase in energy price increase the demand for health 0.02% (Table 3). These values show that the change in health and energy prices is quite low, which can not change the demand for these inputs. All negatively signed cross elasticity coefficients are values that are nearly zero. Accordingly, complementary relationship between the inputs is very low, almost nonexistent.

In case of a price increase in Group II enterprises in any given input, it can be substituted with another input in a very low rate. Accordingly, it can be assumed that each input is essential for milk production. The highest substitution in Group II enterprises is between health and labour, followed by energy-labour, health-feed, feed-labour and labour-feed, respectively (Table 3). As it can be seen in Table 2, the average cost numerators of labour and feed within the total cost in Group II enterprises are very high. Therefore, an increase in labour and feed prices will also increase cost of milk in Group II enterprises. 10% increase in labour price increases the demand for feed 1.85%, while 10% increase in feed price increases the demand for labour 1.47%. 10% in labour price increases the demand for health 7.37%, while 10% increase in health price increases the demand for labour 0.31%. 10% in labour price increases the demand for energy 6.16%, while 10% increase in energy price increases the demand for labour 0.06%. It seems that a change in health and energy prices has only very small effect on the demand for labour. The effect of price changes in these inputs is negligible, nearly zero. Since the elasticities of health and energy factors between them are close to zero, the substitution relationship level between them is very low. Negatively signed cross elasticity coefficients in Group II enterprises are also values that are nearly zero. Accordingly, complementariness relationship between the inputs is very low, almost nonexistent.

Morishima Technical Substitution Elasticities are shown in Table 3 and substitution elasticities are higher than zero. Accordingly, it is understood that there is an incomplete substition between all input pairs in milk production in Group I enterprises. Technical substitution elasticity between feed and labour was found here as 0.483. When labour prices increase and feed prices are constant, labour usage will decrease and more feed (a production factor with lower cost) will be used. The decrease in labour will be 0.483% of feed-labour using rate. Similarly, the decrease in labour use will be 0.400% of health-labour use, 0.727% of energy-labour. A similar situation is valid fort he other inputs, it is understrood that the mentioned inputs for milk in Group I enterprises are inputs which can substitute each other.

Substitution elasticities for milk production in Group II enterprises are higher than zero (Table 3). Accordingly, it is understood that there is an incomplete substition between all input pairs in. Substitution elasticity between feed and labour was found here as 0.382. When labour prices increase and feed prices are constant, labour usage will decrease and more feed (a production factor with lower cost) will be used. The decrease in labour will be 0.382% of feed-labour using rate. Similarly, the decrease in labour use will be 1.726% of health-labour use, 1.222% of energy-labour. A similar situation is valid fort he other inputs, it is understrood that the mentioned inputs for milk in Group II enterprises are inputs which can substitute one another.

Conclusion

Gross margin calculated for Group I enterprises is three times as high as that calculated for Group II enterprises The biggest share among the variable expense items are feed in Group I and labour expenses in Group II. In Group I enterprises, own price elasticities of labour, feed, health and energy were calculated from input demand model as -0.344, -0.247, -0.312 and -0.309, respectively. Accordingly, the reaction of the farmers against the price changes is very low. In Group II enterprises, own price elasticities of labour, feed, health and energy were calculated from input demand model as -0.184, -0.197, -0.989 and -0.607, respectively. According to these values, the input of which the farmer could give up when each input's own price increases is health, followed by energy feed and labour.

The highest substitution in Group I enterprises is between energy and labour, followed by labour-feed, feed-labour, health-feed and health-labour. The highest substitution in Group II enterprises is between health and labour, followed by energyg-labour, health-feed, feed-labour and labour-feed. Substitution relationship between the health and energy factors shows very low level in both groups. There is an incomplete substitution between all input pairs for milk production in both groups.

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