The impact of crop rotation and land fragmentation on farm productivity in Albania

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Abstract:

We estimate the impact of land fragmentation and crop rotation on farm productivity in rural Albania. We employ stochastic production frontier estimation approach and Tobit regression on survey data collected among farm households in Albania in 2013. Our estimates suggest that land fragmentation improves farm efficiency likely because it allows a better use of household labour during the production seasons. Our estimates also suggest that crop rotation increases farm efficiency. However, the land fragmentation dominates the crop rotation in impacting farm efficiency.

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Introduction

Agriculture remains one of the most important sectors in the Albanian economy, representing one fifth of the country's GDP and around half of total employment (INSTAT, 2016). During the early transition period in 1991, Albania adopted a land reform which led to a harsh structural change. Before 1990, 622 collective and state farms used all agricultural land in Albania with an average size of 1065 hectares per farm. The average plot size was 38 hectares. The 1991 land reform had a significant impact on the current state of the farming sector and land use. The reform caused an extensive land fragmentation characterised by numerous and scattered plots per farm. Overall, there were created around 350 thousand small family farms (1.2 ha on average) cultivating 1.9 million small plots (an average of 4.9 plots per farm) with each plot having an average size between 0.25 and 0.3 hectares (Zhllima and Guri, 2013).

Most studies conclude that the land fragmentation is one of the most negative phenomena of the 1991 land reform (Lemel, 2000; Lusho and Papa, 1998; MoAFCP, 2007). However, none of these studies have based these arguments on empirical findings. Instead, few empirical studies have been carried in Albania to study the impacts of land fragmentation. Deininger et al. (2012) find no support for the argument that land fragmentation reduces productivity. The results of Sikor et al. (2009) reveal a rather counterintuitive effect of land fragmentation—villages with more fragmented land holdings tend to have lower abandonment rates in the early transition period but no effect was observed in the latter period in 1996–2003. Further, they found that land fragmentation increases farm productivity. Further, findings of Stahl (2007), Sabates-Wheeler (2002) and Zhllima et al. (2010) show that land fragmentation may have various implications for farmers. For example, Stahl (2007) found that on average a farmer need to travel more than 6 km in order to move from one plot to the other (Stahl, 2007). The analyses of Zhllima et al. (2010) reveal that the likelihood to rent out land increases with fragmentation and dispersion of land at farm level (i.e. with average distance of the plots from farm house and a higher number of plots per farm). Guri, Jouve and Dashi

(2014) conclude that land fragmentation reduces the land market participation especially in marginal areas.

Further, land fragmentation may have implications for crop rotation choices of farmers. For example, Ciaian et al. (2015) show in the case of Albania that land fragmentation is an important driver of production diversification which is indirectly linked to crop rotation. However, there are very few studies analysing the impact of crop rotation on farm performance in Albania (Ahmeti and Grazhdani, 2013). The available studies base their analysis mainly on agronomic experiments rather than on empirical evidence. Ahmeti and Grazhdani (2013) have observed the crop rotation effect on land productivity in south east Albania and found that crop rotation improves land productivity. The general literature on crop rotation widely supports the view that it has a positive impact on land productivity and thus also on farm performance (Havlin et al, 1990; Manjunatha et al, 2013).

To our knowledge there are no studies investigating the impact of both land fragmentation and crop rotation on farm performance in Albania. This paper attempts to fill this gap in the literature by estimating the impact of crop rotation and land fragmentation on farm productivity in Albania. We derive our econometric estimations from a survey data of 1018 farm households in three representative Albanian regions collected in 2013 (Guri et al., 2015). This study contributes to the literature twofold: firstly, it provides an empirical estimation of the land fragmentation effects' on farm efficiency and secondly it observes farm fragmentation impact on farm productivity in association with the effect of crop rotation.

Literature review on the impacts of crop rotation and land fragmentation

There exists rather extensive literature investigating the impact of crop rotation and land fragmentation on farm performance. In general, there is a relatively wide consensus among studies that crop rotation enhances land productivity and indirectly also farm performance. Regarding land fragmentation, studies are inconclusive on its effect on farm performance.

Agronomic studies have revealed a positive impact of crop rotation on crop productivity. According to this studies, crop rotation increases crop productivity because it improves the soil fertility by retaining a higher level of organic Carbon or Nitrate (Havlin et al, 1990). For example, several long term period studies have demonstrated the beneficial effect of crop rotation on yields, showing, among others, that the crop rotation increases the soil organic-matter content available for the upcoming crop which improves its yield (Odell et al., 1984;

Johnston, 1986; Havlin et al, 1990; Liebman and Dyck, 1993). Some studies have performed economic estimations on the impact of crop rotation on farm performance. For example, Chase and Duffy (1991) and Lavoie et al. (1991) reveal that crop rotation is associated with positive returns to land and investment and higher farm net income. Rahman (2009) and Manjunatha et al. (2013) found that farmers who apply crop diversification gain in efficiency compared to farmers pursuing monoculture strategies. The monoculture strategy is accompanied in long term by water quality depletion, loss of soil fertility, water logging and salinity.

While land fragmentation has been much more frequently investigated from economic perspective, compared to crop rotation, there is a divergence in the literature on the findings regarding its impact on farm performance. Although, land fragmentation is widely perceived to be bad from farmers' production perspective (at least from theoretical point of view), there is no full consensus among studies on whether it actually improves or worsens farm performance.

Many studies argue that land fragmented in small plots of small size has negative impact on productivity since it hampers the use of agricultural mechanics and labour causing sub-optimal application of production factors (Mwebaza and Gaynor, 2002; Penov, 2004). According to Ram et al. (1999) land fragmentation may drive farmers towards intensive agricultural practices such as continuous farming and monocropping, resulting in deterioration of land quality, thus increasing production cost and lowering land productivity. All these factors ultimately are expected to adversely affect productivity, efficiency and profitability of farms but also create other concerns on regards to deployment of production factors such as labor and credit (e.g. Bardhan, 1973; Jabarin and Epplin, 1994; Parikh and Shah, 1994; Wan and Cheng, 2001; Parikh and Nagarajan, 2004; Jha et al., 2005; Van Hung et al., 2007; Rahman and Rahman, 2009; Kawasaki, 2010; Di Falco et al., 2010 Corral et al., 2011; Manjunatha et al., 2013; LaTruffe and Piet, 2013). However, there are cases of lack of a statistically significant relationship between land fragmentation and farm efficiency such as revealed in Wu et al. (2005).

In contrast, several studies emphasize the positive role of land fragmentation. Bentley (1987), Blarel et al. (1992) and Goland (1993) found that land fragmentation allows for better exploitation of land parcels by planting different crops according to plot quality, thus facilitating crop diversification, easing allocation of labour and reducing risk from harvesting failures. Sundqvist and Andersson (2007) find that land fragmentation seems to be positively correlated with productivity due to higher use of fertilizers and labour input. Moreover, according to Bentley (1987) there is a positive relation between land fragmentation and farm performance because the split of farm area into several plots facilitates crop rotation and gives the ability to leave some land fallow. Since crops harvesting time differ, especially in short growing seasons and eventually when plots are in different altitudes (on mountainous areas), spreading out the labour time over the different farm activities (e.g. sawing, weeding, harvest) helps farmers to avoid labour shortage and/or hidden unemployment during the year (Bentley 1987).

An important consideration when analysing the effects of land fragmentation is whether it is exogenous (Bentley, 1987) or endogenous with respect to farmers' production related decisions (Blarel et al., 1992; Van Hung et al., 2007). For example, although the estimates of Latruffe and Piet (2013) suggest that land fragmentation increases production costs, reduces crop yields and decreases farm revenue and profitability, they call the attention for the possible endogeneity problem. According to Latruffe and Piet (2013) causality can be reverse in dynamic perspective, because efficient farms are more likely to be in a position to decrease their fragmentation at the expense of neighbouring farms. According to Sen (1966), better quality land is concentrated on small farms, allowing to attain higher output and income, which in turn allows an expansion of family members, and thus via inheritance leading to land fragmentation. This type of exogenous cause of land fragmentation is often relevant for countries which have a long evolutionary phase of land structure, but it does not explain land fragmentation in Albania. In Albania land fragmentation is an exogenous outcome of the land reform implemented in the early 1990s; it is not induced by farmers' behaviour.

Methodology

Following the literature we employ a two-stage approach to estimate the impact of crop rotation and land fragmentation on farm productivity in Albania. In the first stage we estimate the productivity measures (production frontier) while in the second stage productivity measures are regressed on a set of explanatory variables including crop rotation and land fragmentation (e.g. Giannakas et al., 2001; Latruffe et al., 2009; Sauer and Park, 2009; Zhu and Lansink, 2010; Mary, 2013).

Stochastic parametric approach was used to estimate farm production frontier from which an output orientated technical efficiency measures were derived. Stochastic Frontier Analysis (SFA) was originally proposed by Aigner et al. (1977) and Meeusen and van den Broeck

(1977), independently of each other. Assuming the log-linear Cobb-Douglas form, stochastic production frontier can be written as:

$$lny_i = \beta_0 + \sum_{n=1}^{N} \beta_n lnX_{ni} + \varepsilon_i \qquad (1)$$

Where β_0 is a constant, y_i represents the output of each farm i, X_i is a vector of n inputs, β_n is a vector of the parameters to be estimated, ε_i is specified as:

$$\varepsilon_i = v_i - u_{i,} \qquad u_i \geq 0 \qquad (2)$$

v_i captures statistical noise and u_i represents the inefficiency term. According to the original model specification, maximum likelihood estimates are obtained under these assumptions (Coelli et al., 2005):

$$v_i \sim iidN(0, \sigma_v^2) \qquad (3)$$

$$u_i \sim iidN^+(0, \sigma_u^2) \qquad (4)$$

Assumption (3) means that values of v_i are independently and identically distributed normal random variables with zero means and variances σ_u^2. Assumption (4) expresses that values of u_i are independently and identically distributed half-normal random variables with zero means and variances σ_v^2.

The motivation behind efficiency analysis is to estimate maximum feasible frontier and accordingly measure the efficiency scores of every farm relative to that frontier. In the estimation of inefficiency term, the major concern of researchers is to decide on the appropriate distribution function of it. Aigner et al. (1977) proposed half-normal, Stevenson (1980) used truncated normal, Greene (1980) preferred to use gamma, and finally Beckers and Hammond (1987) extended exponential distribution function for inefficiency component of error term. Although, to opt for the best-fitted distribution is overwhelmingly difficult, prior theoretical insights of researchers do shape this decision making process. Coelli et al. (2005) underlines the notion of parsimony which is in favour of choosing the less complicated one ceteris paribus. Therefore, half-normal and exponential distributions are the best candidates which have simpler structures than other above mentioned options (Coelli et al., 2005: 252). In our analysis we use a number of empirical models and apply likelihood ratio tests to selected the preferred model with half-normal distribution.

In the second stage, we estimated Tobit regression model to analyse the impact of land fragmentation and crop rotation and other factors on farm efficiency. The technical efficiency is often estimated in a first step and the determinants of efficiency are obtained in a second-stage regression using Tobit model, since the technical efficiency scores range between 0 and 1 (e.g. Masuku et al, 2015; Sibiko et al., 2013). However, this procedure, when coefficients of efficiency are simply regressed against the factors using Tobit model, is criticized in many studies, as it may induce both bias and inefficiency in the estimations. To avoid this problem, authors propose to assess the technical inefficiency ($\widehat{TIN}$) instead of technical efficiency ($\widehat{TE}$) calculated using the following formula:

$$\widehat{TIN} = \frac{1 - \widehat{TE}}{\widehat{TE}} \quad (5)$$

The Tobit regression is then applied using $\widehat{TIN}$ instead of $\widehat{TE}$. The technical inefficiency scores take a value between 0 and infinity (Scippacercola and D'Ambra, 2014; Sung, 2007).

Data

We use survey data collected among farm households in Albania in 2013. The survey was coordinated by the Joint Research Centre of the European Commission and it was implemented by the Agricultural University of Tirana. In total, 1034 farm households were interviewed face-to-face in three representative agricultural regions of the country: Berat, Elbasan, and Lezhë. The sample was selected to be representative of farming systems at both national and regional level. The selection of the regions was made by using a ranking method according three characteristics: 1) agricultural gross added value, 2) the participation to the agricultural markets and 3) land productivity. The 12 regions of Albania were divided in three groups: regions with advanced agriculture, regions with medium agricultural development and regions with less developed agriculture. Within each group the region ranked in the middle was selected for the survey (Guri et al., 2015). On the regional level, the sample was selected according to regional area frame. After cleaning the data, the final database consists of 1018 observations. The sampling criterion used for sample distribution between regions and villages is based on the area distribution. Figure 1 shows the selected region and the sample distribution among different municipalities of each region (Guri et al., 2015).

Model specification

We consider the total value of agricultural output (in national currency) to proxy the farm production in the stochastic frontier estimation (1). The total farm output was derived as a sum of the value of crop production and value of livestock production. Production factors are represented in the stochastic production frontier (1) by the total agricultural area in hectares, total number of (family and hired) labour days used on farm per year, the value of capital costs (e.g. irrigation, plough, sowing, weeding, spreading, harvesting, transport) and the value of variable costs (e.g. seed, fertilizers, pesticides) plus feed costs (hay, straw, stubble, grain).

The variable considered in the second stage Tobit regression for explaining the determinants of farms inefficiency scores are reported in Table 2. We consider a set of explanatory variables, capturing household-specific characteristics: age (*age*), gender (*gender*), marital status of household head (*marital_status*), education of household head (*education*), agricultural education of household head (*agri_education*), number of families living in the household (*no_families*) number of household members (*family_member*), the share of o remittances in total agricultural expenditure (*remittances*) and the importance of non-agricultural income (*non_agr_income_ratio*).

The second set of explanatory variables include those capturing farm characteristics: share of rented area (*uaa_renting_ratio*), the share of rangeland land (*rangeland_ratio*), share of permanent crops (*perm_crop_ratio*), share of irrigated area (*irrigated_uaa_ratio*), livestock production share (*prod_livestock_ratio*), the share of production sales in total farm production value (*commercialization_ratio*), and the dummy variable measuring whether farm received subsidies (*support_dum*). We also consider district dummies to account for other region-specific drivers of farm efficiency (e.g., agronomic conditions, soil quality, or infrastructure).

The main variable of interest in this paper is the number of plots per farm household (*plot_cropped_no*) and the number of crops per plot (*no_diffcrop_perplot_w*). The number of plots per farm household measures land fragmentation. The average number of crops grown per plot attempts to capture the crop rotation and it is calculated as area weighted average number of different crops grown per a plot in the period 2011-2013. It indicates the average number of crops a farm household cultivated per plot over the three years period. We also consider square variables for these two variables to account for possible non-linear effects. A negative estimated coefficient associated with the number of plots per household would indicate that the farm inefficiency decreases with the number of plots. Similarly, a negative estimated coefficient associated with the average number of crops grown per plot would indicate that the farm inefficiency decreases with the number of crops.

Finally, the third variable of interest is the interaction term between the number of plots and the number of crops per plot. The interaction variables measure the extent to which the number of plots available on farm household together with the number of crops per plot impact farm efficiency. A negative coefficient for the interaction variable would indicate that households with a larger number of plots and greater crop rotation done on its plots have more diversified production structure.

Estimation strategy and farm typologies

In total, we estimate eight different model specifications to account for possible correlations between our variables of interest: land fragmentation and crop rotation. The models differ in including the interaction term and the square variables for the number of plots and the number of crops per plot.

As stated by Sauer et al. (2012) most of the studies estimating the link between land fragmentation and efficiency have one common weak point that they do not account for the heterogeneity in farm households. We attempt to take into consideration the heterogeneity in agricultural production in different farm types and estimate eight different model specifications for full sample as well as by farm typology. We consider farm typologies developed by Guri et al. (2015). They employed cluster analysis using the following variables to split farms in different typologies: farm area, farm crop structure, intensification strategies (total expenses per value of agricultural production, labour per value of agricultural production), commercialization level and the share of non-agricultural income in total income. Their analysis resulted in the following six farms types: (1) multi-culture commercial farms, (2) part-type farms, (3) arable crop farms, (4) fruit tree farms, (5) subsistence farms, and (6) livestock farms. The sample size distribution across the six typologies is relatively well balanced: the sample size varies between 104 farms for fruit tree farms and 289 for livestock farms (Table 3).

Results

The estimates suggest that the coefficients corresponding to our variables of interest (land fragmentation and crop rotation) are statistically significant for most models (Table 4). However, the estimated coefficients corresponding to the land fragmentation appear to be more consistent across the estimated models and the significance level tends to be higher compared to the coefficients associated to the crop rotation.

The negative and significant coefficients for the land fragmentation variable (the number of plots per farm household) indicates that households with a larger number of plots attain lower inefficiency (or higher efficiency) compared to households with fewer plots. This result is consistent across all model specifications (Table 4). This result is contrary to the expectations. As explained above, land fragmentation increases operational costs of farm households because of time and energy spent by machinery and labour to move between plots leading to their sub-optimal deployment potentially causing lower productivity. The reduced possibility of farmers' operating on fragmented land to apply modern technology, to develop irrigation infrastructure or to obtain collateralized loans is also expected to cause an opposite effect (i.e. increase in inefficiency) (Mwebaza and Gaynor, 2002; Penov, 2004). These results could be likely explained the gains in better exploitation of household labour during the growing season within the year (Bentley, 1987; Blarel et al., 1992; Goland, 1993). Albanian rural areas are characteristic for abundance of labour and there is evidence of hidden unemployment in rural areas in Albania (Zhllima et al, 2016; Meyer et al, 2008). Further, Ciaian et al. (2015) showed that land fragmentation leads to production diversification of farm households in Albania. In this context, land fragmentation combined with greater production diversification allows better exploitation of farm labour. By planting different crops on parcels with different labour inputs requirements across the growing season may lead to improvement of allocation and more efficient use of labour. Further, this strategy may contribute to the reduction of production risk to farmers (Bentley, 1987; Blarel et al., 1992; Goland, 1993).

The variables accounting for the distance of plots from the farm house (*plot_distance_farm*) or from the market (*plot_distance_market*) are found to be statistically insignificant in affecting farm efficiency (Table 4). These two variables are also measures of land fragmentation as they measure the geographical dispersion of plots. Their statistical insignificance suggest that transport costs of inputs and goods and travelling costs of labour are not influencing the productivity. This could be mainly due to the strategy of the farmers to cultivate only the area plots that are located near the farm thus reducing the transport costs and their impact on the productivity.

In line with expectations, our estimates suggests that crop rotation (*no_diffcrop_perplot_w*) decreases inefficiency (or increases efficiency) of farm households (Table 4). However, the significance level and the magnitude of the estimated coefficients vary considerably across the estimated models suggesting potential correlation problem with the land fragmentation variable. The crop rotation variable is not statistically significant in specifications M1 and M5 where land fragmentation variable is included and excluded, respectively. The crop rotation variable becomes significant when interaction variable is added (M6) as well as when square variables is considered for crop rotation (M3, M7) and land fragmentation (M8). These results suggest that land fragmentation dominates the impact on farm inefficiency. Land fragmentation likely also accounts for some of the production effects of crop rotation.

The estimates show that the interaction variable between land fragmentation and crop rotation is positive and statistically significant suggesting that inefficiency increases if farms have simultaneously many plots and rotate many crops. This is also confirmed by the obtained significant coefficients for square variables. The estimated coefficients for square variables for both land fragmentation and crop rotation are positive. This implies that the land fragmentation decreases inefficiency but at decreasing rate with the number of plots. Similarly the crop rotation decreases inefficiency but at decreasing rate with the number of rotated crops (Table 4).

Results by farm typology are reported in Tables 1A to Table 6A in Appendix. The impact of land fragmentation and crop rotation are statistically less significant for farm types as compared to the full sample estimations in Table 4. This is expected, given that sample sizes are smaller for farm types compared to the full sample as well as the variation of the explanatory variables reduces when farms are split by type. Similar to the full sample results, coefficients corresponding to the land fragmentation tend to be statistically significant in more models compared to the coefficients associated to the crop rotation. On the other hand, more farm types have statistically significant coefficients for crop rotation than for land fragmentation.

The coefficient associated with land fragmentation is negative and statistically significant only for part-type farms (Table 2A in Appendix) and subsistence farms (Table 5A in Appendix). In this two farm types households with higher land fragmentation attain lower inefficiency compared to households with lower land fragmentation. For the rest of farm types the land fragmentation has statistically insignificant impact on farm efficiency. Crop rotation has statistically significant impact on farm efficiency for part-type farms (Table 2A in Appendix), arable crop farms (Table 3A in Appendix), subsistence farms (Table 5A in Appendix) and livestock farms (Table 6A in Appendix). As expected, the statistically significant coefficients are negative for the first three farm types (part-type farms, arable crop farms, subsistence farms) suggesting that crop rotation improves farm efficiency. The exception is livestock farms for which crop rotation reduces farm efficiency. This is likely due to the fact that generally fodder crops used in Albania are multiannual, implying a low level of rotation.

The coefficients associated with the distance of plots from the farm house or from the market (*plot_distance_farm*, *plot_distance_market*) are statistically significant and positive for multi-culture commercial farms (Table 1A in Appendix) and arable crop farms (Table 3A in Appendix) indicating a decrease of farm efficiency with the distance. For livestock farms the coefficients for the plot distance from the farm house is statistically significant and negative, while the plot distance from the market is positive in some estimated models (Table 6A in Appendix). These results indicate that the plot distance from the farm house is actually increasing farm productivity probably because it may capture some other affects not completely accounted for in the data.

For the other of variables considered, the estimates show that the following ones are statistically significant in the majority of estimated models: marital status (*marital_status*), the share of permanent crops on total farm land (*perm_crop_ratio*), irrigated area (*irrigated_uaa_ratio*), livestock production share in total production (*prod_livestock_ratio*), farm commercialization (*commercialization_ratio*), non-agricultural income (*non_agr_income_ratio*), policy support (*support_dum*), remittances and regional dummies. The rest of variables not listed above (e.g., *education*, *gender*) are statistically insignificant in all estimated models (Table 4).[1]

Surprisingly marital status has statistically significant impact on farms household productivity. Married farmers attain lower inefficiency compared to non-married ones. The negative estimated coefficients could be explained by a better distribution of labour between females and males in the household or that more family labour is available on farm (as compared to hired labour which is perceived to have incentives to perform well). Studies carried in Albania find a higher inclusion of married women in the everyday working tasks compared to men which are more involved in off-farm activities (see Zhllima et al, 2016). On the other hand the majority of agricultural activities producing the cash incomes (milk and dairy products) are generally performed by women within the household. This has a direct impact on the productivity.

[1] Estimation results for the control variables by farm typology are largely consistent with full sample although significance level tends to be lower (Tables 1A to Table 6A in Appendix).

Non-agricultural income (*non_agr_income_ratio*) has a positive impact on the inefficiency. This result is consistent with Taylor et al. (2003) who also find that off-farm income reduces farm efficiency. According to Taylor et al. (2003), if non-agricultural income is earned from off-farm employment, part-time farms have less time to devote it for on-farm activities, substitution to hired labour is not as efficient as farm labour, and hiring agricultural labour incurs transaction costs. Also, off-farm income may be a strategy to diversify employment risks and thus it reduces the gains from specialization. Similarly, remittances also have a positive impact on the inefficiency. This could be explained by an orientation of remittances on off-farm investments. This is confirmed by Deninger et al. (2007) and Belletti and Leksinaj (2016) who find that remittance in rural Albania stimulate investments in off-farm business and promote off-farm activities.

A larger share of livestock production in the total household production (*prod_livestock_ratio*) is associated with a lower inefficiency, potentially due the complementarity effects of the combined crop-livestock production (i.e. manure use on crops). Similarly, the combined farming systems may increase farm efficiency due to more efficient use of labour across different production seasons. For example et al. (2016) show that the mixed crop-livestock farms have higher land productivity compared with crop or livestock farms.

As expected, the commercialization of farm households (*commercialization_ratio*) has a negative effect on their inefficiency. Farm households which sale a greater share of their production achieve higher efficiency compared to farms that produce for own consumption. The commercialization allows farm households to sustain higher productivity as it provides financial resources to purchase inputs (i.e. it alleviates credit constraint) as well as rent in land and labour. Also in line with expectations, irrigation (*irrigated_uaa_ratio*) improves farm efficiency because it rises the crop yields.

Surprisingly, the policy support (*support_dum*) reduces efficiency of farm households. The regional dummy covariates (*Region 2*, *Region 3*) capture any regional differences not accounted for by the other variables. The significant coefficient corresponding to this variables confirm that structural regional differences such as agronomic conditions, soil quality or quality of infrastructure have an impact on the farm household efficiency.

Conclusions

In this paper, we analyse land fragmentation and crop rotation and its implications for farm productivity in rural Albania. Albania represents a particularly interesting case for studying land fragmentation as it is an outcome of land policy reform implemented in the early 1990s. The Albanian land reform fragmented land structures where farmers own several plots of different quality. We estimate stochastic production frontier and Tobit regression to identify the impact of land fragmentation and crop rotation on farm efficiency by using survey data collected among farm households in Albania in 2013.

Our results indicate that land fragmentation is an important factor affecting productivity of farm households in Albania. The estimates suggest that land fragmentation improves farm efficiency likely because it allows a better exploitation of household labour during the growing season. Our estimates also suggest that crop rotation increases farm efficiency. Its influence on farm efficiency might be direct through the positive impact on land productivity (as estimated by Havlin et al, 1990) or indirectly as a joint effect of land fragmentation (Ram et al., 1999). The existence of crop rotation, especially in lowland regions, might reduce the vulnerabilities resulting from the monoculture and intensive use of land which has raised concerns also on water and land quality (e.g. salinity and water depletion). Moreover, it protects the farmers from the adverse effects of droughts and floods. However, the impact of crop rotation is less statistically significant than the land fragmentation suggesting that land fragmentation dominates the impact on farm inefficiency.

Our findings are consistent with the part of literature arguing a positive role of land fragmentation for farm performance. Following Bentley (1987) and Sundqvist and Andersson (2007) and considering the widespread hidden and seasonal unemployment in rural areas in Albania, our analyses support the argument that fragmentation, associated with crop diversification help to reallocate the workload across seasons (e.g. winter and summers season), between farm activities (e.g. pruning, harrowing, sawing, weeding, harvest) and among the plots (e.g. among the less distant and more distant ones). In the context of labor abundance and the prevalence of subsistence farms in rural Albania, land fragmentation allows for better exploitation of land parcels by planting different crops according to plots of different quality, thus facilitating crop diversification, easing allocation of labor, reducing risk from harvesting failures and providing diverse food basket for household consumption.

Overall, our results suggest that the existence of land fragmentation is less detrimental for rural growth compared to what is often perceived in the public or among policymakers.

Therefore, rather than adopting an expensive land consolidation solution to the land fragmentation problem, policy action should aim at addressing the institutional and structural barriers present in rural areas in Albania.

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Table 1. The structural changes to agricultural land

	Unit	1990	1994	2012
Number of farms	No.	622	445000	350000
Average farm size	ha	1 065	1.2	1.2
Average plot size	No.	38	0.2-0.3	0.26
Average number of parcels per farm	No		3.3	4.9
Total number of parcels	million		1.9	1.7

Source: MoAFCP2012

Table 2. List of variables

Variable	Unit	Description
gender	Dummy variable	Equals 1 if farmer is male; 0 otherwise
age	Years	Age of farmer
marital_status	Dummy variable	Marital status of farmer (equals 1 if farmer is married; 0 otherwise (e.g. single, divorced, widow))
education	Years	The education of farmer (years)
agri_education	Dummy variable	Agricultural education of farmer (equals 1 if farmer has agricultural education; 0 otherwise)
no_families	Number of families	Number of families living on the farm
family_member	Number of persons	Total number of family member living on the farm
remittances	%	Share of remittances in total own funding used for to financing of agricultural activities during the agricultural year
non_agr_income_ratio	%	Non-agricultural income in in total farm production value
uaa_renting_ratio	%	Rented land in total farm land
rangeland_ratio	%	Rangeland land in total farm land
perm_crop_ratio	%	Permanent crop land in total farm land
plot_distance_farm	km	Average plot distance from the farm centre
plot_distance_market	km	Average plot distance from the nearest market or product collection facility
irrigated_uaa_ratio	%	Irrigated area in total farm land
prod_livestock_ratio	%	Livestock production in total farm production value
commercialization_ratio	%	Production sales in total farm production value
support_dum	Dummy variable	Support scheme received during the period 2007-2013 (equals 1 if farmer received support in the period 2007-2013; 0 otherwise)
Region 2	Dummy variable	Dummy variable for region 2 _
Region 3	Dummy variable	Dummy variable for region 3
plot_cropped_no	Number of plots	Number of plots
no_diffcrop_perplot_w	Number of crops	Area weighted average number of different crops grown per a plot in the period 2011-2013 (at farm level)
no_diffcrop_perplot_noplot	Interaction variable	Interaction variable: no_diffcrop_perplot_w *plot_cropped_no
plot_cropped_no_sq	Square variable	Square of variable plot_cropped_no
no_diffcrop_perplot_w_sq	Square variable	Square of variable no_diffcrop_perplot_w

Table 3. The sample distribution across farm typologies

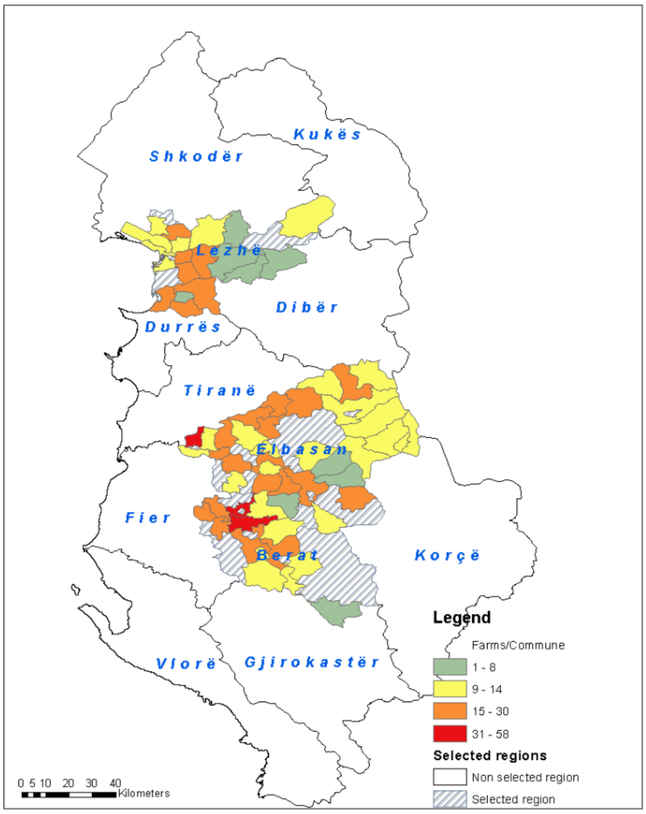
	Number of households	% of households
1. Multi-culture commercial farms	131	12.80
2. Part-type farms	113	11.05
3. Arable crop farms	151	14.77
4. Fruit tree farms	104	10.17
5. Subsistence farms	234	22.89
6. Livestock farms	289	28.27

Source: Guri et al. (2015).

Table 4. Estimated results (Dependent variable: farm inefficiency)

	M1	M2	M3	M4	M5	M6	M7	M8
gender	0.21	0.15	0.28	0.13	0.17	0.15	0.22	0.20
age	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
marital_status	-0.38 **	-0.32 **	-0.36 **	-0.28 *	-0.33 **	-0.33 **	-0.32 **	-0.28 *
education	0.01	0.00	0.01	0.00	0.01	0.01	0.01	0.01
agri_education	-0.15	-0.11	-0.15	-0.12	-0.13	-0.12	-0.13	-0.13
no_families	0.03	0.01	0.01	-0.03	0.02	0.03	0.01	-0.04
family_member	-0.02	0.00	-0.02	0.01	0.01	0.01	0.01	0.01
remittances	0.003	0.004 **	0.003	0.004 **	0.004 *	0.004 *	0.004 *	0.004 *
uaa_renting_ratio	-0.15	-0.21	-0.20	-0.19	-0.25	-0.25	-0.28	-0.25
rangeland_ratio	-0.17	-0.19	-0.24	-0.19	-0.27	-0.33	-0.32	-0.31
perm_crop_ratio	-0.89 ***	-0.85 ***	-0.96 ***	-0.81 ***	-0.92 ***	-0.92 ***	-0.97 ***	-0.90 ***
plot_distance_farm	-0.01	-0.02	-0.01	-0.02	-0.02	-0.02	-0.02	-0.03
plot_distance_market	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.01
irrigated_uaa_ratio	-0.35 ***	-0.43 ***	-0.36 ***	-0.42 ***	-0.46 ***	-0.46 ***	-0.46 ***	-0.45 ***
prod_livestock_ratio	-2.12 ***	-1.99 ***	-2.01 ***	-1.93 ***	-1.98 ***	-1.98 ***	-1.91 ***	-1.87 ***
commercialization_ratio	-0.52 ***	-0.50 ***	-0.54 ***	-0.50 ***	-0.53 ***	-0.51 ***	-0.54 ***	-0.55 ***
non_agr_income_ratio	0.08 ***	0.07 ***	0.08 ***	0.07 ***	0.07 ***	0.07 ***	0.07 ***	0.07 ***
support_dum	1.01 ***	1.14 ***	1.04 ***	1.13 ***	1.14 ***	1.14 ***	1.15 ***	1.11 ***
Region 2	-0.28 ***	-0.32 ***	-0.27 ***	-0.30 ***	-0.33 ***	-0.34 ***	-0.32 ***	-0.28 ***
Region 3	-0.13	-0.30 ***	-0.16	-0.32 ***	-0.31 ***	-0.30 ***	-0.32 ***	-0.33 ***
plot_cropped_no		-0.13 ***		-0.36 ***	-0.13 ***	-0.29 ***	-0.12 ***	-0.39 ***
plot_cropped_no_sq				0.03 ***				0.03 ***
no_diffcrop_perplot_w	-0.11		-1.63 ***		-0.07	-0.40 *	-1.24 **	-1.04 **
no_diffcrop_perplot_w_sq			0.44				0.34 **	0.29 **
no_diffcrop_perplot_noplot						0.11 *		
Constant	2.43	2.79 ***	3.58	3.15 ***	2.85 ***	3.35 ***	3.70 ***	3.92 ***

Figure 1. Sample distribution in commune level



Source: Guri et al. (2014)

Appendix: Estimated results by farm type

Table 1A. Estimated results for multi-culture commercial farms (Dependent variable: farm inefficiency)

	M1	M2	M3	M4	M5	M6	M7	M8
gender	-0.13	-0.13	-0.11	-0.14	-0.16	-0.19	-0.14	-0.15
age	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
marital_status	0.02	0.03	0.04	0.03	0.03	0.03	0.04	0.05
education	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
agri_education	-0.20 **	-0.17 *	-0.20 **	-0.17 *	-0.19 **	-0.21 **	-0.20 **	-0.20 **
no_families	-0.11 *	-0.11 *	-0.11 *	-0.12 **	-0.11 *	-0.10	-0.11 *	-0.12 *
family_member	0.05 **	0.06 ***	0.05 **	0.06 ***	0.06 ***	0.06 ***	0.06 ***	0.06 ***
remittances	-0.01	0.00	-0.01	0.00	0.00	0.00	0.00	0.00
uaa_renting_ratio	-1.55	-1.54	-1.61	-1.53	-1.58	-1.46	-1.64	-1.63
rangeland_ratio	-0.55	-0.85 **	-0.58 *	-0.87 **	-0.76 **	-0.72 *	-0.80 **	-0.83 **
perm_crop_ratio	-0.17	-0.22	-0.11	-0.21	-0.15	-0.15	-0.08	-0.05
plot_distance_farm	0.04 *	0.02	0.04 *	0.02	0.03	0.03	0.02	0.02
plot_distance_market	0.02 **	0.02 ***	0.02 ***	0.02 ***	0.02 ***	0.02 ***	0.02 ***	0.02 ***
irrigated_uaa_ratio	-0.32 **	-0.35 ***	-0.32 **	-0.35 ***	-0.34 ***	-0.34 ***	-0.34 ***	-0.33 **
prod_livestock_ratio	-0.71 ***	-0.68 ***	-0.68 ***	-0.67 ***	-0.67 ***	-0.67 ***	-0.63 ***	-0.62 ***
commercialization_ratio	-0.04	-0.02	-0.05	-0.02	-0.03	-0.02	-0.04	-0.04
non_agr_income_ratio	0.01 *	0.01	0.01 *	0.01	0.01	0.01	0.01 *	0.01 *
support_dum	-0.07	0.02	-0.07	0.01	0.01	0.00	0.01	0.00
Region 2	0.16 **	0.09	0.13 *	0.08	0.10	0.10	0.08	0.07
Region 3	-0.22 **	-0.25 **	-0.23 **	-0.26 **	-0.27 **	-0.28 **	-0.29 ***	-0.30 ***
plot_cropped_no		-0.04 *		-0.07	-0.04 *	-0.15	-0.04 *	-0.08
plot_cropped_no_sq				0.00				0.00
no_diffcrop_perplot_w	0.10		-0.36		0.11	-0.15	-0.38	-0.39
no_diffcrop_perplot_w_sq			0.18				0.19	0.20
no_diffcrop_perplot_noplot						0.08		

Table 2A. Estimated results for part-type farms (Dependent variable: farm inefficiency)

	M1	M2	M3	M4	M5	M6	M7	M8
gender	0.34	0.37	0.32	0.38	0.41	0.40	0.39	0.42
age	-0.01	0.00	-0.01	0.00	0.00	0.00	0.00	0.00
marital_status	-0.56 *	-0.39	-0.51 *	-0.29	-0.45	-0.43	-0.43	-0.35
education	-0.04	-0.03	-0.04	-0.01	-0.03	-0.03	-0.03	-0.01
agri_education	-0.04	-0.12	-0.04	-0.21	-0.06	-0.08	-0.06	-0.13
no_families	-0.05	-0.09	-0.05	-0.06	-0.12	-0.11	-0.11	-0.08
family_member	-0.03	-0.01	-0.04	-0.01	-0.01	-0.01	-0.02	-0.02
remittances	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
uaa_renting_ratio	0.71	2.78	1.11	2.48	1.96	1.65	2.04	1.28
rangeland_ratio	1.75	2.00 *	1.20	2.35 **	1.89 *	1.75	1.52	1.87 *
perm_crop_ratio	-0.56	-0.60	-0.55	-0.41	-0.49	-0.44	-0.49	-0.22
plot_distance_farm	0.01	-0.01	0.01	-0.03	-0.01	-0.01	-0.01	-0.03 *
plot_distance_market	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00
irrigated_uaa_ratio	-0.16	-0.79 *	-0.21	-0.73 *	-0.75 *	-0.72 *	-0.70 *	-0.61
prod_livestock_ratio	-1.58 ***	-1.35 ***	-1.47 ***	-1.29 ***	-1.42 ***	-1.39 ***	-1.37 ***	-1.34 ***
commercialization_ratio	-0.31	-0.02	-0.29	0.05	-0.08	-0.08	-0.10	-0.05
non_agr_income_ratio	0.05 *	0.04	0.05 **	0.03	0.03	0.03	0.03	0.02
support_dum	0.24	0.12	0.21	0.09	0.18	0.17	0.17	0.18
Region 2	-0.28	-0.13	-0.18	-0.07	-0.17	-0.20	-0.12	-0.08
Region 3	-0.17	-0.16	-0.13	-0.11	-0.18	-0.22	-0.16	-0.12
plot_cropped_no		-0.16 ***		-0.69 ***	-0.18 ***	-0.29	-0.15 **	-0.74 ***
plot_cropped_no_sq				0.09 ***				0.10 ***
no_diffcrop_perplot_w	0.10		-1.33 *		0.16	-0.04	-0.75	-0.59
no_diffcrop_perplot_w_sq			0.40 **				0.25	0.23
no_diffcrop_perplot_noplot						0.07		

Table 3A. Estimated results for arable crop farms (Dependent variable: farm inefficiency)

	M1	M2	M3	M4	M5	M6	M7	M8
gender	-0.82	-0.89	-0.58	-0.92	-0.90	-0.79	-0.62	-0.65
age	-0.01	-0.01	-0.01	0.00	-0.01	-0.01	-0.01	-0.01
marital_status	0.90 *	1.00 **	0.97 **	1.06 **	0.99 **	0.93 *	1.00 **	1.05 **
education	0.10 **	0.10 **	0.10 **	0.10 **	0.10 **	0.09 **	0.10 **	0.10 **
agri_education	-0.34	-0.39	-0.33	-0.37	-0.38	-0.36	-0.34	-0.34
no_families	-0.10	-0.09	-0.14	-0.10	-0.09	-0.11	-0.14	-0.14
family_member	-0.17 **	-0.17 **	-0.19 ***	-0.17 **	-0.17 **	-0.16 **	-0.19 ***	-0.19 ***
remittances	0.01 **	0.01 ***	0.01 **	0.01 ***	0.01 ***	0.01 **	0.01 **	0.01 **
uaa_renting_ratio	-0.15	-0.35	-0.04	-0.58	-0.39	-0.26	-0.13	-0.30
rangeland_ratio	1.75	1.76	1.11	1.80	1.79	1.75	1.15	1.20
perm_crop_ratio	-2.49 **	-2.40 **	-2.46 **	-2.40 **	-2.42 **	-2.55 **	-2.44 **	-2.43 **
plot_distance_farm	-0.04	-0.04	-0.06	-0.05	-0.04	-0.04	-0.06	-0.06
plot_distance_market	0.03 *	0.03 *	0.03 *	0.03 **	0.03 *	0.03 *	0.03 *	0.03 **
irrigated_uaa_ratio	0.67	0.73	0.74	0.84	0.72	0.85	0.76	0.83
prod_livestock_ratio	-3.61 ***	-3.51 ***	-3.41 ***	-3.48 ***	-3.51 ***	-3.47 ***	-3.39 ***	-3.37 ***
commercialization_ratio	0.12	0.02	0.06	-0.05	0.02	0.08	0.02	-0.03
non_agr_income_ratio	0.51	0.51	0.56	0.51	0.51	0.44	0.56	0.56
support_dum	0.61	0.68	0.57	0.65	0.67	0.68	0.59	0.58
Region 2	0.30	0.29	0.37	0.30	0.30	0.39	0.37	0.37
Region 3	0.07	-0.03	0.08	-0.03	-0.01	0.00	0.05	0.05
plot_cropped_no		-0.07		-0.30	-0.07	0.24	-0.03	-0.19
plot_cropped_no_sq				0.03				0.02
no_diffcrop_perplot_w	-0.08		-3.05 **		-0.05	0.51	-2.92 **	-2.77 *
no_diffcrop_perplot_w_sq			0.81 **				0.78 **	0.74 *
no_diffcrop_perplot_noplot						-0.19		

Table 4A. Estimated results for fruit tree farms (Dependent variable: farm inefficiency)

	M1	M2	M3	M4	M5	M6	M7	M8
gender	2.38 ***	2.25 ***	2.35 ***	2.23 ***	2.17 ***	2.15 ***	2.17 ***	2.16 ***
age	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
marital_status	-2.98 ***	-2.92 ***	-2.93 ***	-2.90 ***	-2.88 ***	-2.88 ***	-2.87 ***	-2.86 ***
education	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00
agri_education	-0.07	-0.03	-0.09	-0.03	-0.03	-0.03	-0.03	-0.03
no_families	0.02	0.08	0.01	0.07	0.06	0.08	0.06	0.05
family_member	0.04	0.04	0.04	0.04	0.05	0.04	0.05	0.05
remittances	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
uaa_renting_ratio	-1.50	-1.32	-1.60	-1.28	-1.48	-1.35	-1.51	-1.47
rangeland_ratio	-1.00	-1.08	-1.05	-1.08	-1.27	-1.23	-1.27	-1.27
perm_crop_ratio	-1.22 ***	-1.24 ***	-1.24 ***	-1.24 ***	-1.35 ***	-1.33 ***	-1.35 ***	-1.35 ***
plot_distance_farm	-0.02	-0.03	-0.02	-0.03	-0.03	-0.03	-0.03	-0.03
plot_distance_market	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
irrigated_uaa_ratio	-0.64	-0.62	-0.64	-0.62	-0.64	-0.68	-0.64	-0.64
prod_livestock_ratio	-1.71 ***	-1.65 **	-1.68 **	-1.64 **	-1.60 **	-1.64 **	-1.59 **	-1.58 **
commercialization_ratio	-0.79 **	-0.74 *	-0.80 **	-0.72 *	-0.75 *	-0.73 *	-0.76 *	-0.74 *
non_agr_income_ratio	0.02	0.02	0.03	0.02	0.02	0.02	0.02	0.02
support_dum	1.77 ***	1.80 ***	1.79 ***	1.81 ***	1.81 ***	1.82 ***	1.81 ***	1.82 ***
Region 2	-0.51	-0.59 *	-0.49	-0.59 *	-0.58 *	-0.56 *	-0.58 *	-0.57 *
Region 3	-0.45	-0.57 *	-0.49	-0.57 *	-0.56 *	-0.49	-0.56 *	-0.56 *
plot_cropped_no		-0.08		-0.12	-0.08	-0.27	-0.08	-0.11
plot_cropped_no_sq				0.00				0.00
no_diffcrop_perplot_w	-0.24		-1.11		-0.24	-0.71	-0.52	-0.47
no_diffcrop_perplot_w_sq			0.28				0.09	0.08
no_diffcrop_perplot_noplot						0.16		

Table 5A. Estimated results for subsistence farms (Dependent variable: farm inefficiency)

	M1	M2	M3	M4	M5	M6	M7	M8
gender	0.07	0.18	0.09	0.09	0.19	0.21	0.19	0.05
age	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
marital_status	-0.34	-0.31	-0.29	-0.20	-0.33	-0.40	-0.29	-0.16
education	-0.02	-0.03	0.00	-0.03	-0.02	-0.03	-0.01	-0.01
agri_education	-0.14	-0.06	-0.17	-0.12	-0.07	-0.04	-0.10	-0.09
no_families	0.02	-0.01	-0.04	-0.15	-0.02	-0.06	-0.06	-0.16
family_member	-0.02	0.02	-0.01	0.01	0.03	0.04	0.03	0.02
remittances	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
uaa_renting_ratio	-0.07	-0.33	-0.18	-0.42	-0.40	-0.45	-0.44	-0.51
rangeland_ratio	0.01	0.08	0.11	0.17	0.04	-0.09	0.11	0.13
perm_crop_ratio	-1.40 **	-1.06 **	-1.47 ***	-0.76	-1.07 **	-0.97 *	-1.16 **	-0.94 *
plot_distance_farm	-0.01	-0.02	-0.02	-0.02	-0.02	-0.01	-0.03	-0.03
plot_distance_market	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01
irrigated_uaa_ratio	-0.90 **	-0.82 **	-0.89 **	-0.71 *	-0.86 **	-0.86 **	-0.86 **	-0.55
prod_livestock_ratio	-2.15 ***	-2.03 ***	-2.07 ***	-1.89 ***	-2.01 ***	-2.06 ***	-1.96 ***	-1.84 ***
commercialization_ratio	0.00	-0.05	0.08	-0.03	-0.02	0.04	0.04	-0.06
non_agr_income_ratio	0.17 *	0.14	0.17 *	0.13	0.15	0.13	0.16 *	0.14
support_dum	0.24	0.31	0.27	0.30	0.31	0.35	0.33	0.24
Region 2	-0.67 ***	-0.81 ***	-0.64 ***	-0.73 ***	-0.82 ***	-0.83 ***	-0.79 ***	-0.65 ***
Region 3	-0.43 **	-0.74 ***	-0.48 ***	-0.73 ***	-0.76 ***	-0.73 ***	-0.77 ***	-0.74 ***
plot_cropped_no		-0.17 ***		-0.63 ***	-0.19 ***	-0.45 ***	-0.17 ***	-0.72 ***
plot_cropped_no_sq				0.05 ***				0.07 ***
no_diffcrop_perplot_w	-0.14		-2.45 ***		-0.07	-0.62 **	-1.77 **	-1.11
no_diffcrop_perplot_w_sq			0.61 ***				0.45 **	0.28
no_diffcrop_perplot_noplot						0.17 **		

Table 6A. Estimated results for livestock farms (Dependent variable: farm inefficiency)

	M1	M2	M3	M4	M5	M6	M7	M8
gender	0.04	-0.01	0.03	-0.01	0.04	0.04	0.03	0.03
age	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
marital_status	0.13 **	0.12 *	0.13 **	0.12 *	0.13 **	0.12 **	0.13 **	0.13 **
education	-0.01	-0.01	-0.01	0.00	-0.01	-0.01	-0.01	-0.01
agri_education	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03
no_families	-0.05	-0.06	-0.05	-0.04	-0.05	-0.05	-0.05	-0.05
family_member	-0.02 *	-0.01	-0.02 *	-0.02 *	-0.02 *	-0.02 *	-0.02 *	-0.02 *
remittances	0.00 *	0.00 *	0.00 *	0.00 *	0.00 *	0.00 *	0.00 *	0.00 *
uaa_renting_ratio	-0.06	-0.09	-0.05	-0.11	-0.05	-0.05	-0.05	-0.05
rangeland_ratio	1.97 ***	1.88 ***	1.96 ***	1.87 ***	1.96 ***	1.98 ***	1.96 ***	1.96 ***
perm_crop_ratio	-0.34 **	-0.50 ***	-0.34 **	-0.53 ***	-0.35 **	-0.35 **	-0.34 **	-0.34 **
plot_distance_farm	-0.05 ***	-0.04 **	-0.05 ***	-0.04 **	-0.04 **	-0.04 **	-0.05 **	-0.05 **
plot_distance_market	0.00 *	0.00	0.00 *	0.00	0.00 *	0.00 **	0.00 *	0.00 *
irrigated_uaa_ratio	-0.20 **	-0.13 *	-0.20 **	-0.14 *	-0.19 **	-0.18 **	-0.18 **	-0.19 **
prod_livestock_ratio	-0.64 ***	-0.68 ***	-0.65 ***	-0.69 ***	-0.65 ***	-0.65 ***	-0.65 ***	-0.65 ***
commercialization_ratio	0.02	0.07	0.02	0.08	0.03	0.02	0.03	0.02
non_agr_income_ratio	0.09 ***	0.08 ***	0.09 ***	0.08 ***	0.09 ***	0.09 ***	0.09 ***	0.09 ***
support_dum	-0.03	0.00	-0.03	-0.01	-0.03	-0.03	-0.04	-0.03
Region 2	-0.15 ***	-0.11 **	-0.15 ***	-0.11 **	-0.16 ***	-0.16 ***	-0.16 ***	-0.16 ***
Region 3	0.01	0.05	0.01	0.06	0.01	0.01	0.02	0.02
plot_cropped_no		-0.01		0.05	0.01	0.06	0.01	0.00
plot_cropped_no_sq				-0.01 *				0.00
no_diffcrop_perplot_w	0.16 ***		0.26		0.16 ***	0.27 **	0.26	0.26
no_diffcrop_perplot_w_sq			-0.03				-0.03	-0.03
no_diffcrop_perplot_noplot						-0.03		