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Land fragmentation and production diversification: A case study from rural Albania☆

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ABSTRACT

We analyze the impact of land fragmentation on production diversification in rural Albania. Albania represents a particularly interesting case for studying land fragmentation as the fragmentation is a direct outcome of land reforms. The results indicate that land fragmentation is an important driver of production diversification of farm households in Albania. We find that land fragmentation stimulates significantly more diversification for subsistence farm households than for market-oriented households. Our findings have two key policy implications: (i) the consolidation policies that relocate and enlarge plots would have a significant impact on reducing agricultural production diversification; and (ii) land fragmentation contributes to the nutritional security improvement by increasing the variety of foodstuffs produced by subsistence farm households.

1. Introduction

Many countries in Central and Eastern Europe (CEE) and the Commonwealth of Independent States (CIS) have implemented massive land reforms over the past decades[1] as part of the transition process from the centralized system to a market-driven economy. The reforms aimed, with varying degree, at transferring property rights from the state and collective ownership to private individuals. Fragmentation of land use, ownership, or both was an unintended effect of this reform process in several countries.

Albania implemented a radical land reform which led to one of the most fragmented land structures among CIS and CEE countries (Civici, 2003a,b). The causes of land fragmentation in Albania date back to the land privatization in 1991. Three main factors shaped farm structures in the country: (i) land distribution per capita, (ii) split of distributed land by its type (e.g., arable land, orchards, irrigation facilities), and (iii) land scarcity relative to the density of rural population. These factors led to both ownership and use fragmentation of land. Due to the rigid functioning of land markets and subsistence farming, land fragmentation still persists (Lusho and Papa, 1998; Cungu and Swinnen, 1999; Wandel et al., 2011; Deininger et al., 2012; Zhllima and Guri, 2013).

Although farmland fragmentation is mostly understood as a high number of farmed plots or as a high number of plot co-owners, it is a more complex phenomenon. It includes plot size, the shape of individual plots, the distance of plots from farm buildings, and distances between plots (Latruffe and Piet, 2013).

Because the quantification of several dimensions of land fragmentation simultaneously is challenging, most studies measure farmland fragmentation only based on one dimension (e.g., the number of plots or their average size) (e.g., Sichoongwe et al., 2014; Tana et al., 2010). If more than one dimension is considered, this is typically done using land fragmentation indices such as the Simpson or the Januszewski index (e.g., Blarel et al., 1992; Van Hung et al., 2007). However, these indices ignore critical spatial variables such as the shape of parcels as well as non-spatial variables, for example, ownership type and the existence or absence of road access to each land parcel.

Whether or not land fragmentation yields net benefits is not clear a priori because it may generate both positive and negative effects specific to each case considered. For example, more fragmented farmed plots are likely to enhance biodiversity, thus increasing the value the

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[1] The exceptions are, for example, Poland and the countries that emerged from former Yugoslavia. We thank an anonymous reviewer for pointing this out.

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society places on the landscape. On the other hand, the longer the distance a farmer needs to travel to reach a plot, the higher his or her direct (e.g., fuel) and opportunity costs (e.g., time spent) are which ultimately may affect farmers' performance and income. For example, the literature on land fragmentation in Central and Eastern Europe (e.g., Thomas, 2006; Sklenicka et al., 2009; Sikor et al., 2009), in general, finds that a high degree of agricultural land fragmentation hampers the emergence of a private commercial farming structure (Van Dijk, 2003) as well as the development of the agricultural sector and rural areas (Hartvigsen, 2014).

One aspect of the agricultural sector performance which land fragmentation may impact is the agricultural production diversification. There is a rich literature on farm diversification in agriculture. Two strands of research on diversification can be distinguished: (i) farm level and (ii) aggregate agricultural sector level (e.g., Bhattacharyya, 2008; Saraswati et al., 2011). Although both literatures seemingly address the same issue, the two strands of analysis are not equivalent. In fact, they may diverge, meaning that farms might be highly specialized in a given country, whereas the degree of diversification of the aggregate agricultural sector in the same country might be high. Pingali and Rosegrant (1995) argue that economic growth and commercialization of the agricultural sector lead to an increase in the diversity of marketed products at the aggregate country level, while they lead to increasing regional and farm level specialization. According to Bhattacharyya (2008) and Saraswati et al. (2011), important drivers of aggregate diversification are, among others, demand-side factors, rural infrastructure, and market institutions.

The main objective of this paper is to analyze the impact of land fragmentation on production diversification in Albania. We derive our econometric estimations from a survey of 1018 farm households in three Albanian regions in 2013. In this paper, we focus on the farm level production diversification. The main factors affecting farm production diversification identified in the literature include risk, crop rotation, cost complementarities, farm size, and production for household self-consumption (White and Irwin, 1972; Pope and Prescott, 1980; Benin et al., 2004; Culas, 2005; Bowman and Zilberman, 2013; Sichoongwe et al., 2014).

Empirical studies mostly focus on the relationship between diversification and farm size, yielding mixed results, however. For example, White and Irwin (1972) found that larger farms have less diversified production; on the other hand, Pope and Prescott (1980), Culas (2005), and Sichoongwe et al. (2014) find the opposite relationship. Weiss and Briglauer (2000) focus on the dynamics and the importance of off-farm employment for product diversification. They find that off-farm income reduces the degree of diversification; they also find that farms operated by older, less educated, part-time farmers show a lower degree of diversification and a stronger reduction in diversification over time. Empirical literature also finds different micro-level variables that affect diversification choices such as farm household characteristics, farm organization, technological changes, geographical location, labor, experience, wealth, and education (Benin et al., 2004; Culas, 2005; Sichoongwe et al., 2014).

Despite a considerable number of studies analyzing determinants of farm production diversification, few empirical studies estimate the relationship between land fragmentation and production diversification (Benin et al., 2004; Sichoongwe et al., 2014). Land fragmentation is often induced by policies (land reforms) and can have important implications for farmers' production choices and overall rural development. The available studies do not focus on policy-induced fragmentation and its impact on diversification. Moreover, the few available studies find mixed evidence. For example, Benin et al. (2004) found a positive impact of land fragmentation on cereal crop diversity in Ethiopia, but Sichoongwe et al. (2014) find a statistically insignificant impact of land fragmentation on the diversification among smallholders in Zambia.

Studies on land fragmentation in Albania analyzed the impact of fragmentation on the abandonment of cropland cultivation (Sikor et al., 2009) and productivity (Deininger et al., 2012) with mixed evidence and rather insignificant effects. 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.

Our paper has significant policy implications for land consolidation policies and rural nutritional security. State-regulated consolidation is often perceived as a key measure to tackle the land fragmentation problem with the expectation of generating productivity gains (Lusho and Papa, 1998). Land consolidation might be justifiable if land structure dispersed in many small plots constraints the functioning of land markets, and if it represents an impediment to productivity and efficiency gains. Although Deininger et al. (2012) do not find support for the argument that fragmentation reduces productivity in Albania, our results suggest that one of the important associations of land fragmentation could be diversification of farm production activities. If this is the case, then land consolidation policies may have indirect consequences for farmer's production structure choices, potentially contributing to the specialization of production into a smaller number of products. On the other hand, land fragmentation may contribute to the provision of a less expensive and more heterogeneous food basket to subsistence farmers, thus contributing to the nutritional security of rural households in Albania.

2. Land reform in Albania

Three waves of radical land reforms were implemented in Albania during the last century: (i) land reforms before the World War II, (ii) collectivization, and (iii) the land reform of 1991 (decollectivization). These reforms produced opposing effects on farming systems and land structures. The first reform aimed at redistributing land from big landlords to rural peasants as a means of correcting the huge ownership inequality inherited from the Ottoman Empire (Civici, 2003a,b). However, this reform succeeded only partially in redistributing the land as most of the land remained under the control of big landowners. Following other communist regimes in the region, Albania implemented a large-scale collectivization and nationalization process of land after the World War II. By 1976, most land was either in state or collective ownership, and agricultural production was organized in large farming conglomerates (cooperatives and state farms) with an average size of more than 1,000 ha (Civici, 1997; Guri et al., 2011).

Collectivization of land led to the collapse of the Albanian agricultural sector. There were serious shortages of basic foodstuffs, causing widespread discontent in the general population (Cungu and Swinnen, 1999). Food shortage and inefficiencies associated with the state and collective ownership of assets generated pressure for decollectivization and the introduction of private property after the fall of the communist regime in 1990 (de Waal, 2004). Under these pressures, third radical land reform was implemented in 1991. The reform process pursued the principle of social equity among rural population (Guri et al., 2011). This is in contrast to the reform approach implemented in most other CEE countries which also attempted to correct the historical injustice of expropriation of private properties during the communist regime (Civici, 2003a,b).

The privatization process distributed land in the same quantity and quality to all rural inhabitants. The reform was implemented at the village level where a land distribution committee, elected by villagers, was responsible for carrying out the distribution. The reform distributed more than 700,000 ha of agricultural land, previously controlled by the state and collective farms, to 490,000 families living in the rural areas. The decollectivization process was not applied in the same way in all areas. In northern regions, the expropriated owners received back all their land. In other regions, where the equity rule was

applied, a farm structure dominated by small farms (1 ha on average), high level of fragmentation (3–5 plots by farms), and the land insecurity[2] resulted in the agricultural sector being in a stand-off situation in terms of productivity and investments. Thus, in less than thirty years (1976–1991) agricultural land in Albania changed its legal status from full state ownership to private ownership and became fragmented.

3. Conceptual framework and hypotheses

3.1. Determinates of production diversification

Farm production diversification refers to farm choices about the number of activities carried out on the farm. A rational farm household chooses a production structure that maximizes household's utility. Adding a production line to farm operation induces both costs and benefits. Other things being equal, if the benefit is larger than the opportunity cost of resource use in an alternative activity, a farmer will have an incentive to expand the production structure.

There are several factors which may affect farms' production choices and determine the degree of production structure diversity (e.g., risk, economies of scope, farm size, market access, land fragmentation, and household characteristics). A key driver of diversification extensively analyzed in the literature is linked to the strategy of farms to cope with risk. Diversification can be instrumental in reducing the overall production risk if farm selects a mixture of activities with negatively correlated performance. As a result, in a risky environment, risk-averse farmers will tend to diversify their production more compared to a more stable environment (Bowman and Zilberman, 2013).

Production diversification could be a result of economies of scope, that is, when it is more profitable to produce several goods jointly instead of producing each of them separately. For example, this effect can be a result of crop rotation. Crops are usually cultivated in different rotation systems where a series of different crops are grown on the same area in sequential multi-year periods. The crop rotation enriches nutrient quality of soil which increases the overall farm productivity. The crop rotation affects the number of crops grown on the farm, thus also determining production diversification. The number of crops rotated depends on the rotation system which may differ across farms and regions due to soil quality differences and farm specialization (e.g., cereal *versus* horticultural specialization) (e.g., Weiss and Briglauer, 2000).

The economies of scope may also emerge due to cost complementarities. The cost complementarity refers to a situation when the marginal costs are lower for a production activity once the input factors have been used for the production of others. This could be the case when different products have different timing of tasks through the growing season which allows more efficient use of farm resources throughout the season (e.g., machinery and labor). A similar complementary effect may exist when farms combine crop and livestock production. The benefit of combined production can go both ways from livestock to crop production and *vice versa*. The livestock can provide manure which enriches nutrient quality of farmland, whereas crop production may supply crop residues as fodder for livestock feeding. In both cases, input costs are reduced hence stimulating more diversified operation (Weiss and Briglauer, 2000).

Farm size could also be an important determinant of product diversification. Larger farms may increase production diversity by increasing the capacity of households to allocate land to try out other crops and varieties (Benin et al., 2004).

Land fragmentation is an additional factor that may lead to a higher degree of production diversification because of efficiency-driven motives of farmers. Land fragmentation may cause more diversification particularly if plots have heterogeneous quality. A profit-maximizing farmer will allocate the land to its best use. Given that soil suitability differs among crops, the number of crops grown by a rational farmer will increase if plots are heterogeneous. According to Benin et al. (2004), the more heterogeneous plots a farmer has, the more he can diversify.

Benin et al. (2004) show that when consumption and production of household decision-making are non-separable (i.e., in the presence of markets imperfections), the diversity of production is affected not only by farm-related characteristics (e.g., those mentioned above), as it would be in the case of a market-oriented commercial farmers, but also by household-specific characteristics and by other factors related to the costs of transacting in markets such as household size, age, education, and market access.

3.2. Causes of land fragmentation in Albania

Land fragmentation is very significant in Albania and is a direct outcome of the land reform of 1991. The reform caused the split of land into many small plots of heterogeneous quality. This effect was determined by the egalitarian principle applied to the land distribution. The land distribution aimed to ensure that all households in a given village receive land of the same quality and quantity per head of household member.

The land distribution was implemented at village level in Albania, and the land availability per village determined how much land could be distributed. Three main criteria were used to differentiate land quality: (i) land type (e.g., arable land, olives groves, vineyards, vegetable gardens near the house), (ii) location (the distance from household house or village), and (iii) physical condition of land (e.g., flat, and mountainous land, irrigation facilities, fertility). Each household was allocated a set of plots of different quality, depending on the number of household members. First, the size of land parcels was defined in different quality groups at the village level. The per capita plot size of each quality group was determined by the total available area of the given quality and the number of eligible persons. Then the number of eligible family members determined the size of agricultural land and sometimes even the number of plots that each household was allocated. The head of the household was recognized as the official owner of the land. The final outcome of the reform was that land parcels were distributed to each household in different sizes, qualities, and places, usually scattered throughout the village (Lusho and Papa, 1998).

Table 1 reports the land fragmentation after completion of the land reform process in Albania in 1993–1994. Before the implementation of the 1991 land reform, the land was controlled by 420 collective and state farms with an average farm size greater than 1,000 ha. After the reform, the land was split in approximately 1.9 million small parcels owned by 490,000 households, with an average area of 0.25 ha per parcel and with an average of about 3.3 separately located parcels per each farm household. The average farm size was around 1 ha (Grace, 1995; Cungu and Swinnen, 1998; MoAFCP, 2011; Zhllima and Guri, 2013).

From a political economy point of view, the dispersal of land into several parcels may originate from individual and community decisions and political support for this type of reform in reaction to the socio-economic environment present in Albania (Sikor et al., 2009). In an unstable environment of the transition period and food insecurity, land fragmentation may be desired by the population as it may contribute to the less expensive supply of a more diversified basket of food for household self-consumption. Indeed, Cungu and Swinnen (1999) argue that rural households (as opposed to former landowners and rural nomenklatura)[3] was the actual group which determined the political choice of full distribution of land given that this stratum represented

[2] The former landlords still claim their land because they have not been compensated for their property loss until now.

[3] Rural nomenklatura includes communist leaders and former state farms' managers (Cungu and Swinnen, 1999).

Table 1
Land indicators in Albania (1993–2012).
Source: Calculated based on the data from Grace (1995), (MoAFCP, 2011; INSTAT, 2012).

Fragmentation indicators	Unit	1993–1994	2004	2012
Average farm size	hectare	1	1.13	1.20
Average plot size	hectare	0.2 − 0.3	0.20	0.26
Average number of parcels/farm		3.3	4.5	4.9
Private farms with < 1 ha	%	n/a	45.53	54.44
Total number of farms	million	0.49	0.37	0.35
Total number of parcels	million	1.9	1.65	1.7

the majority of rural population and was the one with the lowest income and the one able to increase agricultural output in a relatively short period.

As Table 1 shows the land fragmentation caused by the 1991 land reform remained largely unchanged until present days with minimal changes taking place since its completion in 1994 (Grace 1995; Cungu and Swinnen, 1998; MoAFCP, 2011; Zhllima and Guri, 2013). One main reason that may explain the persistence of land fragmentation and the minimal change in the Albanian land structure is a dysfunctional land market. Well-functioning land markets may facilitate the exchange of land between rural households and may remedy (at least) partially the problem of fragmentation induced by land policies. However, rental and sale markets are very thin in Albania. Land renting represents only around 10 percent of the total land (Swinnen et al., 2006). Qineti et al. (2015) report a 15-percent land renting rate based on a survey conducted in four villages in Albania in 2013. However, the vast majority of rental arrangements happen among family relatives (more than 70 percent of rented land). Sale markets hardly exist in Albania. Most of them developed in the coastal and suburb areas for urbanization purposes (Guri, 2008). Less than 3 percent of the total agricultural land was exchanged through sales between households since the end of the privatization process in the early 1990s (Qineti et al., 2015). Qineti et al. (2015) also report that in the surveyed villages more than 88 percent of land in 2013 had the same owner who received it through the land reform in the period 1991–1993. Similarly, Deininger et al. (2012) report 7 percent of land sales, whereas land acquisition through privatization and inheritance represents 70 and 30 percent, respectively, based on the 2005 Albanian Living Standards Survey.

While rigid land markets may contribute to the persistence of fragmented land structure in Albania, subsistence farming and self-consumption of farm products may have also contributed to the persistence of this situation until present days. The unstable socio-economic environment of the transition period characterized by high unemployment rate may have motivated farm household to keep land received through the land reform process for food security reasons instead of disposing it on land markets (i.e., on sale or rental markets) (Sikor et al. (2009); UNDP, 2013). Further, the distribution of plots of heterogeneous quality through the 1991 land reform allowed subsistence farm household to operate a more diversified production to satisfy household nutrient requirements which also might have prevented exchanging it on land markets.

The emergence of subsistence farming in Albania was an outcome of the missing job opportunities, particularly in rural areas. Macours and Swinnen (2002) argue that in transition countries farmers' labor opportunity costs decreased as economic transition involved closing unprofitable enterprises. This was primarily the case in Albania where the performance of the labor market (especially in rural areas) was lagging behind other transition countries (Çuka et al., 2003; UNDP, 2013). As the World Bank (2006) puts it, although "jobless growth" has been a regional problem, Albania stands out among transition countries with a poor job creation record but apparently strong output growth. The low labor opportunity costs were reinforced by weak social security provisions (e.g., unemployment benefits, pensions) in transition countries (including in Albania) (Kostov and Lingard, 2002; Mathijs and Noev, 2004; Çuka et al., 2003). As a result, this restricted the labor outflow out of agriculture and favored the emergence of the subsistence type farming based on labor-intensive production aiming mainly at securing the availability of food for household consumption.

4. Methodology and data

The answer to the key question of this paper requires quantification of land fragmentation and production diversification in rural Albania. We quantify both categories by calculating the Simpson's index for each household in our database. The Simpson's index can be expressed as (e.g., Tan et al., 2008, Monchuk et al., 2010)

$$S = 1 - \sum_{i=1}^{N} a_i^2 \Big/ \left(\sum_{i=1}^{N} a_i\right)^2, \quad (1)$$

where a_i is the value of a product i that a household produces, and N is the number of products. Likewise, for land fragmentation, a_i is the area of plot i and N is the total number of plots. The value of the index varies between zero and one, with a larger value indicating more diversity (greater land fragmentation). We use the land fragmentation index together with other control variables in a regression model to investigate their relationship with product diversification.

The linear regression model we use takes the form

$$y_j = \alpha + \beta x_{1j} + \gamma x + \varepsilon_j, \quad (2)$$

where y_j denotes the production diversification of household j (dependent variable); α is the intercept; x_{1j} denotes land fragmentation of household j; the parameterβ measures by how many percentage points the index of production diversity changes if the index of fragmentation increases by one percentage point[4]; and $\boldsymbol{x}$ is the vector of control variables in the model with corresponding regression coefficients grouped in the vector γ. The residuals ε_j are assumed to be independent and identically distributed. We use OLS with White heteroscedasticity-consistent standard errors to estimate the coefficients of model (2). Because the index is bordered by 0 and 1, we also use the tobit model to estimate regression (2). As we show later in the results section, the values of estimated parameters change minimally compared to OLS, and the signs do not change at all.

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 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. 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. Fig. 1 shows the selected regions and the sample distribution among different municipalities of each region (Guri et al., 2015).

According to Benin et al. (2004), when consumption and production of household decision-making is non-separable, the household production choices are affected by both farm- and household-specific characteristics. The former characteristics include land fragmentation index, irrigated area, livestock production share, plot distance from market, and plot distance from the household house (Table 2).

The explanatory variables capturing household-specific characteristics in our model are number of household members, age and education of household head, non-agricultural income, loan repayment, and variables measuring households' self-consumption of own produced products. We also consider district dummies to take into account other region-specific drivers of production diversification (e.g., agronomic conditions, soil quality, or infrastructure).

[4] The values of the Simpson's index vary between zero and one, or if multiplied by 100, between zero and 100 percent. A change in the index value in our model is, therefore, measured in percentage points and not in percentages.

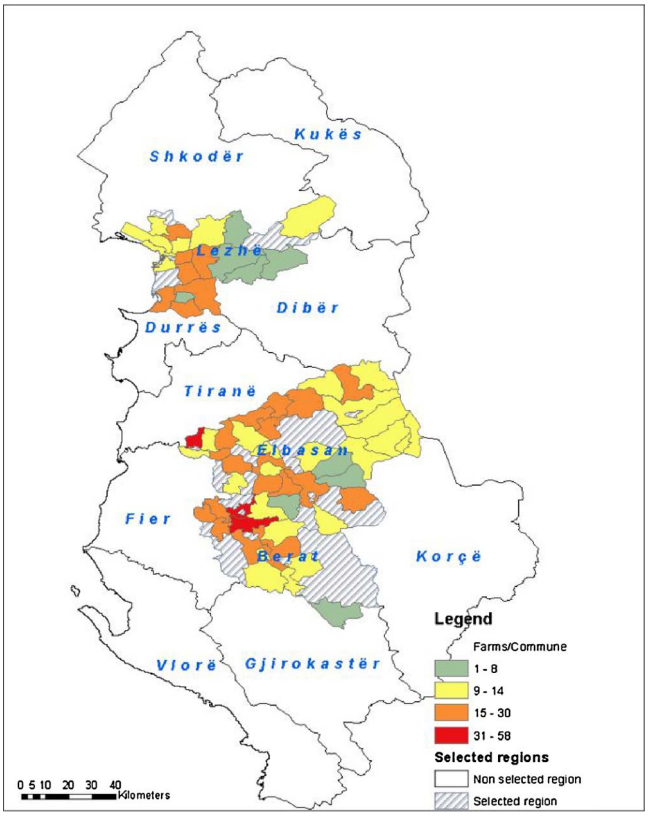

Fig. 1. Sample distribution in commune level.
Source: Guri et al. (2015)

The main variable of interest in our model is the land fragmentation index. A positive estimated coefficient associated with it would indicate that the production diversification increases with the more fragmented land. The second variable of interest is self-consumption of farm products and its interaction with land fragmentation. For this reason, we include two distinct variables to measure the food self-consumption: the share of self-consumption of food in total household agricultural production (*self-consumption share in HH agricultural production*) and the share of self-consumption of food in total household income (*self-consumption share in HH income*).

The interaction variables measure the extent to which land fragmentation (i.e., the number of plots and their areas) together with the food demand of households stimulate production diversification. A positive coefficient for these interaction variables would indicate that households whose land is more fragmented and who have a higher self-consumption share of farm products have more diversified production structure. Since the size of the household may also capture the effect of self-consumption, we include a model in which we interact land fragmentation with the number of household members. In total, we estimate five models the results of which are presented in Table 5 for OLS regression and in Table 6 for tobit regression.

According to the descriptive statistics reported in Table 2, the average Simpson's index for diversification of farm production in our sample is 0.656 and for land fragmentation 0.585. Households have 4.8 members on average but the household size can go as high as 14 members given that households often include extended family relatives. The average age of the head of household is 59 years and varies between 18 and 92 years. The average duration of education of household head is 8.7 years. Non-agricultural income comprises only 6 percent of the total household income. Loan payments are insignificant, representing less than 1 percent of the total household expenditures. On average, the irrigated area represents 0.35 ha, and the share of livestock production is relatively sizable at 33 percent in the total agricultural production.

Appendix A and Appendix B show descriptive statistics for households with a smaller and larger number of plots. The median number of plots in our sample is four, and the maximum is ten. Appendix A, therefore, presents descriptive statistics for farms with one to four plots and Appendix B for farms with five to ten plots.

Summary statistics on land fragmentation indicators for the surveyed farm households are reported in Table 3. The land use fragmentation is visible from small average farm size and relatively large number of small plots per farm in the study villages. The average farm size is 1.16 ha, and it varies between 0.02 and 19.7 ha. The average number of plots per farm is 3.7 and goes as high as ten plots per household with an average size of 0.32 ha per plot.[5]

Following the implementation of the 1991 land reform, households with more members were allocated more (parcels of) land. According to the survey data depicted in Fig. 2, a household with one member uses on average 2.3 plots, whereas a household with 14 members uses more than twice as many, 6.3 plots. The average size of plots slightly decreases with the number of household members: from an average of 0.6 ha for a household with one member to an average of 0.23 ha for a household of 14. Larger households also tend to operate a larger farm which is a direct outcome of the per capita land distribution principle of the 1991 reform (Fig. 2).

Similar correlations are visible for the number of plots reported Fig. 3. More plots are associated with larger households, whereas households using fewer plots have larger plots on average. Households with fewer plots operate smaller farms.

The dispersion of plots from the household house is quite significant. On average, plots are located 1.39 kilometers away from the household house; for some farms, the distance goes up to 70 kilometers. The average distance of plots to the nearest marketplace is 10 kilometers and varies between 0 and 73 kilometers (Table 3).

Farm production is well diversified in the surveyed households. Farmers carry out on average 5.8 production activities. The maximum amount of products is 12 (Fig. 2). Most common products include fruits and vegetables, wheat, olives, milk, and meat. Households with a larger number of members have on average more products (3.9 products for a household with one member *versus* 7.3 products for households with 14 members) (Table 3) and households with more plots have on average a larger number of products (four products in household with one plot *versus* 11 products in households with ten plots) (Fig. 3).

One of the primary purposes of agricultural production represents the provision of food to own household members in the surveyed households. According to the results reported in Table 4, own food consumption represents 27 percent of the total agricultural production and 25 percent of the total household income. Food is a key item in total household expenditures. Households devote 55 percent of their total income to food consumption. Out of the total household food consumption, 45 percent comes from own production. The heterogeneity of households is extensive for all consumption indicators reported in Table 4. Households vary from being entirely self-sufficient (i.e., producing only for household self-consumption) to being fully market-oriented (i.e., selling the whole production on the market).

5. Results

We present the estimation results of regression (2) in Table 5 for OLS regression and in Table 6 for tobit regression and focus on the interpretation of the parameters of model specification 1. The remaining models are variations of it and differ in including alternative interaction terms.[6]

[5] Both farm and plot size are consistent with the country average reported in Table 1.

[6] We consider interaction terms in the tobit regression to provide a robustness check of the OLS estimation. However, these estimates need to be analyzed with caution because tobit regression suffers from some shortcomings when introducing interaction terms. The magnitude of the interaction effect does not equal the coefficient on the interaction term, can be of opposite sign, and is conditional on all the independent variables (Ai and Norton, 2003).

Table 2
Descriptive statistics.

Variable	Description	Unit	Mean	Std. dev.	Min	Max
Dependent variable						
Simpson's index of diversification			0.656	0.212	0.00	0.89
Farm-specific explanatory variables						
Simpson's index of fragmentation			0.585	0.205	0.00	0.86
Irrigated area	Surface of irrigated area	ha	0.35	0.52	0.00	10.00
Livestock production share	Share of livestock production value in total production value	%	0.33	0.23	0.00	0.92
Plot distance from market	Average distance of plots from the nearest market or product collection facility	km	10.06	9.23	0.00	73.00
Plot distance from HH house	Average plot distance from the farm center (from HH house)	km	1.39	3.21	0.00	70.00
HH-specific explanatory variables						
Number of HH members	Number of household members		4.78	1.83	1.00	14.00
Age of HH head	Age of household head	years	59.31	11.62	18.00	92.00
Education of HH head	Education of household head	years	8.73	2.73	4.00	17.00
Non-agricultural income	Share of non-agricultural income in total income	%	0.06	0.16	0.00	0.98
Loan repayment	Share of total HH expenses that is used to repay the loans	%	0.00	0.01	0.00	0.20
Self-consumption share in HH agricultural production	Share of self-consumption of food in total HH agricultural production	%	0.27	0.21	0.00	1.00
Self-consumption share in HH income	Share of self-consumption of food in total HH income		0.25	0.21	0.00	1.00
(Index of land fragmentation) x (Self-consumption share in HH agricultural production)	Interaction variable		0.15	0.12	0.00	0.74
(Index of land fragmentation) x (Self-consumption share in HH income)	Interaction variable		0.14	0.11	0.00	0.74
(Index of land fragmentation) x (Number of HH members)	Interaction variable		2.87	1.59	0.00	12.25
Districts						
Kuçove	Dummy variable for Kuçove		0.06	0.23	0.00	1.00
Skrapar	Dummy variable for Skrapar		0.05	0.21	0.00	1.00
Elbasan	Dummy variable for Elbasan		0.22	0.41	0.00	1.00
Gramsh	Dummy variable for Gramsh		0.07	0.26	0.00	1.00
Librazhd	Dummy variable for Librazhd		0.10	0.30	0.00	1.00
Peqin	Dummy variable for Peqin		0.10	0.30	0.00	1.00
Kurbin	Dummy variable for Kurbin		0.07	0.26	0.00	1.00
Lezhë	Dummy variable for Lezhë		0.12	0.32	0.00	1.00
Mirdite	Dummy variable for Mirdite		0.06	0.23	0.00	1.00
Berat	Benchmark district		0.16	0.37	0.00	1.00

Notes: HH: household.

Table 3
Land fragmentation and diversification (survey results).

	Mean	Std. Dev.	Min	Max
UAA (ha)	1.16	0.94	0.02	19.70
Rented in land (ha)	0.04	0.60	0.00	18.00
Rented out land (ha)	0.02	0.14	0.00	1.90
Owned UAA (ha)	1.12	0.71	0.00	4.50
Average plot size (ha)	0.32	0.26	0.02	3.94
Share of rented in area on UAA (%)	0.02	0.10	0.00	1.00
Share of rented out area on UAA (%)	0.02	0.09	0.00	1.00
Share of own area on UAA (%)	0.98	0.10	0.00	1.00
Number of plots per household	3.68	1.57	1.00	10.00
Average distance of plots from the farmer house (km)	1.39	3.21	0.00	70.00
Average distance of plots from the nearest market (km)	10.06	9.23	0.00	73.00
Total number of products	5.84	2.20	1.00	12.00

Note: The number of observations in all cases is 1018.

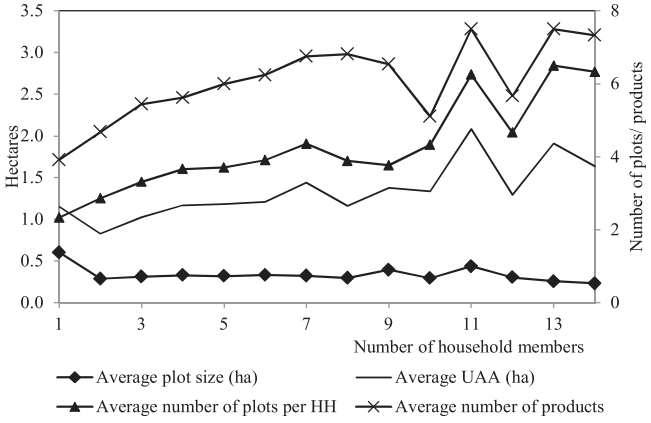

Fig. 2. Number of HH members and average values of selected HH characteristics.
Notes: HH: Household

The positive and highly significant coefficient of 0.45 for land fragmentation in OLS regression indicates that greater land fragmentation is associated with greater diversification of farm production. More specifically, if the value of the index of fragmentation increases by one percentage point, the index measuring product diversification is expected to increase on average by 0.45 percentage points (Table 5). The tobit regression results provide similar magnitude of the impact of land fragmentation on production diversification, i.e. 0.47 (Table 6). These results suggest that households with a more fragmented land are likely to produce more types of different products. As explained above,

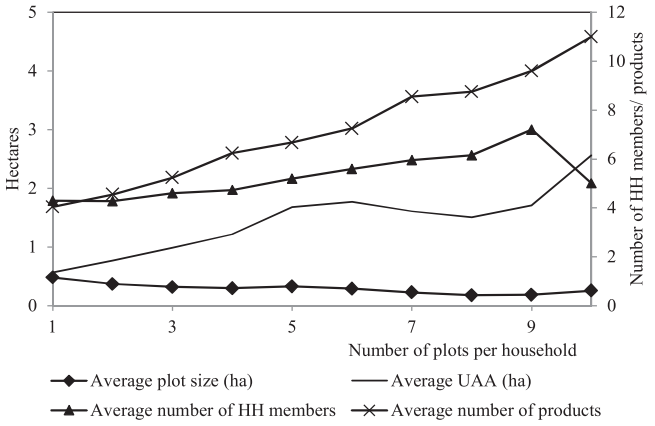

Fig. 3. Number of plots per HH and average values of selected HH characteristics.
Notes: HH: Household

Table 4
Self-consumption food (survey results).

	Mean	Std. Dev.	Min	Max
Food consumption in total HH income (%)	0.55	0.19	0.01	1.00
Self-consumption of food in total HH income (%)	0.25	0.21	0.00	1.00
Self-consumption of food in total HH food consumption (%)	0.45	0.27	0.00	1.00
Self-consumption of food in total HH agricultural production (%)	0.27	0.21	0.00	1.00

Note: The number of observations in all cases is 1018. HH: household.

this could be driven by efficiency reasons or subsistence motives. The efficiency motives could be determined by the profit maximization behavior leading to the allocation of land to its best use, thus causing a more heterogeneous production structure when household land is split into more and heterogeneous plots. The subsistence motive is driven by the food demand for household self-consumption.

A variation in the share of self-consumption in agricultural production does not directly translate into the more diverse composition of production. This result holds for all model specifications, except the second one in tobit regression where the effect it is negative (Tables 5 and 6).

However, self-consumption measured by the share in agricultural production appears to interact with land fragmentation as suggested by both OLS and tobit regressions (see model 2), while the interaction between the self-consumption share in household income and land fragmentation is statistically significant only in the tobit regression (model 4) (Tables 5 and 6). The positive value of the interaction terms means that a higher household's share of self-consumption in agricultural production or in household income increase the rate at which land fragmentation affects production diversity (Tables 5 and 6). We can use our OLS regression model to illustrate the meaning of the interaction term parameter in model specification 2. If the share of household's self-consumption in agricultural production increases by 0.01 to 0.28 (from the sample average value of 0.27) (Table 2), while the Simpson's index of land fragmentation stays fixed at the sample average value of 0.59 (Table 2), then the interaction term is expected to increase by $0.321 * 0.59 * (0.28 - 0.27) = 0.002$. Similarly, if the Simpson's index of land fragmentation increases by one decimal point to 0.60 from the sample average value of 0.59, while the share household's self-consumption stays fixed at the sample average, 0.27, then the interaction term is expected to increase by

Table 5
OLS regression results (dependent variable: Simpson's index of production diversification).

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Simpson's index of fragmentation	0.450***	0.363***	0.450***	0.399***	0.509***
Self-consumption share in HH agricultural production	0.033	−0.119			
(Index of land fragmentation) x (Self-consumption share in HH agricultural production)		0.321**			
Self-consumption share in HH income			0.044	−0.056	
(Index of land fragmentation) x (Self-consumption share in HH income)				0.209	
Number of HH members	−0.001	−0.001	−0.001	−0.001	0.007
(Index of land fragmentation) x (Number of HH members)					−0.014
Age of HH head	−0.000	−0.000	−0.000	−0.000	−0.000
Education of HH head	0.003	0.002	0.003	0.002	0.002
Non agric. income	0.002	0.007	0.019	0.019	0.006
Loan repayment	−0.006	−0.005	−0.006	−0.006	−0.007
Irrigated area	0.022***	0.024***	0.023***	0.024***	0.020***
Livestock production share	0.439***	0.437***	0.439***	0.439***	0.436***
Plot distance from market	−0.001	−0.001	−0.001	−0.001	−0.000
Plot distance from HH house	−0.004	−0.005*	−0.005	−0.005*	−0.004
Kuçove	0.029	0.022	0.030	0.026	0.026
Skrapar	0.069***	0.067***	0.069***	0.067***	0.069***
Elbasan	0.065***	0.060***	0.065***	0.062***	0.063***
Gramsh	0.011	0.007	0.012	0.008	0.011
Librazhd	0.060***	0.049**	0.059***	0.053***	0.065***
Peqin	0.070***	0.071***	0.070***	0.071***	0.070***
Kurbin	0.084***	0.084***	0.084***	0.084***	0.083***
Lezhë	0.134***	0.132***	0.134***	0.133***	0.135***
Mirdite	0.099***	0.099***	0.096***	0.096***	0.111***
Constant	0.184***	0.232***	0.182***	0.211***	0.159**
R-squared	0.526	0.532	0.526	0.529	0.526

Notes: *** Significant at 1%; ** Significant at 5% and * Significant at 10%.

Table 6
TOBIT regression results (dependent variable: Simpson's index of production diversification).

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Simpson's index of fragmentation	0.475***	0.374***	0.476***	0.417***	0.553***
Self-consumption share in HH agricultural production	0.029	−0.152***			
(Index of land fragmentation) x (Self-consumption share in HH agricultural production)		0.375***			
Self-consumption share in HH income			0.041	−0.077	
(Index of land fragmentation) x (Self-consumption share in HH income)				0.242**	
Number of HH members	−0.001	−0.001	−0.001	−0.001	0.010
(Index of land fragmentation) x (Number of HH members)					−0.017
Age of HH head	−0.000	−0.000	−0.000	−0.000	−0.000
Education of HH head	0.003	0.003	0.003	0.002	0.002
Non agric. income	0.002	0.007	0.016	0.016	0.004
Loan repayment	−0.006	−0.005	−0.006	−0.005	−0.007
Irrigated area	0.024**	0.025**	0.025**	0.025**	0.022**
Livestock production share	0.452***	0.450***	0.453***	0.452***	0.450***
Plot distance from market	−0.001	−0.001	−0.001	−0.001	−0.000
Plot distance from HH house	−0.004***	−0.005**	−0.005***	−0.005**	−0.004***
Kuçove	0.029	0.022	0.031	0.026	0.026
Skrapar	0.068**	0.066**	0.068**	0.066**	0.068**
Elbasan	0.069***	0.064***	0.070***	0.066***	0.068***
Gramsh	0.012	0.006	0.012	0.008	0.012
Librazhd	0.062***	0.051**	0.061***	0.054***	0.067***
Peqin	0.070***	0.071***	0.070***	0.070***	0.070***
Kurbin	0.085***	0.085***	0.085***	0.085***	0.084***
Lezhë	0.141***	0.139***	0.141***	0.140***	0.141***
Mirdite	0.105***	0.105***	0.100***	0.100***	0.114***
Constant	0.184***	0.216***	0.158***	0.192***	0.123**

Notes: *** Significant at 1%; ** Significant at 5% and * Significant at 10%.

$0.363 * (0.60 - 0.59) + 0.321 * (0.60 - 0.59) * 0.27 = 0.004$. The remaining interaction terms are not statistically significant (models 3, 4, and 5 in the OLS regression, and 3 and 5 in the tobit regression).

Irrigated area is positively related to the variability of household's production with each additional hectare of land under irrigation increasing the diversity of production by 0.02 percentage points (Tables 5 and 6). This finding shows that households that can irrigate their fields can grow a greater spectrum of crops. We also find a positive correlation between the share of livestock production in total agricultural production and the production diversification (Tables 5 and 6). Two effects are possible drivers of this result. First, cost complementarity effects of the mixed crop-livestock production might exist among the studied households, and, second, households might need to produce animal feed on the farm.

A larger distance of plots from the farmhouse (*plot distance from HH house*) corresponds to lower diversification likely because of the cost associated with operating a farm with a broader spread of plots from the farm center. This negative relationship between the distance of plots from the farmhouse and production diversification is statistically significant in all model specifications in the tobit regression and in model specifications 1, 3 and 5 in the OLS regression (Tables 5 and 6). Intuitively, a farmer is likely to produce fewer crops on a more distant parcels to minimize the number of commutes and maximize the use of machinery (e.g., he might prefer to produce only hay as opposed to hay and beets because of different timing of harvest and more efficient use of machinery). On the other hand, a greater plots' distance from farm household may lead to higher production diversification due to the economies of scope or cost complementarities. For example, to minimize operational costs farmers might choose a more extensive crop cultivation on the remote plots as compared to plots located closer to the farmhouse. These factors imply positive relationship between the plots' distance from the farmhouse and farm production diversification.[7] However, given that our estimates show a negative relationship between these two variables, it implies that the former factors, which cause lower production diversification, affect farmers' production decisions to a greater degree than the latter factors that stimulate production diversification.

The final set of parameters that are statistically significant in our model is that of district variables. The variables for different districts (*Kuçove*, *Skrapar*, *Elbasan*, *Gramsh*, *Librazhd*, *Peqin*, *Kurbin*, *Lezhë*, and *Mirdite*) are regional dummy covariates meant to capture any regional differences not accounted for by the other variables. The district Berat serves a counterfactual with respect to other districts. With the exception of the Gramsh and Kuçove districts, the households in other districts display a greater diversity of farm products relative to the Berat district (Tables 5 and 6). The differential production diversity between districts may result from regional structural differences such as agronomic conditions, soil quality, quality of infrastructure, or historical difference in land redistribution.

The remaining control variables are not statistically significant in our models, suggesting that they do not affect product diversification at the surveyed farms.

6. Conclusions

In this paper, we analyze land fragmentation and its implications for production diversification in rural Albania. Albania represents a particularly compelling case for studying land fragmentation as that is an outcome of land policy reform implemented in the early 1990s. The Albanian land reform caused one of the most fragmented land structures among countries of Central and Eastern Europe and the Commonwealth of Independent States, and the fragmentation persists until the present.

Our results indicate that land fragmentation is highly linked with production diversification of farm households in Albania. We find that land fragmentation correlates significantly more with diversification for households which use a larger proportion of agricultural production for self-consumption than for more market-oriented households. One

[7] We thank an anonymous reviewer for pointing this out.

could, therefore, conjecture that land fragmentation led to a more diversified food basket for self-consumption among subsistence farmers, thus increasing their nutritional security.

Whether the production diversification is costly or beneficial to farm households in Albania is a wider concept, and it is not linked only to issues covered in this paper. A diversified production structure driven by policies rather than market signals may inflict efficiency losses to farm operations due to potential suboptimal use of machinery and inability of farms to fully benefit from specialization. On the other hand, by operating fragmented and heterogeneous plots, subsistence farmers (as it is the case for many farms in Albania) may gain a more efficient supply of a diversified food basket for self-consumption which, however, may conflict with the consolidation policy. Thus, the choice whether to implement land consolidation in a given region or village needs to consider to what extent the production diversification issue is relevant to the local community; that is, whether diversification is beneficial or detrimental to farm households in a region or village.

Our findings are consistent with the argument of Sikor et al. (2009) for the need to consider a broader socio-economic context when analyzing implications of land fragmentation and consolidation policy. Land fragmentation might lead to production diversification which may help to cope with risk in an unstable economic environment during the transition period; it can also potentially provide a more diversified set of food items for subsistence needs of rural households. Indeed, our estimates indicate that the land fragmentation contributed to ensuring a higher likelihood of meeting nutrient requirements that can promote good health of the rural population in Albania. In such a situation, there might be an argument for less land consolidation policies.

Appendix A. Descriptive statistics for farms with 1–4 plots.

Variable	Description	Unit	Mean	Std. dev.	Min	Max
Dependent variable						
Simpson's index of diversification			0.62	0.22	0.00	0.89
Farm-specific explanatory variables						
Simpson's index of fragmentation			0.53	0.21	0.00	0.79
Number of products	Number of produced products (crop and livestock products)		5.39	2.11	1.00	12.00
Number of plots	Number of plots		3.01	0.99	1.00	4.00
UAA	Total area of household	ha	9.96	6.66	0.20	65.00
Irrigated area	Surface of irrigated area	ha	0.32	0.41	0.00	5.00
Livestock production share	Share of livestock production value in total production value	%	0.32	0.25	0.00	0.92
Plot distance from market	Average distance of plots from the nearest market or product collection facility	km	9.34	8.84	0.00	73.00
Plot distance from HH house	Average plot distance from the farm center (from HH house)	km	1.47	3.59	0.00	70.00
HH-specific explanatory variables						
Number of HH members	Number of household members		4.56	1.71	1.00	14.00
Age of HH head	Age of household head	years	59.01	12.16	18.00	92.00
Education of HH head	Education of household head	years	8.88	2.75	4.00	17.00
Non-agricultural income	Share of non-agricultural income in total income	%	0.06	0.17	0.00	0.98
Loan repayment	Share of total HH expenses that is used to repay the loans	%	0.09	0.99	0.00	20.00
Self-consumption share in HH agricultural production	Share of self-consumption of food in total HH agricultural production	%	0.29	0.23	0.00	1.00
Self-consumption share in HH income	Share of self-consumption of food in total HH income		0.26	0.22	0.00	1.00
(Index of land fragmentation) x (Self-consumption share in HH agricultural production)	Interaction variable		0.15	0.13	0.00	0.74
(Index of land fragmentation) x (Self-consumption share in HH income)	Interaction variable		0.14	0.12	0.00	0.74
(Index of land fragmentation) x (Number of HH members)	Interaction variable		2.47	1.35	0.00	8.75

Notes: HH: household.

Appendix B. Descriptive statistics for farms with 5–10 plots.

Variable	Description	Unit	Mean	Std. dev.	Min	Max
Dependent variable						
Simpson's index of diversification			0.75	0.13	0.00	0.89
Farm-specific explanatory variables						
Simpson's index of fragmentation			0.74	0.09	0.00	0.88
Number of products	Number of produced products (crop and livestock products)		7.22	1.89	2.00	12.00
Number of plots	Number of plots		5.75	1.19	5.00	10.00
UAA	Total area of household	ha	16.79	13.72	2.20	197.00
Irrigated area	Surface of irrigated area	ha	0.44	0.74	0.00	10.00
Livestock production share	Share of livestock production value in total production value	%	0.35	0.19	0.00	0.90
Plot distance from market	Average distance of plots from the nearest market or product collection facility	km	12.27	10.04	0.00	40.00
Plot distance from HH house	Average plot distance from the farm center (from HH house)	km	1.14	1.44	0.00	16.00
HH-specific explanatory variables						
Number of HH members	Number of household members		5.48	2.00	2.00	14.00
Age of HH head	Age of household head	years	60.26	9.69	37.00	82.00
Education of HH head	Education of household head	years	8.28	2.62	4.00	17.00
Non-agricultural income	Share of non-agricultural income in total income	%	0.05	0.13	0.00	0.86
Loan repayment	Share of total HH expenses that is used to repay the loans	%	0.00	0.00	0.00	0.00
Self-consumption share in HH agricultural production	Share of self-consumption of food in total HH agricultural production	%	0.22	0.15	0.01	0.91
Self-consumption share in HH income	Share of self-consumption of food in total HH income		0.20	0.14	0.01	0.91
(Index of land fragmentation) x (Self-consumption share in HH agricultural production)	Interaction variable		0.16	0.11	0.00	0.61
(Index of land fragmentation) x (Self-consumption share in HH income)	Interaction variable		0.15	0.10	0.00	0.61
(Index of land fragmentation) x (Number of HH members)	Interaction variable		4.10	1.65	0.00	12.25

Notes: HH: household.

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