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Analysis of factors affecting land fragmentation in Erzurum Province, Turkey

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Fragmentation of agriculture prevents the efficient use of production factors. The aim of this study is to determine the factors which affect land fragmentation of farms in villages of Central District of Erzurum Province in 2004. Ordered logit model was used for this purpose. As a result of the study, it has been found that there is a positive relationship between tools and machinery assets which constitute the explanatory variable, the size of the enterprise, forage crop cultivation, population working in the agricultural sector and land fragments number. In addition, a negative relationship was found between arid land rental value and land fragmentation.

Key words: Land fragmentation, ordered logit, Erzurum, Turkey.

INTRODUCTION

The fact that land size per agricultural enterprise is insufficient and multi-fragmented in Turkey, affects the agricultural production and the income of the enterprise negatively. Multi-fragmentation of the agricultural land is to a large extent, the result of inheritance. Under the current circumstances, agricultural enterprises on the average are small, dispersed and uses conventional methods of production.

Fragmentation, dispersity and irregular shapes of land in the agricultural enterprises lead to time wastage in going to and coming from these parcels, difficulty in machinery use, inability to apply modern agricultural technology, waste of capital and labor, loss of soil and productivity and land conflicts, while development and modernization of the agricultural enterprises have a very slow pace because of such problems (Cicek, 1996).

One of the activities used to improve agricultural structure is land consolidation. As a result of consolidation activities, fragmented lands are united, fragment numbers decrease, fragment sizes increase and fragment shapes are re-formed (Kumbasaroglu and Dagdemir, 2007).

There are 3.076.650 agricultural enterprises in Turkey.

67.4% of these enterprises are dealing with both crop and animal production, while 30.2% are dealing with only crop production and 2.4% with only animal production. Average enterprise size is 60.1 decare and land fragment number per enterprise is 4.07. A comparison of this situation with developed countries such as the ones in EU may show that in Turkey, the average size of the agricultural enterprise is smaller and the number of the fragments in the enterprise's land is higher. When it comes to figures for Erzurum, total enterprise number is 52.807.

While 87% of them are dealing with both crop and animal production, 11% deal with only crop production and 2% with only animal production. Average enterprise size is 69.6 decare and land fragment number per enterprise is 3.3 (Anonymous, 2009). As it can be understood from the figures, the number of fragments per enterprise is lower while the average size is higher in Erzurum Province than those in Turkey as a whole.

Many local and foreign studies have been carried out on this issue. Most of these studies have aimed to examine the effect of fragmentation on the income of the enterprise. These studies include the following: Shaw (1963); Aksoz (1970); Meer (1975); Erkan and Cicek (1988); Esengun and Karalar (1989); Karli and Yurdakul (1992); Korkmaz (1995); Pulido (2000) and Brabec et al. (2002).

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In this study, fragment numbers of the enterprises' land in Erzurum and factors affecting this fragmentation were examined. In conclusion, factors affecting the fragmentation were put forward according to their relative importance rate, which will make it possible for them to be used as indicators in land policies which will be applied from now on.

MATERIALS AND METHODS

The data used in this study were collected through face to face survey study from 16 villages in the central district of Erzurum Province, Turkey. The questionnaires were designed to collect data on land fragmentation of farms. 16 research villages in Erzurum were selected by Non-Random Sampling Method by taking into consideration their total agricultural land holding. The number of surveys was determined as 149 by Simple Random Sampling Method (Ikikat, 2004; Birinci and Ikikat, 2006). The questionnaire was implemented with a total of 149 randomly selected farmers on a face- to-face manner in 2004.

In the questionnaire, the respondents were asked to give infor-mation on household socio-economic and demographic attributes such as household size, land and livestock holdings, form of farming, tools and machinery number, age, education level and social security status. The aim of the survey was to determine factors affecting land fragmentation of farmers in Erzurum Province, Turkey.

Limited dependent variable regression models were used to identify dependent variable. Dependent variable, showing two conditions, indicates the probability of an event existing or not. In the case, when an event happens, dependent variable becomes '1', and if it does not, it becomes '0' (Gujarati 1995 and Yavuz 2001). Ordered logit is a generalization of the popular logit analysis used for ordinal multinomial dependent variables. It can be thought of as an extension of the logistic regression model for dichotomous dependent variables, allowing for more than two (ordered) response categories. The ordered logit model allows the dependent variable (number of land fragmentation) to assume values which are in order. Dependent variable, level of land fragmentation, is divided into three groups (low = 0, medium = 1 and high = 2).

In this study, farmers having less than 3 fragments were considered as the group with low level fragmentation (Y = 0). Farmers having land in 4 to 8 fragments were considered as the group with medium level fragmentation (Y = 1). Lastly, farmers having a land fragmented in more than 8 pieces were considered as the group with high level fragmentation (Y = 2).

Limited dependent variable econometric model is shown in the following equation. Hence,

$$y_i^* = \beta_0 + \beta_1 X_i + [$$

Where, the left hand side (y_i) refers to the level of land fragmentation.
y_i^* = Unobserved land fragmentation level,
y_i = Level of land fragmentation,
y_i = 0 if $y^* \leq 0$, indicating that the farm enterprise had less than three fragment (low),
y_i = 1 if $0 \leq y^* < \mu$, indicating that the farm enterprise had between four and eight fragment (medium),
y_i = 2 if $\mu \leq y^*$, indicating that the farm enterprise had more than eight fragment (high).
μ is unknown parameters to be estimated with an estimated β.

In the right hand side of the model, it presents explanatory variables, x, a constant and the error terms.

The explanatory variables used in the econometric analysis are as follows.

Education: Education level (Illiterate :1, Literate :2, Primary :3, Secondary :4, High :5 and University :6)

Tool and machinery: Number of tools and machinery owned by the farm enterprise,

Land: Land owned by the farm enterprise,

Forage crops: Producing forage crops in the farm enterprise (Producing :1, Others :0),

Income: Agricultural income,

Population working: Population working in agriculture

Arid land rental value: Arid land rental value in the farm enterprise

Forms of farm: Forms of the farm enterprise (mixed/both animal husbandry and crop production :1, Other :0).

FINDING AND DISCUSSION

Table 1 shows descriptive statistics of the explanatory variables, tool and machinery, land, income and population working.

According to the results obtained from the question-naire, the enterprises possess on the average 1.268 tools and maximum number of machinery possession is 5. These enterprises possess on the average 78.493 decare land and 6.550 TL income per year. Population working in the agricultural sector ranges between 1 - 5, approximately, 2 people work in the agricultural sector, on the average. Arid land rental value in the study region ranges between 7 - 15 TL and is calculated as 9.477 TL on the average (Table 1).

Of the farmers included in the study, 30.20% were found to be in the low, 42.95% in the medium and 26.85% in the high fragmentation group. Primary school graduates have the highest rates in all three groups. The lowest rate in the high level fragmentation group belongs to the literates, while the same in the low level fragmentation group belongs to the university graduates, and in the medium level to illiterate and university graduates groups (Table 2).

The highest rate in the low level fragmentation group is the ones whose agricultural income is TL 4.000 or less (18.12%). The highest rate seen in the medium level fragmentation group is the farmers whose agricultural income ranges between TL 4001 - 7999 (14.77%). The highest rate seen in the high level fragmentation group is the farmers whose agricultural income is TL 8.000 or more (14.77%). In other words, the higher the income of the farmers from agriculture, the higher the number of fragments in the farm land (Table 3).

The highest rate of forage crop cultivating farmers is in the medium level fragmented group (40.27%), while the highest rate of farmers who do not cultivate forage crop is

Table 1. Descriptive statistics of the explanatory variables.

	Minimum	Maximum	Mean	Std. dev.
Tool and machinery	0	5	1.268	1.723
Land	0	600	78.493	89.846
Income	200	22700	6550	5013.768
Population working	1	5	1.906	1.016
Arid land rental value	7	15	9.477	2.372

Table 2. Distribution of education level of the farmers within land fragmentation groups (%).

Education	Land fragmentation level			
	Low	Medium	High	Total
Illiterate	2.69	0.67	1.34	4.70
Literate	2.01	2.69	0.00	4.70
Primary	18.12	27.52	17.45	63.09
Secondary	2.69	6.71	4.03	13.42
High	4.03	4.70	3.36	12.08
University	0.67	0.67	0.67	2.01
Total	30.20	42.95	26.85	100.00

Table 3. Distribution of income level of the farmers within land fragmentation groups (%).

Income	Land fragmentation level			
	Low	Medium	High	Total
< TL 4000	18.12	15.44	3.36	36.91
4001-7999	6.71	19.46	8.72	34.90
8000 >	5.37	8.05	14.77	28.19
Total	30.20	42.95	26.85	100.00

in the low level fragmented group (12.08%) (Table 4).

In order to analyze the factors affecting land fragmentation, we ran an ordered logit regression model of land fragmentation against farmer socio-economic characteristics. The explanatory variables in the model, the estimation results and Odds Ratio are shown in Table 5. LR $\chi^2_{(7)}$ value of the ordered logit regression model (p = 0.000) shows that the model is statistically usable.

Although the variable education is statistically insignificant, it has the expected sign. Education affects the dependent variable (land fragmentation) negatively. As the level of education received by the farmer increases, land fragmentation of the land owned by the farmer decreases as well.

As can be watched in Table 5, there is a positive relationship between the tools and machinery assets and fragment number of the land. Fragment number of land is increasing with the increase of tools and machinery assets. Proceeding lands far from the establishment site

becomes easier with the increase in the number of tools and machinery such as tractors and ploughs. Therefore, lands far away from the establishment site of the enterprise are included in it and the number of fragments increases. This situation is very important from the statistical point of view (p < 10%). In case of 1 unit increase in the tools and machinery possessed by the enterprise, the probability of being in the high level land fragmentation group becomes 1.2578 times of the probability of being in the medium or low level fragmentation group. Similarly, in case of 1 unit increase in the tools and machinery possessed by the enterprise, the probability of being in the high or medium level land fragmentation group becomes 1.2578 times of the probability of being in the low level fragmentation group.

As it can be seen in Table 5, it is found that there is a positive relationship between the size of the enterprise and the number of land fragments. Number of land fragments is increasing with the increase in size of the enterprise. Increase in the number of land fragments is a natural result of the land assets, in other words, the size of the enterprise. This situation is very important from the statistical point of view (p < 1%). It is found that, in case of 1 unit increase in the land assets possessed by the enterprise, the probability of being in the high level land fragmentation group becomes 1.0204 times of the probability of being in the medium or low level fragmentation group. In addition, in case of 1 unit increase in the land assets possessed by the enterprise, the probability of being in the high or medium level land fragmentation group becomes 1.0204 times of the probability of being in the low level fragmentation group.

It was found that there is a positive relationship between forage crop cultivation and number of fragments of the land (Table 5). Number of land fragments is higher in enterprises which deal with forage crops cultivation. Forage crops can be cultivated without a significant maintenance. In addition, it can also be cultivated in arid and distant lands in the region. This situation is very important from the statistical point of view (p < 1%). It was found that the probability of being in the high level land fragmentation group for farmers cultivating forage crops will be 4.7653 times greater in comparison with being in the medium or low level fragmentation group. In addition, it is understood from the analysis that the probability of being in the high and medium level land

Table 4. Distribution of farmers to land fragmentation groups according to their position in forage crop cultivation.

	Land fragmentation			
	Low	Medium	High	Total
Farmers who do not cultivate forage crop	12.08	2.68	0.67	15.44
Farmers who cultivate forage crop	18.12	40.27	26.17	84.56
Total	30.20	42.95	26.85	100.00

Table 5. Ordered Logit estimation results.

	Coefficient (Std. error)		Odds ratio (Std. error)	
Education	-0.0369 (0.1870)		0.9638 (0.1802)	
Tools and machinery	0.2294 (0.1238)	***	1.2578 (0.1557)	***
Land	0.0202 (0.0042)	*	1.0204 (0.0042)	*
Forage crops	1.5614 (0.5930)	*	4.7653 (2.8257)	*
Population working	0.3344 (0.1948)	***	1.3971 (0.2721)	***
Arid land rental value	-0.1562 (0.0654)	**	0.8554 (0.0559)	**
Form of farm	0.7361 (0.3547)	**	2.0877 (0.7405)	**
cut1	2.6754 (1.3585)		2.6754 (1.3585)	
cut2	5.8579 (1.4274)		5.8579 (1.4274)	
Log likelihood	-107.3850			
LR chi2(7)	106.3600	*		

*0.01,**0.05,***0.10 in significant leve

fragmentation group for farmers cultivating forage crops will be 4.7653 times greater in comparison with being in the low level fragmentation group.

According to the analysis, there is a positive relationship between the population working in the agriculture and fragmentation of the land (Table 5). Number of land fragments is increasing with the increase of the family members working in the enterprise. This situation shows a resemblance to land assets and possession of tools and machinery. Number of land fragments is increasing with the increase of the enterprise's assets. This situation is important from the statistical point of view (p < 10%). In case of 1 individual increase in the population working in agriculture, the probability of being in the high level land fragmentation group becomes 1.3971 times of the probability of being in the medium or low level fragmentation group. Similarly, in case of 1 individual increase in the population working in agriculture, the probability of being in the high or medium level land fragmentation group becomes 1.3971 times of the probability of being in the low level fragmentation group.

According to the obtained results, there is a negative relationship between the arid land rental value and land fragmentation (Table 5). The productivity of the arid lands is low. An increase in such a land decreases its demand.

This situation is important from the statistical point of view (p < 5%). Therefore, in case of 1 unit increase in the arid land rental value, the probability of being in the high level land fragmentation group becomes 14.46% lower than the probability of being in the medium or low level fragmentation group. Similarly, it was found that in case of 1 unit increase in the arid land rental value, the probability of being in the high or medium level land fragmentation group becomes 14.46% lower than the probability of being in the low level fragmentation group.

Another result obtained from the analyses is that, there is a positive relationship between the enterprise type and the land fragmentation (Table 5). The number of land fragments of the enterprises dealing with both crop and animal production is higher in comparison to the others. Farmers in the study region should be encouraged to get specialized in a certain production field rather than mixed production.

The probability of being in the high level land fragmentation group for enterprise (both animal husbandry and crop production) becomes 2.088 higher than being in middle or low level fragmentation groups. Similarly, it was found that the probability of being in the high and medium level land fragmentation group for this enterprise becomes 2.088 higher than being in low level fragmentation group.

RESULTS

There is a positive relationship between tools and machinery, size of the enterprise, forage crop cultivation, population working in agriculture, the type of enterprise and number of land fragments. There is a negative relationship between the arid land rental value and land fragmentation.

The probability of being in the high level land fragmentation group for farmers cultivating forage crops is 4.765 times greater in comparison with being in the medium or low level fragmentation group. Similarly, it was found that the probability of being in the high and medium level land fragmentation group for farmers cultivating forage crops will be 4.765 times greater in comparison with being in the low level fragmentation group. Enterprises dealing with forage crop cultivation are generally the ones which deal with both crop and animal production together, that is, mixed production. In this context, one of the measures to be taken in order to decrease the land fragmentation in the region can be to encourage the enterprises to get specialized, that is, to inspire them to deal only with animal or crop production. According to the results obtained from the study, the number of land fragments of farmers who obtain high income from agricultural production is higher. The current law of inheritance should be re-arranged in order to reduce the land fragmentation in the study region. In addition, for the sake of successful business management, the farmers should be made aware of the importance of working in a less fragmented land using every available incentive tools. These farmers should be trained to gather their fragmented lands together and reduce the number of fragments. A gradual land consolidation policy should be developed. At the beginning of the process, It will be more practical to begin with farmers that has low number of fragments. A success in this group will inevitably encourage the others to take action towards land consolidation.

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