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Econometric Analysis of Land Tenure Systems in Cotton Production in Turkey

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ABSTRACT

The aim of this study was to examine the effect of land tenure systems on cotton production by using production functions. Data were collected from 64 cotton farms by face to face questionnaire method. Econometric analyses were carried out by using Linear, Cobb-Douglas, Semi Log, Exponential production functions. The data revealed that land tenure systems had no significant effect on cotton production. Moreover, the land tenure systems did not show any difference in cotton production technology pursued by farmers.

Key Words: Land tenure; Production function; Cotton; Turkey

INTRODUCTION

Small farm size, land fragmentation and high agricultural population are major obstacles to agricultural progress in Turkey. Farms are largely family owned (92.57%) and the number of farms is increasing in contrast to developed countries. The number of farms was 3.1 million in 1963 and it reached 4.1 million in 1991. Similarly average farm size was 7.73 hectares in 1950, it decreased to 5.69 hectares in 1991 (Anonymous, 1994; Yilmaz, 1996). In view of the scarcity of land and land fragmentation emphasis was given on land tenure system in addition to intensifying input use. As a result of this poor agricultural structure, the problem associated with land tenure system in Turkish agriculture has grown over the years. This agricultural structure has also led to the deterioration of soil quality and fertility mainly due to the indiscriminate use of agricultural inputs, particularly fertilizer and pesticides. In this regard, research studies on land tenure systems can provide valuable information in terms of land productivity and sustainable agricultural production.

The land issues can be examined in two different standpoints. The first includes the technical and economical use of the land and the second requires examining the type of land tenure system in terms of legislation. Main problem with these approaches is to find how to use basic production factor. This issue is closely related to the land tenure systems (Aksoy, 1984).

Considerable research has been conducted in the other countries on these lines (Jacobs & Hirsch, 1998; Melmed-Sanjak *et al*., 1998; Ravenscroft *et al*., 1999; Freudenberger, 2000; Goodale & Sky, 2000; Lal *et al*., 2001; Lemel, 2001). Many of them, however, examined that relationships between agricultural production and land tenure systems has been limited in Turkey. Therefore, the aim of this study is to examine the effect of land tenure systems on cotton production by using production functions.

MATERIALS AND METHODS

In the study, data were collected from cotton farmers through a questionnaire survey. The survey was conducted on 64 cotton farms located in the villages of Central, Serik and Manavgat districts of Antalya province of Turkey. The study area was comprised of 97.29% in the total cotton production area of the province (Anonymous, 1999). The sample for the cotton farm survey was determined by using the formula given by Yamane (1967). The sample size was calculated based on 64 farms by considering 0.2 hectares deviation and 95% significance level.

In the study, data were collected based on parcel allocated to cotton production in the sampled farms. Thus, evaluation problem of data obtained from the farms producing cotton both on their own lands and on rented lands or share cropping lands was prevented. Additionally, this approach increases measurement sensitivity. Data were gathered from one cotton parcel only for each farm. In the selection of these parcels, priority was given to those which were rented because their number was lower than the owned ones. Preference of the producer was also considered in the parcel selection.

Share cropping was found in only 3 of the 64 farms studied. For that reason, cotton production in owned and rented parcels was studied in this research. The data were collected from 38 owned and 26 rented parcels. The production function was used in the econometric analysis to identify the effects of land tenure systems on the cotton production. The production function stipulates the technical relationships between inputs and output in any production schemes or processes (Olayide & Heady, 1982; Chambers, 1988.). It can be expressed in implicit form as:

$$Y= f (X_i)$$

Where Y_i and X_i denote output and inputs (labour, land, seed, fertilizer, chemicals, and tractor), respectively, and i is the i'th output and input. The models used in the study to estimate production functions were; Linear, Cobb-Douglas, Semi Log, Exponential (Olayide & Heady, 1982). Error term (u_i) is added to these functional forms and econometric forms of all these production functions are given as follows:

Linear: $Y_i = \alpha + \beta_1 X_1 + ... + \beta_n X_n + u_i$ (1)

Cobb-Douglas: $Y_i = \alpha X_1^{\beta_1} X_2^{\beta_2} ... X_n^{\beta_n} e^{u_i}$ (2)

Semi Log: $Y_i = \alpha + \beta_1 \ln X_1 + ... + \beta_n \ln X_n + u_i$ (3)

Exponential: $Y_i = \alpha e^{\beta_1 X_1 + ... + \beta_n X_n + u_i}$ (4)

Gujarati (1988), Maddala (1992) and Koutsoyiannis (1992) suggest that dummy variables can be used in the structural comparisons. In this paper, land tenure types were included into the model as a dummy variable. This approach was preferred to benefit from using all data as a whole. As the land tenure type was a qualitative variable, it took the value of 1 in the case of owned parcels and the value of 0 in the case of rented parcels. All of the variables in the models, except chemicals, were taken as physical values of inputs. The variable of chemicals was included into the model as a total monetary value since the chemicals used in the cotton production were heterogeneous and their usage purposes were different. The variables used in the cotton production function models are the following:

Y: Cotton production (kg),
D: Land tenure type (dummy variable),
X_1: Parcel size (ha),
X_2: Labour (hour),
X_3: Tractor (hour),
X_4: Seed (kg),
X_5: Nitrogen (kg, as plant nutrient),
X_6: Chemicals (million TL).

Three diagnostics for multiple regressions, i.e. multi-collinearrity, heteroscedasticity and autocorrelation were used to analyze cross-sectional data. Condition index for multicollinearity, White-test for heteroscedasticity and Durbin-Watson statistics for autocorrelation were used to detect these diagonostics (Gujarati, 1988; Long & Ervin, 1998).

RESULTS AND DISCUSSION

The econometric models (1-4) of all functional forms were estimated using ordinary least square (OLS) estimation technique and estimations were carried out using SPSS 10.0. The averages of variables per hectare are given in Table I. The coefficients of the estimated production functions, their F values, adjusted R^2, Durbin-Watson statistics and Condition index values (Table II).

Regression analysis indicated that number of statistically significant parameters varied among the functional forms used in this study. However, the F-test results showed that overall regression models were statistically significant. Adjusted R^2 was higher in the linear and Cobb-Douglas production functions than others. A condition index of 30 to 100 indicates moderate to strong collinearity. All estimated equations have multicollinearity problems regarding condition index. Durbin-Watson statistics indicated that all models excluding semi-log functions do not have autocorrelation. Assessments of the White test results show that all regressions except semi log regression were not problematic in terms of heteroscedasticity. All these evaluations showed that

Table I. Variable averages per hectare by land tenure system

Variables	Owned Parcels		Rented Parcels	
	Mean	Std.Dev.	Mean	Std.Dev.
Parcel size (ha)	1.9	1.7	2.9	2.4
Labor[1] (hr ha^{-1})	680.2	166.0	686.7	130.0
Tractor (hr ha^{-1})	29.8	4.9	30.0	4.4
Seed (kg ha^{-1})*	57.8	19.6	65.7	20.0
Nitrogen[2] (kg ha^{-1})	230.0	70.4	238.6	58.6
Phosporus[2] (kg ha^{-1})	68.9	32.6	64.0	31.1
Potassium[2] (kg ha^{-1})*	36.7	28.1	49.8	24.4
Chemicals[3] (gr ha^{-1})	3821.6	1260.8	3524.6	1630.1
Chemicals (Million TL ha^{-1})	105.5	69.7	103.5	82.4

[1]: Excluding tractor driver, [2]: Plant nutrients, [3]: Active ingredients, * : $P<0.10$

Table II. Estimated Parameters of Production Functions

Variables	Linear	Cobb-Douglas	Semi Log	Exponential
Constant	69.15 (392.0)[1]	3.69** (0.73)	-27278* (11978)	7.66** (0.13)
Land tenure type	-301.77 (350.58)	-0.07 (0.05)	-854 (890)	3.8E-03 (0.12)
Parcel size	373.49** (69.53)	0.72** (0.25)	7943* (4074)	3.3E-02 (0.02)
Labour	1.12* (0.56)	0.53** (0.13)	1840 (2033)	3.2E-04 (0.00)
Tractor	-16.51 (13.88)	- 0.07 (0.18)	-1256 (2939)	-5.0E-03 (0.01)
Seed	2.01 (4.78)	- 0.17 (0.09)	-1202 (1418)	1.5E-03 (0.00)
Nitrogen	-2.68** (1.01)	0.03 (0.08)	-171 (1230)	-1.0E-04 (0.00)
Chemicals	2.8E-04 (0.00)	0.01 (0.03)	988 (556)	-1.0E-07 (0.00)
F	285.47	161.63	35.89	28.58
Adjusted R^2	0.97	0.95	0.79	0.75
Durbin-Watson[2]	2.42	2.24	1.28	1.88
Condition Index	41.10	134.38	134.38	41.10

[1]: The values given in parenthesis indicate standard errors, *: $P<0.05$, ** : $P<0.01$.,
[2]: d_L=1.37, d_U =1.84 for α=0.05, n=64 and k=7 If $d_U<d<(4–d_L=2.63)$, no autocorrelation exists.

estimated regressions were not suitable to analyse the structure of production because of multicollinearity problem in this case. Although estimated regressions might violate some assumptions, some additional information can be obtained from all estimated production functions in terms of objective of the study.

Among these functional forms, linear model seems to yield better results in term of R^2, number of statistically significant parameters and expected signs of parameters. In the linear model, parcel size, labour and nitrogen variables were statistically significant. This suggested that all the statistically significant parameters have an important impact on cotton production. Land tenure type variable resulting in the linear model implies that farmer who rented parcel obtained more cotton yield on rented parcel than owned parcel. However, this variable was not significant.

In the Cobb-Douglas functional form, only two variables, parcel size and labour, were found statistically significant and have expected signs. This finding implies that these two variables have a positive impact on cotton production. The sign of the land tenure type coefficient was consistent with prior expectation, although it was statistically insignificant.

Semi log and exponential forms produced poor results in terms of significance level of the parameters. For this reason, explanatory variables in the two models were not discussed in detail.

The econometric results of the study indicated that the effects of land tenure systems do not have any significant impact on cotton production. The same results were obtained from the previous study conducted in the province of Erzurum (Karagolge, 1973). This result might have stemmed from those farmers who had rented parcels in addition to their own parcels and also used same technology and input levels in the former. In other words, tenant system does not stimulate farmers to exploit from the rented parcel. This indicated that farmers do not differentiate between owned and rented parcels in terms of agricultural practices in the research area. Moreover, the rented farmers are not able to exploit the rented area mainly due to not having sufficient financial resources to use high level of inputs.

CONCLUSION

It is concluded that land tenure type did not show any difference in the cotton production. Even tenant system is expected to have positive impact on cotton production, results contradict with this expectation. However, it was evident that the farmers owning land have greater incentive to sustainable production than farmers who rent land. Furthermore, farmers without land ownership do not have collateral required to obtain loans for investment in relation to sustainable production. Since credit constraints generally limit farmer's investment in Turkey.

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